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Bureau of Mines

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Minerals Yearbook

1982

Volume I

METALS AND MINERALS

Prepared by staff of the

BUREAU OF MINES

UNITED STATES DEPARTMENT OF THE INTERIOR • William P. Clark, Secretary

BUREAU OF MINES • Robert C. Horton, Director

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities to protect and conserve our land and water, energy and minerals, fish and wildlife, and park and recreation areas, and for the wise use of all those resources. The Department also has a major responsibility for American Indian reservation communities and for the people who live in Island Territories under U.S. administration.

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Foreword

With the 1982 Minerals Yearbook, the Federal Government begins its second century of annual reports on the mineral industries. This edition discusses the performance of the worldwide mineral industry during 1982 and provides background information to assist in interpreting developments during the year being reviewed. Content of the individual volumes follows:

Volume I, Metals and Minerals, contains chapters on virtually all metallic and nonmetallic mineral commodities important to the U.S. economy. In addition, it includes a statistical summary chapter and a chapter on mining and quarrying trends.

Volume II, Area Reports: Domestic, contains chapters on the mineral industry of each of the 50 States, the U.S. island possessions in the Pacific Ocean and the Caribbean Sea, and the Commonwealth of Puerto Rico. This volume also has a statistical summary.

Volume III, Area Reports: International, contains the latest available mineral data on more than 130 foreign countries and discusses the importance of minerals to the economies of these nations. A separate chapter reviews the international mineral industry in general and its relationship to the world economy.

The Bureau of Mines continually strives to improve the value of its publications to its users. Therefore, constructive comments and suggestions by readers of the Yearbook will be welcomed.

Robert C. Horton, *Director*

Acknowledgments

Volume I, Metals and Minerals, of the Minerals Yearbook presents data on about 90 mineral commodities that were obtained as a result of the mineral information gathering activities of the Bureau of Mines.

The collection, compilation, and analysis of domestic mineral industries data were performed by the staffs of the Divisions of Ferrous Metals, Nonferrous Metals, and Industrial Minerals of the Assistant Directorate, Minerals Information. Statistical data were compiled from information supplied by mineral producers and consumers in response to canvasses, and their voluntary response is gratefully appreciated. Information obtained from individual firms by means of Bureau of Mines canvasses has been grouped to provide statistical aggregates. Data on individual firms are presented only if available from published or other nonproprietary sources or when permission of the respondent has been granted. Other material appearing in this volume was obtained from the trade and technical press, industry contacts, and other sources, and this cooperation is gratefully acknowledged.

Statistics on world production were compiled in the Division of Foreign Data from numerous sources including reports from the Foreign Service, U.S. Department of State. U.S. foreign trade data were obtained from reports of the Bureau of the Census, U.S. Department of Commerce.

The Branch of Publication Support Services, Division of Publication, provided general guidance on the preparation and coordination of the chapters in this volume and reviewed the manuscripts to insure statistical consistency among the tables, text, and figures between this volume and other volumes, and between this edition and those of former years.

The Bureau of Mines has been assisted in collecting mine production data supporting information by numerous cooperating State agencies. These organizations are listed in the acknowledgments to Volume II.

Albert E. Schreck, *Chief, Division of Publication*

Contents

Mining and Quarrying Trends in the Metal and Nonmetal Industries

By Lawrence L. Davis[1]

This chapter includes tables for 1981 that were not available in time for publication of the 1981 Minerals Yearbook, but does not include corresponding tables for 1982.

The value of raw nonfuel minerals produced in the United States during 1982 was estimated at about $20 billion, a decrease of $5 billion compared with that of 1981. The decline in value is the first since 1971 and is the largest percentage drop since 1938. Although the domestic mining industry continued to be troubled by difficulties in attracting capital and by import competition from countries with lower overall production costs, the principal cause of the decline was sharply decreased demand brought on by the worldwide economic slowdown. Metal commodities were impacted most severely with only 4 of 21 metals registering production value gains and only 3 of 21 showing production quantity increases. Overall metal production value decreased 37% from that of 1981, a reflection of the domestic slowdown in the automobile and construction industries, which are major metal users. Overall production value of nonmetals decreased 12% compared with that of 1981, with only 14 out of 44 nonmetals showing increases. Nonmetal production quantities increased over 1981 for only 6 of the 44 nonmetals.

The nonfuel mineral industry during 1982 was characterized by sharply reduced production, mine closures, layoffs, idle capacity, implementation of cost-cutting measures, and delay of expansions and new development. Lower inflation rates during 1982 and declining interest rates gave hope by the end of the year that economic recovery was beginning and demand for minerals would increase.

Legislation and Government Programs.—On April 5, 1982, President Reagan sent to Congress a materials and minerals policy statement. Titled the "National Materials and Minerals Program Plan and Report to Congress," the report contained the administration's activities to be undertaken to implement the National Materials and Minerals Policy, Research and Development Act of 1980. Highlights of the policy statement were the intention to dispose of excess stockpiles as quickly as possible, to increase purchase of strategic metals, to remove regulatory barriers to mining strategic metals, and to explore ways to open more Federal land to exploration and development. The policy statement also called for Government-financed minerals research to focus on long-term, high-risk, high-potential-payoff projects with the best chance for wide, generic application and stated that incentives offered by the Economic Recovery and Tax Act of 1981 should stimulate shorter term minerals research and development in the private sector.

On October 2, Congress extended the Defense Production Act through March 31, 1983. Authority of the program had expired after September 30. The act, first passed in 1950, authorizes the Secretary of the Interior to certify particular strategic and critical materials as likely to be in short supply in time of war or national emergency and authorizes the President to make provisions for purchases of metals or minerals for Government use or resale and to encourage exploration, development, and mining of these minerals.

During December, Congress passed legislation designating Federal wilderness areas in five States. In Florida, seven wilderness areas totaling 49,150 acres were designated in the Apalachicola, Ocala, and Osceola National Forests. The Florida legislation included a ban on leasing in the Osceola National Forest unless the President declared a clear and present national need for the phosphate resulting from a domestic shortage and included a mechanism for compensating four companies that obtained previous rights through lease applications filed prior to 1972. The President vetoed the bill in January 1983. In the other actions, three areas in West Virginia's Monongahela National Forest (Cranberry, Laurel Fork North, and Laurel Fork South) totaling 47,800 acres; the 6,888-acre Paddy Creek area in Mark Twain National Forest in Missouri; the 6,780-acre Cheaha area in Talladega National Forest, Ala.; and 12,953 acres in Indiana were designated as wilderness areas.

On December 10, 117 nations signed the Law of the Sea Treaty. The treaty, which establishes a framework for a global authority to administer and regulate deep seabed mining, takes effect when ratified by 60 nations and will be binding only on the ratifiers. The United States refused to sign the treaty because of objections to a global authority that would limit mining production and require industrialized nations to share technology with undeveloped nations.

During 1982, a new agency, the Minerals Management Service, was created in the U.S. Department of the Interior to streamline lease-related activities and strengthen royalty-accounting functions. As a result of the realignment, the Minerals Management Service will now handle all Outer Continental Shelf leasing activities and the Bureau of Land Management will handle onshore leases other than those under the purview of the Bureau of Indian Affairs.

Exploration.—With the exception of precious metals, exploration activities were sharply reduced in 1982, reflecting the depressed state of the minerals industry. Exploration for precious metals, gold in particular, remained at relatively high levels. The discovery of high-grade polymetallic sulfide deposits off the Pacific coast has generated considerable interest, and exploration activity is expected to intensify in the future.

In technological developments, UNC Nuclear Industries introduced its Metals Analysis Probe for borehole or sample assaying of base and precious metals. The system is commercially available for silver, molybdenum, tin, antimony, uranium, lead, and tungsten at the present time. Efforts to apply the technology to gold are underway. The system uses X-ray fluorescence principles, and the basic system incorporates a 3-foot-long by 1-1/4-inch-outside-diameter probe for assaying in drill holes or a scanning gun for face or sample assaying with a microprocessor that can be interfaced with existing mine computers. A 2-inch-outside-diameter dipmeter sonde incorporating downhole digitization and multiplexed data transfer was introduced by EG&G Geometrics, Mt. Sopris Div. The device, which can be used in holes ranging in diameter from 3 to 10 inches provides 0.4-inch sampling at a logging speed of 16.4 feet per second.

In electromagnetic exploration development, Questor Surveys Ltd., announced availability of a helicopter survey system that uses a Barringer Research Ltd. INPUT EM unit adapted for use on helicopters. Data from test flights over known sulfide conductors compared favorably with results from fixed-wing surveys. Helicopter adaptation permits INPUT EM use in areas inaccessible to fixed-wing aircraft. Dighem III, a new system introduced by Dighem Ltd., is reported to be effective in identifying sulfide concentrations overlain by resistive overburden. The system employs user-selected EM frequencies between 38 and 7,200 hertz and contains one vertical coaxial and two horizontal coplanar coil-pairs. Barringer's newly introduced COTRAN system, based on the company's INPUT EM system, contains curve matching procedures that allow the pattern responses from conductive bodies to be classified in terms of conductivity-size parameters. Through narrow band filtering techniques, the COTRAN system provides a fivefold to tenfold improvement in signal-to-noise ratios and achieves deeper penetration than INPUT.

A new proton magnetometer system, called MP-3, was developed by Scintrex Ltd. Its full memory expansion option can store up to 14 hours of 2-second interval readings and features a 32-character display that offers a clear language question-and-answer sequence to the operator. EDA Instrument Inc.'s new proton precession total field magnetometer, PPM-350, is claimed to increase survey productivity by up to 50% by making diurnal variation corrections automatically in a matter of minutes instead of hours, by requiring only one reading per station, and by recording all necessary data at each station in 10 seconds.

Development.—Bored raises and shafts continued to gain in popularity as a faster, less expensive, and safer alternative to conventional drill-blast methods. The Robbins Co., the pioneer and largest producer of raise boring machines, introduced a new series of machines in 1982. The new series, designated RM, is the first complete line offering a choice of alternating current (AC), direct current (DC), or hydraulic drive for most models. The largest, the 123 RM, is capable of drilling a 14-foot-diameter raise up to 3,000 feet long.

The Hughes Tool Co.'s Micon CSD 300 shaft drill, introduced in 1981, was used by Santa Fe Shaft Drilling Co. to drill a ventilation shaft for Agnew Mining Co. in Australia. This is the first blind shaft to be drilled in Australia and measures 14 feet in diameter and will be 3,378 feet deep. A 20-foot-diameter shaft to 2,820 feet is planned after completion of the first shaft. Maximum compressive strengths of the rock exceed 50,000 pounds per square inch. The CSD 300 is the world's largest mine shaft drill and is capable of drilling a 20-foot-diameter hole to depths exceeding 3,000 feet. Small-diameter shafts can be drilled to greater depths.

A rodless shaft boring machine, operated and driven from within the shaft, set a new world shaft sinking record for footage in a single month. Thyssen Mining Construction Inc. advanced a 23-foot-diameter shaft 1,622.5 feet during October 1982 using a Wirth V Mole machine manufactured by Wirth Maschinen-und Bohrgerate-Fabrik GmbH of the Federal Republic of Germany. The Wirth V Mole was modified to use U.S. electrical components and some hydraulic parts. The shaft is one of four coal mine ventilation shafts being sunk for Jim Walter Resources Corp. in Brookwood, Ala. The technology could also be applied to nonfuel mineral development.

The Bureau of Mines instrumented and is evaluating the structural characteristics of a circular, concrete-lined shaft at Hecla Mining Co.'s Lucky Friday Mine in Idaho's Coeur d'Alene district. The 18-foot-diameter shaft is scheduled for a depth of 7,700 feet, which will make it the deepest shaft in North America. The circular, concrete-lined design is a departure from the timbered, rectangular shafts typically constructed in the Coeur d'Alene district. Strain gages, pressure cells, and extensometers were installed at the 2,400-, 4,000-, and 5,000-foot levels as the shaft sinking progressed. An additional installation is planned at the 6,000-foot level. Analysis of the data is expected to help in determining the relationship of field stress, rock properties, support loads, and deformations to shaft orientation shape, size, and support systems and to lead to improved shaft design criteria.

Underground Mining.—Vertical crater retreat stoping continued to attract attention as a viable technique for lowering costs and allowing lower grade, vein-type deposits to be mined. Following Homestake Mining Co.'s success at the Homestake gold mine in South Dakota, other mines are beginning to adopt the method and realize cost savings. Standard Metals Corp. reported a 25% savings in mining costs after vertical crater retreat stoping was instituted in part of the Silverton gold mine in Colorado. Ranchers Exploration and Development Corp. reported successful results with a modified vertical crater retreat method at the new Escalante silver mine in southwestern Utah. Vertical slices, 100 feet high by 20 feet wide by 10 feet thick, are taken and mining proceeds along strike rather than progressing upward as in usual vertical crater retreat mining. At the Carr Fork Mine in Utah, the Bureau of Mines and The Anaconda Company are cooperating in a joint research effort to develop general design criteria for optimizing stope and pillar size and maximizing resource recovery and productivity for vertical crater retreat mining. A test stope was fully instrumented and data gathered before, during, and after mining will be analyzed in an attempt to develop the design criteria. Vertical crater retreat mining was introduced in Peru during 1982 when the Monterrosas copper mine came onstream. The new method has allowed the mine to operate at low cost.

A prototype pneumatic ore lift, invented by Hardcostle & Richards Pty. Ltd., was tested successfully at Mount Isa Mines in Queensland, Australia. The innovative system uses low-pressure air as the hoisting medium and is claimed to offer a simple, inexpensive alternative in places where typical methods might not be practical.

A prototype of a compact load-haul machine to meet ore handling needs in vein mine stopes as narrow as 5 feet was designed, built, and tested on the surface by a Bureau of Mines contractor. Intended as an improved method for moving muck to the ore pass, the unit loads ore at one end and discharges off the other end, eliminating the need to turn around. The scoop not only lifts the ore on to the machine but also pushes the ore to the rear of the carrying compartment. Four passes fill the compartment, and the unit travels to the ore pass where the scoop pushes the ore off the rear. Preparations are being made for underground mine tests of the unit.

Bureau of Mines research to increase hoisting efficiency and speed and to reduce energy requirements has led to the design of experimental ore skips featuring improved riding characteristics, improved bearings at critical locations, and weight savings of about 2 tons without loss of strength. An experimental aluminum skip is undergoing field tests at Kerr-McGee Nuclear Corp.'s Church Rock Mine in New Mexico.

Surface Mining.—A significant development in surface mining is the introduction of movable in-pit crushing systems that, when coupled with belt conveyors, are expected to reduce overall ore handling and haulage costs. Duval Corp. announced that it designed and began installing a prototype crusher at its Sierrita Mine in Arizona. The system includes a 60-inch gyratory crusher, a portable apron feeder that is 172 feet long and has a pan width of 10 feet, and a portable discharge conveyor with a length of 100 to 115 feet and a belt width of 118 inches. The transporter is a diesel-powered, crawler-type unit with a speed (loaded) of 1 mile per hour on level ground and 0.5 mile per hour on a 12% grade. The system has a capacity of 4,000 tons per hour. Duval estimates that the system will be moved every 6 to 9 months and expects that moves up to one-half mile can be accomplished in a 48-hour period. The crusher will be fed by the current truck fleet, and the crushed ore will be moved out of the pit by belt conveyor. Without the system, the truck fleet would eventually double as the pit depth increases. The prototype system, exclusive of the main-line conveyors, will cost about $14 million. The company estimates portable crushers could save $8 to $10 million per year in truck haulage costs at Sierrita and other mines of similar size.

In a related development, Mountain States Mineral Enterprises, Inc., began offering movable in-pit crushing-conveying systems custom-designed around any 54- or 60-inch gyratory crusher. The system incorporates a mobile hopper-feeder, a derrick crane for servicing, a movable crusher support and housing, reclaim conveyer, movable conveyor system, portable conveyor drive units, shiftable waste conveyors, and a transporter; all are reportedly standard vendor items.

A Bureau of Mines contractor completed fabrication of a test section of a conveying system designed to handle lump ore of 60-inch maximum size at capacities up to 5,900 tons per hour. Tests will be conducted in 1983. The Bureau of Mines also completed an evaluation of high angle conveyor system concepts for use in open pits in conjunction with movable in-pit crushers. A sandwich-type belt was determined to be the most promising concept. Following the Bureau of Mines study, Continental Conveyor and Equipment Co. designed and constructed a full-scale prototype of a high angle conveyor capable of conveying 3,000 tons per hour at angles up to 60° on a 60-inch belt.

Trucks are presently the predominant means of haulage in surface mines and will probably continue to be for many years especially in existing mines that were designed for truck haulage and have fleets in operation. Alternative haulage techniques, such as conveyor systems, are more likely to be installed in new or expanding mines. The trend in recent years toward larger and larger truck capacities seem to have slowed, if not stopped. Emphasis now is on cost, reliability, ease of maintenance, and more efficient utilization as mine operators search for ways to reduce costs. More mines are looking at computer-based truck dispatching to improve haulage efficiency. About 10 systems, ranging from semimanual to fully computer controlled are installed worldwide, and at least seven vendors are marketing, or are planning to offer, such systems. Trolley-assist for uphill hauls and regeneration of electricity during descents are other ideas being considered by some mines. Palabora Mining Co. Ltd. estimates that trolley-assist, installed in its open pit mine in the Republic of South Africa during 1981, reduced fuel consumption in 1982 by 22%.

Hydraulic excavators continue to gain in popularity. Marion Power Shovel Div. of Dresser Industries Inc. reported that the success of its Marion 3560, with a 20-cubic-yard bucket, has convinced the company to enter the market for larger hydraulic excavators, a market currently dominated by foreign manufacturers. Bucyrus-Erie Co. introduced its 550-HS, a 10-cubic-yard hydraulic shovel that is reported to have greater fuel efficiency, digging ability, and reliability.

A static AC motor drive system is now being offered by Bucyrus-Erie on its electric shovels and draglines. The system, called Acutrol, provides variable-speed control to the main motion drives and uses squirrel-cage induction motors to power each main motion. Advantages cited are greater speeds in all motions over a wider range of torque, faster cycling time, reduced maintenance requirements, and superior performance over conventional DC motor drives. The company expects AC motor drives to become, in the next few years, the predominant drive system in excavators.

New blasthole drill rigs introduced in 1982 include the D80K by Driltech Inc. The D80K is reported to be the largest truck-mounted production drill in the world. It weighs 60 tons and drills blastholes up to 12-1/4 inches in diameter. Advantages claimed are high mobility, easy maintenance, and setup time of about 5 minutes. Tamrock Corp. introduced a new blasthole drill rig called Herbert. Equipped with a hydraulic percussive rock drill, the rig is claimed to drill 7- to 9-inch holes at penetration rates two to four times faster than rotary drills. A mechanized pipe handler eliminates normal handling of drill pipes to a depth of 95 feet.

Tround International Inc. has tested a new drilling concept that generates fractures in hard rock ahead of the drill bit. A projectile pod mounted in the center of the bit-rod assembly fires small (0.245-inch-diameter by 1.5-inch-long) ceramic bullets at 4,500 feet per second at microsecond intervals through three discharge barrels. The resulting fractures enable faster penetration and increased bit life. The system senses when hard rock is encountered, fires enough bullets to shatter the rock, and automatically stops firing when softer rock is entered. In premining tests at a granite quarry, the Tround-assisted system achieved a 12-foot-per-hour penetration rate while drilling with a 9-7/8-inch tricone bit at 50 revolutions per minute and 27,000 pounds of pull-down pressure. The same equipment at the same rotation speed and pull-down pressure drilling without the Tround-assist achieved only 4 feet per hour. At higher speed (100 revolutions per minute), the conventional rotary drilling rate did not exceed 7 feet per hour.

In Situ Mining.—Noranda Lakeshore Mines, Inc., announced plans to begin leaching in 1983 at the Lakeshore copper mine 30 miles southwest of Casa Grande, Ariz. Leaching is planned on a mined-out level of the underground oxide ore body, where a substantial amount of low-grade (less than 0.7% copper) ore was left behind after conventional mining. Initially, leaching solution will be fed to the ore body through 25 injection holes drilled from the surface. The number of injection holes is expected to increase gradually to 60. The pregnant solutions will be collected in storage ponds underground and then pumped to a holding tank on the surface.

At its in situ uranium leaching pilot project near Crownpoint, N. Mex., Mobil Research and Development Corp. is testing the use of sodium sulfide and sodium erythorbate for restoring ground water quality after leaching with sodium bicarbonate. It is hoped that the chemicals will accelerate and improve aquifer restoration.

The Bureau of Mines developed and tested an improved system for leak-testing in in situ leaching wells. The system includes packers designed especially for use in the fiberglass or plastic casing used for in situ leaching. Wells are tested by sealing them with packers, pressurizing, and measuring the pressure drop. Previously available packers were designed for steel-cased wells, were cumbersome and expensive, and often leaked when used in in situ leaching wells.

A Bureau of Mines contractor found that accumulations of microorganisms can contribute to the plugging of in situ leaching wells. Analysis of samples collected from uranium in situ leaching operations revealed that four microorganisms that are common in soils thrived in the lixiviant during leaching. By collecting and multiplying in pores of fine-grained ore or on well screens, the microorganisms could cause an order-of-magnitude drop in permeability. Preliminary laboratory tests indicated that addition of hydrogen peroxide to the leach solution might effectively inhibit microorganism growth.

Interest in using in situ leaching to recover manganese continues. The Bureau of Mines is conducting column leaching experiments using aqueous SO_2 on samples from a variety of domestic deposits. At least two operators in Arizona and one in Colorado were conducting pilot-scale or laboratory tests to evaluate manganese leaching possibilities.

FMC Corp. reports that experiments with a proprietary process for solution mining of trona near Green River, Wyo., have been successful, and they are ready to begin commercial operation as soon as permits are approved. The company is hoping to cut production costs by 25% compared with conventional underground mining. Cost savings come from reduced personnel and elimination of costs associated with shaft sinking and underground construction. Full-scale production is expected to be 1 million tons per year of soda ash.

Beneficiation.—A major technologic trend in beneficiation is toward larger capacity equipment, particularly grinding mills and flotation cells where economies of scale are being realized with larger units. AS Sydvaranger of Norway recently installed a 1,100-short-ton-per-hour wet-process ball mill at its iron ore plant in Kirkenes, Norway. The 21-foot-diameter mill is driven at 13.1 revolutions per minute by a 10,860-horsepower gearless ring motor. Although gearless motor drives have been used in the cement industry, this is the first application in iron ore grinding, and the installation is the world's largest gearless ore grinder. With mill sizes climbing beyond ring and pinion gear capabilities, the success of the gearless drive mill at Kirkenes could lead to adoption of the technology throughout the world.

With the mining of lower grade ores putting increased tonnage requirements on concentrators, the industry is moving toward larger flotation machines. The first 1,000-cubic-foot machine went into production in 1979, and with the numerous installations that have followed, the trend toward the use of larger machines is well established. The large cells have been shown to give equivalent or better performance compared with smaller cells, and operating control is simplified, power and maintenance requirements are reduced, and less floor space is required.

At the Magmont mill in Bixby, Mo., the addition of a zinc regrind circuit has resulted in the upgrading of zinc concentrates to a level acceptable for feed to an electrolytic zinc refinery. Prior to the installation, zinc concentrates contained too high a magnesia content. Additional benefits were a 4% increase in zinc grade and a more uniform concentrate quality.

The Bureau of Mines agglomeration pretreatment to enhance heap leaching of clayey precious metals continued to gain acceptance. The technique is now in use at 30 commercial operations and allows recovery of gold and silver from ores that otherwise could not be processed.

The Bureau of Mines developed a method for recovering phosphate from a wide variety of complex western phosphate materials such as low-grade ores, tailings, and unused fines. Use of the method can extend the life of western phosphate reserves. The method uses flotation techniques that include depression of phosphate minerals and anionic flotation of carbonate minerals, followed by cationic flotation of silicate minerals. Pilot plant tests at J. R. Simplot Co.'s facility at Conda, Idaho, convinced the company to build its own unit based on the Bureau's design. Projected benefits are a 13% increase in the amount of phosphate recovered from each ton of ore. The increased recovery rate will allow the company to reduce its mine production by 16% without reducing its phosphate output.

The Bureau of Mines is also investigating single fatty-acid flotation techniques for recovery of phosphate minerals from high-magnesia and calcite-bearing resources that are bypassed in current mining operations and is studying flotation and hydrometallurgical methods for the recovery of cobalt and nickel from Missouri lead ores.

Health and Safety.—Preliminary injury statistics compiled by the Mine Safety and Health Administration showed a nonfatal injury rate of 4.46 per 200,000 employee-hours in metal and nonmetal mines, a decrease from the 5.72 rate in 1981. The fatal injury rate was 0.03, unchanged from that of 1981.

The Bureau of Mines developed and tested automatic fire protection systems for underground fueling areas. Optical fire sensors automatically activate alarms and release dry chemical and aqueous film-forming fluid fire suppressants. The systems were successfully tested at an underground refueling station in a tungsten mine in California and an underground fuel storage and transfer area in a lead-zinc-silver mine in Missouri. The Bureau also investigated various industrial odorants to determine their application as stench gases to warn miners of an underground fire. A 10-to-1 mixture of Freon 113 and thiopane was found to be superior to the Freon and ethyl mercaptan presently used. Reported advantages of thiopane are that the odor does not fade over long distances, the odor does not build up to unbearable levels, and the thiopane is less toxic and corrosive than ethyl mercaptan. Tests at a uranium mine in New Mexico showed substantial improvement in warning time and no complaints of excessive odor intensity.

In dust control research, the Bureau of Mines determined that water flow rates between 0.25 and 0.5 gallon per minute are effective for controlling dust produced by cutting machines used in water-soluble ores and that a through-the-drill-steel water and foam injection technique, tested in a gypsum mine and a salt mine, reduced by up to 95% the dust generated by blasthole face drills. A lightweight portable device for nondestructive testing of the integrity of resin-grouted roof bolt bonding was designed and tested by the Bureau of Mines. The device transmits an energy pulse into the bolt and measures reflected energy. The amount of reflected energy indicates the amount of bolt surface that is unbonded, and the ratio of initial energy to reflected energy correlates with bond integrity.

The Bureau of Mines announced development of a radio communication system that takes advantage of existing wiring, such as telephone lines or electric power cables, in underground mines. The existing wiring distributes radio signals throughout the mine, making communications possible between roving miners, vehicle operators, dispatchers, and other personnel.

[1]Geologist, Division of Conservation and Development.

Table 1.—Material handled at surface and underground mines in the United States, by type

(Million short tons)

Type and year	Surface			Underground			All mines[1]		
	Crude ore	Waste	Total[1]	Crude ore	Waste	Total[1]	Crude ore	Waste	Total
Metals:									
1977	490	1,030	1,530	74	12	87	564	1,050	1,610
1978	554	995	1,550	74	21	95	628	1,020	1,640
1979	580	1,350	1,930	93	10	103	673	1,360	2,030
1980	520	1,180	1,700	77	11	88	597	1,190	1,790
1981	592	1,050	1,650	82	15	97	674	1,070	1,740
Nonmetals:									
1977	2,120	472	2,590	80	6	86	2,200	478	2,680
1978	2,320	571	2,890	87	1	88	2,410	572	2,980
1979	2,360	590	2,950	81	([2])	81	2,440	590	3,040
1980	2,060	620	2,680	78	([2])	78	2,140	620	2,760
1981[3]	1,150	584	1,740	68	6	74	1,220	590	1,820
Total metals and nonmetals:[1]									
1977	2,610	1,510	4,120	155	18	173	2,760	1,520	4,290
1978	2,870	1,570	4,440	161	22	183	3,030	1,590	4,620
1979	2,940	1,940	4,880	174	10	185	3,120	1,950	5,070
1980	2,580	1,800	4,380	155	11	167	2,730	1,810	4,540
1981	1,750	1,640	3,390	151	20	171	1,900	1,660	3,560

[1]Data may not add to totals shown because of independent rounding.
[2]Less than 1/2 unit.
[3]Includes industrial sand and gravel. Construction sand and gravel was not available for 1981 because of biennial canvassing.

Table 2.—Material handled at surface and underground mines in the United States in 1981, by commodity[1]

(Thousand short tons)

Commodity	Surface			Underground			All mines[2]		
	Crude ore	Waste	Total[2]	Crude ore	Waste	Total[2]	Crude ore	Waste	Total
METALS									
Bauxite	2,990	18,400	21,300	--	--	--	2,990	18,400	21,300
Copper	273,000	657,000	930,000	32,600	3,670	36,300	305,000	661,000	966,000
Gold:									
Lode	8,460	26,200	34,600	2,410	643	3,050	10,900	26,800	37,700
Placer	5,520	2,810	8,330	49	10	58	5,570	2,820	8,390
Iron ore	251,000	162,000	413,000	W	W	W	251,000	162,000	413,000
Lead	--	--	--	9,650	2,230	11,900	9,650	2,230	11,900
Silver	3,570	10,600	14,100	1,970	2,260	4,230	5,530	12,800	18,400
Titanium and ilmenite	23,200	W	23,200	--	--	--	23,200	W	23,200
Tungsten	2	W	2	895	607	1,500	897	607	1,500
Uranium	9,530	128,000	137,000	5,130	1,890	7,020	14,700	130,000	144,000
Zinc	--	--	--	7,100	840	7,940	7,100	840	7,940
Other[3]	15,000	45,000	60,000	22,400	2,550	25,000	37,500	47,500	85,000
Total metals[2]	592,000	1,050,000	1,650,000	82,200	14,700	97,000	674,000	1,070,000	1,740,000
NONMETALS									
Abrasives[4]	400	W	400	W	W	W	400	W	400
Asbestos	1,910	W	1,910	W	--	W	1,910	W	1,910
Barite	5,260	8,120	13,400	--	--	--	5,260	8,120	13,400
Clays[e]	40,400	[e]35,000	75,400	545	[e]8	552	41,000	[e]35,000	76,000
Diatomite	765	338	1,100	--	--	--	765	338	1,100
Feldspar	1,830	4,500	6,330	--	--	--	1,830	4,500	6,330
Fluorspar	W	W	W	401	40	441	401	40	441
Gypsum	10,000	4,120	14,200	2,300	--	2,300	12,300	4,120	16,400
Mica (scrap)	351	64	415	--	--	--	351	64	415
Perlite	727	400	1,130	--	--	--	727	400	1,130
Phosphate rock	203,000	459,000	662,000	W	W	W	203,000	459,000	662,000
Potassium salts	--	--	--	20,400	187	20,600	20,400	187	20,600
Pumice[5]	511	36	547	--	--	--	511	36	547

Salt	1,340	--	1,340	8,950	--	8,950	10,300	--	10,300
Sand and gravel[6]	30,000	--	30,000	--	--	--	30,000	--	30,000
Sodium carbonate (natural)	--	--	--	10,200	W	10,200	10,200	W	10,200
Stone:									
Crushed and broken	846,000	e67,400	913,000	24,800	e172	25,000	870,000	e67,500	938,000
Dimension	4,090	e1,540	5,630	25	e(7)	25	4,120	e1,540	5,650
Talc, soapstone, pyrophyllite	979	167	1,150	370	(7)	370	1,350	167	1,520
Other[8]	2,540	4,540	7,100	430	5,120	5,550	2,970	9,660	12,600
Total nonmetals[2]	1,150,000	584,000	1,740,000	68,400	5,530	73,900	1,220,000	590,000	1,820,000
Grand total[2]	1,750,000	1,640,000	3,390,000	151,000	20,300	171,000	1,900,000	1,660,000	3,560,000

[e]Estimated. W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Excludes material from wells, ponds, or pumping operations.
[2]Data may not add to totals shown because of independent rounding.
[3]Includes antimony, beryllium, manganiferous ore, mercury, molybdenum, nickel, platinum, rare-earth metals, tin, vanadium, and metal items indicated by symbol "W."
[4]Includes abrasive stone, emery, garnet, and tripoli.
[5]Excludes volcanic cinder and scoria.
[6]Includes industrial sand and gravel. Construction sand and gravel was not available for 1981 because of biennial canvassing.
[7]Less than 1/2 unit.
[8]Includes aplite, boron minerals, greensand marl, iron oxide pigments (crude), kyanite, lithium minerals, magnesite, olivine, tube-mill liners, vermiculite, wollastonite, and nonmetal items indicated by symbol W.

Table 3.—Material handled at surface and underground mines (including industrial sand and gravel and stone) in the United States in 1981, by State[1]

(Thousand short tons)

State	Surface			Underground			All mines[2]		
	Crude ore	Waste	Total[2]	Crude ore	Waste	Total[2]	Crude ore	Waste	Total
Alabama	23,600	5,210	28,800	9	(³)	9	23,600	5,210	28,800
Alaska	10,700	2,570	13,300	W	W	W	10,700	2,570	13,300
Arizona	198,000	343,000	541,000	24,800	2,850	27,600	222,000	346,000	568,000
Arkansas	17,400	17,000	34,500	W	W	W	17,400	17,000	34,500
California	49,500	32,300	81,800	1,450	256	1,700	51,000	32,500	83,500
Colorado	13,800	48,400	62,200	21,800	797	22,600	35,700	49,200	84,800
Connecticut	7,630	696	8,320	--	--	--	7,630	696	8,320
Florida	264,000	321,000	585,000	--	--	--	264,000	321,000	585,000
Georgia	45,100	13,800	58,900	W	W	W	45,100	13,800	58,900
Hawaii	5,710	469	6,170	--	--	--	5,710	469	6,170
Idaho	10,100	53,300	63,400	1,780	803	2,580	11,900	54,100	66,000
Illinois	47,900	3,750	51,700	2,130	51	2,180	50,100	3,800	53,900
Indiana	26,400	2,620	29,000	1,100	1	1,100	27,500	2,620	30,100
Iowa	22,100	2,550	24,700	2,200	13	2,210	24,300	2,570	26,900
Kansas	13,900	1,470	15,400	2,170	10	2,180	16,100	1,480	17,600
Kentucky	26,000	2,630	28,600	7,110	51	7,160	33,100	2,690	35,800
Louisiana	10,100	996	11,100	3,540	--	3,540	13,600	996	14,600
Maine	1,430	162	1,600	--	--	--	1,430	162	1,600
Maryland	17,100	1,800	18,900	W	W	W	17,100	1,800	18,900
Massachusetts	8,450	939	9,390	--	--	--	8,450	939	9,390
Michigan	87,600	52,500	140,000	W	--	W	87,600	52,500	140,000
Minnesota	192,000	68,900	261,000	--	--	--	192,000	68,900	261,000
Mississippi	3,540	1,250	4,790	--	--	--	3,540	1,250	4,790
Missouri	42,600	4,000	46,600	12,900	3,980	16,900	55,600	7,980	63,500
Montana	19,800	1,100	20,900	1,100	905	2,000	20,900	2,000	22,900
Nebraska	3,090	296	3,390	W	W	W	3,090	296	3,390
Nevada	19,100	40,900	60,000	589	921	1,510	19,700	41,800	61,500
New Hampshire	875	170	1,050	--	--	--	875	170	1,050
New Jersey	20,100	911	21,000	W	--	W	20,100	911	21,000
New Mexico	32,700	188,000	220,000	24,300	1,540	25,800	57,000	189,000	246,000
New York	32,400	3,010	35,400	2,600	130	2,730	35,000	3,130	38,200
North Carolina	43,600	103,000	146,000	--	--	--	43,600	103,000	146,000
North Dakota	W	W	W	--	--	--	W	W	W
Ohio	40,200	4,500	44,700	3,700	8	3,700	43,900	4,510	48,400
Oklahoma	33,400	2,830	36,200	W	W	W	33,400	2,830	36,200
Oregon	19,900	3,450	23,300	W	W	W	19,900	3,450	23,300
Pennsylvania	53,200	5,370	58,600	2,950	52	3,000	56,200	5,420	61,600
Rhode Island	156	12	168	--	--	--	156	12	168

South Carolina	17,900	3,380	21,300	--	--	--	17,900	3,380	21,300
South Dakota	3,280	428	3,710	W	W	W	3,280	428	3,710
Tennessee	35,000	8,500	43,500	9,470	886	10,400	44,500	9,390	53,900
Texas	89,000	23,700	113,000	W	--	W	89,000	23,700	113,000
Utah	43,900	135,000	179,000	2,380	1,160	3,550	46,300	136,000	182,000
Vermont	3,640	1,210	4,840	236	--	236	3,870	1,210	5,080
Virginia	37,300	3,420	40,800	1,390	5	1,390	38,700	3,430	42,200
Washington	11,000	4,500	15,500	52	17	69	11,100	4,510	15,600
West Virginia	7,900	942	8,840	W	W	W	7,900	942	8,840
Wisconsin	18,900	7,660	26,600	W	W	W	18,900	7,660	26,600
Wyoming	15,600	116,000	132,000	10,700	5,120	15,800	26,300	121,000	147,000
Undistributed	3,360	350	3,710	10,500	744	11,200	13,900	1,100	15,000
Total[2] [4]	1,750,000	1,640,000	3,390,000	151,000	20,300	171,000	1,900,000	1,660,000	3,560,000

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Excludes material from wells, ponds, or pumping operations.
[2]Data may not add to totals shown because of independent rounding.
[3]Less than 1/2 unit.
[4]Includes estimated data in table 2.

Table 4.—Value of principal mineral products and byproducts of surface and underground ores mined in the United States in 1981

(Value per ton)

Ore	Surface			Underground			All mines		
	Principal mineral product	By-product	Total	Principal mineral product	By-product	Total	Principal mineral product	By-product	Total
METALS									
Bauxite	$9.84	$3.09	$12.93	--	--	--	$9.84	$3.09	$12.93
Copper	8.89	1.96	10.85	$13.36	$3.80	$17.16	9.37	2.16	11.53
Gold:									
Lode	29.04	.86	29.90	68.98	11.21	80.19	38.50	3.31	41.81
Placer	2.39	--	2.39	W	--	W	2.39	--	2.39
Iron ore	11.30	W	11.30	W	W	W	11.30	W	11.30
Lead	--	--	--	32.94	17.21	50.15	32.94	17.21	50.15
Silver	12.58	4.96	17.54	88.44	14.56	103.00	40.44	8.48	48.92
Titanium and ilmenite	2.54	1.39	3.93	--	--	--	2.54	1.39	3.93
Tungsten	73.59	--	73.59	50.66	2.30	52.96	50.71	2.30	53.01
Uranium	31.05	--	31.05	86.89	7.51	94.40	45.65	1.97	47.62
Zinc	--	--	--	30.86	2.41	33.27	30.86	2.41	33.27
Average[1]	11.15	1.02	12.17	26.40	4.94	31.34	13.03	1.51	14.54
NONMETALS									
Asbestos	39.81	--	39.81	W	--	W	39.81	--	39.81
Barite	19.10	W	19.10	--	--	--	19.10	W	19.10
Clays	23.88	--	23.88	5.89	--	5.89	23.64	--	23.64
Diatomite	81.03	--	81.03	--	--	--	81.03	--	81.03
Feldspar	11.20	5.60	16.80	--	--	--	11.20	5.60	16.80
Fluorspar	W	--	W	43.26	10.73	53.99	43.26	10.73	53.99
Gypsum	7.73	--	7.73	7.60	--	7.60	7.71	--	7.71
Mica (scrap)	19.59	--	19.59	--	--	--	19.59	--	19.59
Perlite	14.25	--	14.25	--	--	--	14.25	--	14.25
Phosphate rock	6.87	.07	6.94	W	--	W	6.87	.07	6.94
Potassium salts	--	--	--	13.04	--	13.04	13.04	--	13.04
Pumice	4.40	--	4.40	--	--	--	4.40	--	4.40

Salt	20.37	18.72	39.09	12.94	.68	13.62	13.74	2.62	16.36
Sand and gravel[2]	10.93	--	10.93	--	--	--	10.93	--	10.93
Sodium carbonate (natural)	--	--	--	58.99	--	58.99	58.99	--	58.99
Stone:									
Crushed and broken	3.53	.02	3.55	4.65	--	4.65	3.56	.02	3.58
Dimension	35.04	1.33	36.37	W	W	W	35.04	1.33	36.37
Talc, soapstone, pyrophyllite	22.23	1.97	24.10	18.55	--	18.55	21.26	1.38	22.64
Average[1]	5.79	.07	5.86	16.73	.25	16.98	6.42	.08	6.50
Average, metals and nonmetals[1]	7.60	.39	7.99	21.98	2.79	24.77	8.76	.58	9.34
Average, nonmetals (excluding stone and sand and gravel)[1]	11.67	.19	11.86	23.27	.39	23.66	13.28	.21	13.50
Average, metals and nonmetals (excluding stone and sand and gravel)[1]	11.31	.75	12.07	25.30	3.33	28.63	13.11	1.08	14.20

W Withheld to avoid disclosing company proprietary data.
[1]Includes unpublished data.
[2]Includes industrial sand and gravel. Construction sand and gravel was not available for 1981 because of biennial canvassing.

Table 5.—Crude ore and total material handled at surface and underground mines in the United States in 1981, by commodity

(Percent)

Commodity	Crude ore		Total material	
	Surface	Underground	Surface	Underground
METALS				
Antimony	--	100.0	--	100.0
Bauxite	100.0	--	100.0	--
Beryllium	100.0	--	100.0	--
Copper	89.3	10.7	96.2	3.8
Gold:				
Lode	77.9	22.1	91.9	8.9
Placer	99.1	.9	99.3	.7
Iron ore	99.3	.7	99.1	.9
Lead	--	100.0	--	100.0
Manganiferous ore	100.0	--	100.0	--
Mercury	100.0	--	100.0	--
Molybdenum	30.8	69.2	71.6	28.4
Nickel	100.0	--	100.0	--
Platinum	100.0	--	100.0	--
Rare-earth metals	100.0	--	100.0	--
Silver	64.5	35.5	77.0	23.0
Titanium and ilmenite	100.0	--	100.0	--
Tungsten	.2	99.8	.5	99.5
Uranium	65.0	35.0	95.1	4.9
Vanadium	100.0	--	100.0	--
Zinc	--	100.0	--	100.0
Average	87.8	12.2	94.5	5.5
NONMETALS				
Abrasives	[1]100.0	W	[1]100.0	W
Aplite	100.0	--	100.0	--
Asbestos	[1]100.0	W	[1]100.0	W
Barite	100.0	--	100.0	--
Boron minerals	100.0	--	100.0	--
Clays	98.7	1.3	99.3	.7
Diatomite	100.0	--	100.0	--
Feldspar	100.0	--	100.0	--
Fluorspar	W	[2]100.0	W	[2]100.0
Gypsum	81.4	18.6	86.0	14.0
Iron oxide pigments (crude)	100.0	--	100.0	--
Kyanite	100.0	--	100.0	--
Lithium minerals	100.0	--	100.0	--
Magnesite	100.0	--	100.0	--
Mica (scrap)	100.0	--	100.0	--
Millstones	100.0	--	100.0	--
Olivine	100.0	--	100.0	--
Perlite	100.0	--	100.0	--
Phosphate rock	[1]100.0	W	[1]100.0	W
Potassium salts	--	100.0	--	100.0
Pumice	100.0	--	100.0	--
Salt	13.0	87.0	13.0	87.0
Sand and gravel	100.0	--	100.0	--
Sodium carbonate (natural)	--	100.0	--	100.0
Stone:				
Crushed and broken	97.1	2.9	97.3	2.7
Dimension	99.4	.6	99.5	.5
Talc, soapstone, pyrophyllite	72.6	27.4	75.6	24.4
Vermiculite	100.0	--	100.0	--
Average	94.5	5.5	96.0	4.0
Average, metals and nonmetals	92.1	7.9	95.2	4.8

W Withheld to avoid disclosing company proprietary data; included with "Surface" or "Underground."
[1]Includes underground; the Bureau of Mines is not at liberty to publish separately.
[2]Includes surface; the Bureau of Mines is not at liberty to publish separately.

Table 6.—Crude ore and total material handled at surface and underground mines in the United States in 1981, by State

(Percent)

State	Crude ore		Total material	
	Surface	Underground	Surface	Underground
Alabama	100.0	--	100.0	--
Alaska	100.0	--	100.0	--
Arizona	88.8	11.2	95.1	4.9
Arkansas	[1]100.0	W	[1]100.0	W
California	97.2	2.8	98.0	2.0
Colorado	38.8	61.2	73.3	26.7
Connecticut	100.0	--	100.0	--
Florida	100.0	--	100.0	--
Georgia	97.9	2.1	98.4	1.6
Hawaii	100.0	--	100.0	--
Idaho	85.1	14.9	96.1	3.9
Illinois	97.0	3.0	97.1	2.9
Indiana	96.0	4.0	96.3	3.7
Iowa	91.0	9.0	91.8	8.2
Kansas	86.5	13.5	87.6	12.4
Kentucky	78.5	21.5	80.0	20.0
Louisiana	74.0	26.0	75.8	24.2
Maine	100.0	--	100.0	--
Maryland	[1]100.0	W	[1]100.0	W
Massachusetts	100.0	--	100.0	--
Michigan	[1]100.0	W	[1]100.0	W
Minnesota	100.0	--	100.0	--
Mississippi	100.0	--	100.0	--
Missouri	76.7	23.3	73.4	26.6
Montana	94.8	5.2	91.3	8.7
Nebraska	[1]100.0	W	[1]100.0	W
Nevada	97.0	3.0	97.5	2.5
New Hampshire	100.0	--	100.0	--
New Jersey	[1]100.0	W	[1]100.0	W
New Mexico	57.3	42.7	89.5	10.5
New York	92.6	7.4	92.9	7.1
North Carolina	100.0	--	100.0	--
North Dakota	100.0	--	100.0	--
Ohio	91.6	8.4	92.3	7.7
Oklahoma	[1]100.0	W	[1]100.0	W
Oregon	[1]100.0	W	[1]100.0	W
Pennsylvania	94.8	5.2	95.1	4.9
Rhode Island	100.0	--	100.0	--
South Carolina	100.0	--	100.0	--
South Dakota	[1]100.0	W	[1]100.0	W
Tennessee	78.7	21.3	80.8	19.2
Texas	[1]100.0	W	[1]100.0	W
Utah	94.8	5.2	98.1	1.9
Vermont	93.9	6.1	95.3	4.7
Virginia	96.4	3.6	96.7	3.3
Washington	99.5	.5	99.6	.4
West Virginia	[1]100.0	W	[1]100.0	W
Wisconsin	[1]100.0	W	[1]100.0	W
Wyoming	59.4	40.6	89.3	10.7
Average	92.1	7.9	95.2	4.8

W Withheld to avoid disclosing company proprietary data; included with "Surface."
[1]Includes underground; the Bureau of Mines is not at liberty to publish separately.

Table 7.—Number of domestic metal and nonmetal mines in the United States in 1981, by commodity[1]

Commodity	Total number of mines	Less than 1,000 tons	1,000 to 10,000 tons	10,000 to 100,000 tons	100,000 to 1,000,000 tons	1,000,000 to 10,000,000 tons	More than 10,000,000 tons
METALS							
Bauxite	10	--	1	3	6	--	--
Copper	44	1	3	8	2	19	11
Gold:							
Lode	107	56	19	14	15	3	--
Placer	36	6	7	14	8	1	--
Iron ore	31	--	4	5	4	11	7
Lead	29	8	7	4	7	3	--
Platinum	1	--	--	--	1	--	--
Silver	75	38	16	11	9	1	--
Titanium and ilmenite	5	--	--	--	2	3	--
Tungsten	29	22	4	--	3	--	--
Uranium	195	23	60	72	38	2	--
Zinc	17	1	--	3	12	1	--
Other[2]	17	3	3	2	5	3	1
Total	596	158	124	136	112	47	19
NONMETALS							
Abrasives[3]	13	2	5	4	2	--	--
Asbestos	4	1	--	2	--	1	--
Barite	34	--	5	15	14	--	--
Clays	1,054	49	274	625	106	--	--
Diatomite	10	--	2	6	2	--	--
Feldspar	15	1	--	5	9	--	--
Fluorspar	5	--	2	--	2	1	--
Gypsum	72	1	6	25	40	--	--
Mica (scrap)	13	2	4	6	1	--	--
Perlite	14	1	3	7	3	--	--
Phosphate rock	43	--	4	2	12	16	9
Potassium salts	7	--	--	--	--	7	--
Pumice	23	5	9	8	1	--	--
Salt	18	--	2	4	8	4	--
Sand and gravel[4]	141	2	9	53	74	3	--
Sodium carbonate	4	--	--	--	--	4	--
Stone:							
Crushed and broken	3,781	90	423	1,569	1,554	145	--
Dimension	327	82	157	82	6	--	--
Talc, soapstone, pyrophyllite	41	5	11	20	5	--	--
Other[5]	32	7	6	10	7	2	--
Total	5,651	248	922	2,443	1,846	183	9
Grand total	6,247	406	1,046	2,579	1,958	230	28

[1]Excludes wells, ponds, or pumping operations.
[2]Antimony, beryllium, manganiferous ore, mercury, molybdenum, nickel, rare-earth metals, and vanadium.
[3]Abrasive stone, emery, garnet, and tripoli.
[4]Includes industrial sand and gravel. Construction sand and gravel was not available for 1981 because of biennial canvassing.
[5]Aplite, boron minerals, greensand marl, iron oxide pigments (crude), kyanite, lithium, magnesite, olivine, tube-mill liners, vermiculite, and wollastonite.

Table 8.—Twenty-five leading metal and nonmetal[1] mines in the United States in 1981, in order of output of crude ore

Mine	State	Operator	Commodity	Mining method
METALS				
Minntac	Minnesota	United States Steel Corp	Iron ore	Open pit.
Utah Copper	Utah	Kennecott Minerals Co	Copper	Do.
Sierrita	Arizona	Duval Sierrita Corp	do	Do.
Morenci	do	Phelps Dodge Corp	do	Do.
Peter Mitchell	Minnesota	Reserve Mining Co	Iron ore	Do.
Hibbing Taconite	do	Pickands Mather & Co	do	Do.
Erie Commercial	do	do	do	Do.
Empire	Michigan	Empire Iron Mining	do	Do.
San Manuel	Arizona	Magma Copper Co	Copper	Caving.
Tilden	Michigan	Tilden Mining Co	Iron ore	Open pit.
Pinto Valley	Arizona	Cities Service Co	Copper	Do.
Thunderbird	Minnesota	Oglebay Norton Co	Iron ore	Do.
Climax	Colorado	Climax Molybdenum Co., a division of AMAX Inc.	Molybdenum	Caving and open pit.
Berkeley Pit	Montana	The Anaconda Company	Copper	Open pit.
Tyrone	New Mexico	Phelps Dodge Corp	do	Do.
Ray Pit	Arizona	Kennecott Minerals Co	do	Do.
Bagdad	do	Cyprus Bagdad Copper Co	do	Do.
Twin Butte	do	Anamax Mining Co	do	Do.
Pima	do	Cyprus Pima Mining Co	do	Do.
Henderson	Colorado	Climax Molybdenum Co., a division of AMAX Inc.	Molybdenum	Caving.
New Cornelia	Arizona	Phelps Dodge Corp	Copper	Open pit.
Green Cove	Florida	Associated Minerals Corp	Titanium	Dredging.
National Pellet Project	Minnesota	Hanna Mining Co	Iron ore	Open pit.
Eisenhower	Arizona	ASARCO Incorporated	Copper	Do.
Minorca	Minnesota	Inland Steel Mining Co	Iron ore	Do.
NONMETALS				
Noralyn	Florida	International Minerals & Chemical Corp.	Phosphate rock.	Open pit.
Suwannee	do	Occidental Petroleum Corp	do	Do.
Swift Creek	do	do	do	Do.
Ft. Meade	do	Mobil Oil Corp	do	Do.
Kingsford	do	International Minerals & Chemical Corp.	do	Do.
Ft. Green	do	Williams Co	do	Do.
Clear Spring	do	International Minerals & Chemical Corp.	do	Do.
Hookers	do	W. R. Grace & Co	do	Do.
Haynsworth	do	American Cyanamid Co	do	Do.
Payne Creek	do	Williams Co	do	Do.
Lee Creek	North Carolina	Texasgulf Inc	do	Do.
Feld	Texas	Texas Crushed Stone Co	Stone	Open quarry.
Lonesome	Florida	American Cyanamid Co	Phosphate rock.	Open pit.
Rockland	do	United States Steel Corp	do	Do.
Big Four	do	Amax Phosphate, Inc	do	Do.
Thornton	Illinois	General Dynamics Corp	Stone	Open quarry.
Calcite	Michigan	United States Steel Corp	do	Do.
Ft. Meade	Florida	Gardinier, Inc	Phosphate rock.	Open pit.
FEC Hialea	do	Rinker Materials Corp	Stone	Open quarry.
International	New Mexico	International Minerals & Chemical Corp.	Potassium salts.	Stopes.
Stoneport	Michigan	Presque Isle Corp	Phosphate rock.	Open pit.
Bonny Lake	Florida	W. R. Grace & Co	do	Do.
Nichols	do	Mobil Oil Corp	do	Do.
Pennsuco	do	Lone Star Florida, Inc	Stone	Open quarry.
McCook	Illinois	Vulcan Material Co	do	Do.

[1]Brines and materials from wells excepted.

Table 9.—Twenty-five leading metal and nonmetal[1] mines in the United States in 1981, in order of output of total materials handled

Mine	State	Operator	Commodity	Mining method
		METALS		
Utah Copper	Utah	Kennecott Minerals Co	Copper	Open pit.
Tyrone	New Mexico	Phelps Dodge Corp	do	Do.
Pima	Arizona	Cyprus Pima Mining Co	do	Do.
Morenci	do	Phelps Dodge Corp	do	Do.
Sierrita	do	Duval Sierrita Corp	do	Do.
Climax	Colorado	Climax Molybdenum Co., a division of AMAX Inc.	Molybdenum	Caving and open pit.
Chino	New Mexico	Kennecott Minerals Co	Copper	Open pit.
Twin Butte	Arizona	Anamax Mining Co	do	Do.
Empire	Michigan	Empire Iron Mining	Iron ore	Do.
Erie Commercial	Minnesota	Pickands Mather & Co	do	Do.
Ray Pit	Arizona	Kennecott Minerals Co	Copper	Do.
Minntac	Minnesota	United States Steel Corp	Iron ore	Do.
Bagdad	Arizona	Cyprus Bagdad Copper Co	Copper	Do.
Hibbing Taconite	Minnesota	Pickands Mather & Co	Iron ore	Do.
Thunderbird	do	Oglebay Norton Co	do	Do.
Tilden	Michigan	Tilden Mining Co	do	Do.
Shirley	Wyoming	Pathfinder Minerals Corp	Uranium	Do.
Eagle Mountain	California	Kaiser Steel Corp	Iron ore	Do.
Shirley	Wyoming	Getty Oil Co	Uranium	Do.
Peter Mitchell	Minnesota	Reserve Mining Co	Iron ore	Do.
Inspiration	Arizona	Inspiration Consolidated Copper Corp.	Copper	Do.
Eisenhower	Arizona	ASARCO Incorporated	do	Do.
San Manuel	do	Magma Copper Co	do	Do.
Pinto Valley	do	Cities Service Co	do	Do.
Esperanza	do	Duval Corp	do	Do.
		NONMETALS		
Lee Creek	North Carolina	Texasgulf Inc	Phosphate rock.	Open pit.
Suwanee	Florida	Occidental Petroleum Corp	do	Do.
Swift Creek	do	do	do	Do.
Kingsford	do	International Minerals & Chemical Corp.	do	Do.
Noralyn	do	do	do	Do.
Ft. Green	do	Williams Co	do	Do.
Clear Spring	do	International Minerals & Chemical Corp.	do	Do.
Haynsworth	do	American Cyanamid Co	do	Do.
Lonesome	do	do	do	Do.
Ft. Meade	do	Mobil Oil Corp	do	Do.
Payne Creek	do	Williams Co	do	Do.
Bonny Lake	do	W. R. Grace & Co	do	Do.
Hookers	do	do	do	Do.
Mabie Canyon	Idaho	Conda Partnership	do	Do.
Ft. Meade	Florida	Gardinier, Inc	do	Do.
Nichols	do	Mobil Oil Corp	do	Do.
Silver City	do	Estech General Chemical Corp.	do	Do.
Big Four	do	Amax Phosphate, Inc	do	Do.
Watson	do	Estech General Chemical Corp.	do	Do.
Conda	Idaho	J. R. Simplot Co	do	Do.
Gay	do	do	do	Do.
Feld	Texas	Texas Crushed Stone Co	Stone	Open quarry.
Rockland	Florida	United States Steel Corp	Phosphate rock.	Open pit.
Wooley Valley	Idaho	Stauffer Chemical Co	do	Do.
Westvaco	Wyoming	FMC Corp	Sodium carbonate.	Artificial stopes.

[1]Brines and materials from wells excepted.

Table 10.—Ore treated or sold per unit of marketable product at surface and underground mines in the United States in 1981, by commodity[1]

Commodity	Surface: Ore treated (thousand short tons)	Surface: Marketable product (units)	Surface: Ratio of units of ore to units of marketable product	Underground: Ore treated (thousand short tons)	Underground: Marketable product (units)	Underground: Ratio of units of ore to units of marketable product	Total[2]: Ore treated (thousand short tons)	Total[2]: Marketable product (units)	Total[2]: Ratio of units of ore to units of marketable product
METALS									
Bauxite ... thousand long tons	2,690	1,490	1.8:1	--	--	--	2,690	1,490	1.8:1
Copper ... thousand short tons	272,000	1,420	191.4:1	32,800	257	127.4:1	305,000	1,680	181.6:1
Gold:									
Lode ... thousand troy ounces	8,350	527	15.8:1	2,590	389	6.7:1	10,900	916	11.9:1
Placer ... do	5,510	29	192.5:1	W	W	W	5,510	29	192.5:1
Iron ore ... thousand long tons	252,000	70,600	3.6:1	W	W	W	252,000	70,600	3.6:1
Lead ... thousand short tons	--	--	--	9,540	430	22.2:1	9,540	430	22.2:1
Silver ... thousand troy ounces	3,420	4,090	0.8:1	1,980	16,700	0.1:1	5,400	20,800	0.3:1
Titanium and ilmenite ... thousand short tons	14,600	524	27.8:1	--	--	--	14,600	524	27.8:1
Uranium ... do	15,700	8	1,994.0:1	5,560	8	712.4:1	21,200	16	1,356.1:1
Zinc ... do	--	--	--	6,840	237	28.9:1	6,840	237	28.9:1
NONMETALS									
Asbestos ... do	766	83	9.2:1	W	W	W	766	83	9.2:1
Barite ... do	5,310	2,830	1.9:1	--	--	--	5,310	2,830	1.9:1
Clays ... do	40,400	40,400	1.0:1	545	545	1.0:1	41,000	41,000	1.0:1
Diatomite ... do	1,400	687	2.0:1	--	--	--	1,400	687	2.0:1
Feldspar ... do	1,820	587	3.1:1	--	--	--	1,820	587	3.1:1
Fluorspar ... do	W	W	W	413	109	3.8:1	413	109	3.8:1
Gypsum ... do	10,400	9,200	1.1:1	2,300	2,300	1.0:1	12,700	11,500	1.1:1
Mica (scrap) ... do	357	95	3.8:1	--	--	--	357	95	3.8:1
Perlite ... do	1,220	591	2.1:1	--	--	--	1,220	591	2.1:1
Phosphate rock ... do	208,000	58,900	3.5:1	W	W	W	208,000	58,900	3.5:1
Potassium salts ... do	--	--	--	20,000	1,770	11.4:1	20,000	1,770	11.4:1
Pumice ... do	979	498	2.0:1	--	--	--	979	498	2.0:1
Salt ... do	1,290	1,180	1.1:1	10,800	10,600	1.0:1	12,000	11,800	1.1:1
Sand and gravel[3] ... do	30,000	29,600	1.0:1	--	--	--	30,000	29,600	1.0:1
Sodium carbonate (natural) ... do	--	--	--	10,100	6,630	1.5:1	10,100	6,630	1.5:1
Stone:									
Crushed and broken ... do	[e]846,000	842,000	1.0:1	[e]24,800	24,500	1.0:1	[e]870,000	867,000	1.0:1
Dimension ... do	[e]4,090	1,270	3.2:1	[e]25	20	1.2:1	[e]4,120	1,300	3.2:1
Talc, soapstone, pyrophyllite ... do	980	874	1.2:1	370	370	1.0:1	1,350	1,240	1.1:1

[e]Estimated. W Withheld to avoid disclosing company proprietary data.
[1]Excludes wells, ponds, or pumping operations.
[2]Data may not add to totals shown because of independent rounding.
[3]Includes industrial sand and gravel. Construction sand and gravel was not available for 1981 because of biennial canvassing.

Table 11.—Material handled per unit of marketable product at surface and underground mines in the United States in 1981, by commodity[1]

Commodity	Surface			Underground			Total[2]		
	Total material handled[3] (thousand short tons)	Marketable product (units)	Ratio of units of material handled to units of marketable product[4]	Total material handled[3] (thousand short tons)	Marketable product (units)	Ratio of units of material handled to units of marketable product[4]	Total material handled[3] (thousand short tons)	Marketable product (units)	Ratio of units of material handled to units of marketable product[4]
METALS									
Bauxite ---- thousand long tons	20,900	1,490	11.7:1	--	--	--	20,900	1,490	11.7:1
Copper ---- thousand short tons	930,000	1,420	572.6:1	36,300	257	134.9:1	966,000	1,680	505.5:1
Gold:									
Lode ---- thousand troy ounces	34,700	527	49.1:1	3,050	389	6.7:1	37,700	916	31.1:1
Placer ---- do	8,330	29	264.5:1	W	W	W	8,330	29	264.5:1
Iron ore ---- thousand long tons	413,000	70,600	5.9:1	W	W	W	413,000	70,600	5.9:1
Lead ---- thousand short tons	--	--	--	11,900	430	23.2:1	11,900	430	23.2:1
Silver ---- thousand troy ounces	14,100	4,090	3.5:1	4,230	16,700	.2:1	18,400	20,800	.8:1
Titanium and ilmenite ---- thousand short tons	23,400	524	44.6:1	--	--	--	23,400	524	44.6:1
Uranium ---- do	137,000	8	15,447.2:1	7,020	8	743.8:1	144,000	16	8,127.9:1
Zinc ---- do	--	--	--	7,940	237	30.3:1	7,940	237	30.3:1
NONMETALS									
Asbestos ---- do	2,800	83	33.6:1	W	W	W	2,800	83	33.6:1
Barite ---- do	13,400	2,830	4.5:1	--	--	--	13,400	2,830	4.5:1
Clays ---- do	75,400	40,400	1.9:1	552	545	1.0:1	76,000	41,000	1.9:1
Diatomite ---- do	1,100	687	1.6:1	--	--	--	1,100	687	1.6:1
Feldspar ---- do	6,330	587	10.8:1	--	--	--	6,330	587	10.8:1
Fluorspar ---- do	W	W	W	441	109	3.7:1	441	109	3.7:1
Gypsum ---- do	14,200	9,200	1.5:1	2,300	2,300	1.0:1	16,400	11,500	1.4:1
Mica (scrap) ---- do	415	95	3.9:1	--	--	--	415	95	3.9:1
Perlite ---- do	1,130	591	1.9:1	--	--	--	1,130	591	1.9:1
Phosphate rock ---- do	662,000	58,900	10.8:1	W	W	W	662,000	58,900	10.8:1
Potassium salts ---- do	--	--	--	20,600	1,770	11.7:1	20,600	1,770	11.7:1
Pumice ---- do	547	498	1.1:1	--	--	--	547	498	1.1:1

Salt	do	1,340	1,180	1.1:1	8,950	10,600	.9:1	10,300	11,800	.9:1
Sand and gravel[5]	do	30,000	29,600	1.0:1	--	--	--	30,000	29,600	1.0:1
Sodium carbonate (natural)	do	--	--	--	15,200	6,630	1.5:1	15,200	6,630	1.5:1
Stone:										
Crushed and broken	do	[e]913,000	842,000	1.1:1	25,000	24,500	1.0:1	938,000	867,000	1.1:1
Dimension	do	[e]5,630	1,270	4.4:1	251	20	1.3:1	5,650	1,300	4.4:1
Talc, soapstone, pyrophyllite	do	1,150	874	1.2:1	370	370	1.0:1	1,520	1,240	1.1:1

[e]Estimated. W Withheld to avoid disclosing company proprietary data.
[1]Excludes material from wells, ponds, or pumping operations.
[2]Data may not add to totals shown because of independent rounding.
[3]Includes material from development and exploration activities.
[4]Material from development and exploration activities is excluded from the ratio calculation.
[5]Includes industrial sand and gravel. Construction sand and gravel was not available for 1981 because of biennial canvassing.

Table 12.—Mining methods used in open pit mining in the United States in 1981, by commodity

(Percent)

Commodity	Total material handled: Preceded by drilling and blasting	Total material handled: Not preceded by drilling and blasting[1]
METALS		
Bauxite	83	17
Copper	96	4
Gold:		
Lode	92	8
Placer	--	100
Iron ore	92	8
Manganiferous ore	73	27
Mercury	10	90
Molybdenum	87	13
Nickel	45	55
Rare-earth metals	100	--
Silver	100	--
Titanium and ilmenite	--	100
Tungsten	--	100
Uranium	52	48
Vanadium	28	72
NONMETALS		
Abrasives	83	17
Aplite	--	100
Asbestos	100	--
Barite	52	48
Boron minerals	6	94
Clays	--	100
Diatomite	--	100
Feldspar	72	28
Fluorspar	1	99
Gypsum	92	8
Iron oxide pigments (crude)	--	100
Kyanite	100	--
Lithium minerals	100	--
Magnesite	100	--
Mica (scrap)	21	79
Millstones	100	--
Olivine	100	--
Perlite	80	20
Phosphate rock	25	75
Pumice	22	78
Salt	--	100
Sand and gravel	--	100
Stone:		
Crushed and broken	99	1
Dimension	--	100
Talc, soapstone, pyrophyllite	96	4
Vermiculite	59	41
Average	75	25

[1]Includes drilling or cutting without blasting, dredging, mechanical excavation and nonfloat washing, and other surface mining methods.

Table 13.—Development and exploration activity in the United States in 1981, by method

Method	Metals		Nonmetals		Total[1]	
	Feet	Percent of total[2]	Feet	Percent of total[2]	Feet	Percent of total[2]
DEVELOPMENT						
Shaft and winze sinking	27,600	1.8	2,700	0.4	30,300	1.4
Raising	104,000	6.8	1,380	.2	105,000	4.9
Drifting, crosscutting, or tunneling	657,000	43.3	644,000	98.7	1,300,000	59.9
Solution mining	730,000	48.1	4,430	.7	734,000	33.8
Total[1]	1,520,000	100.0	653,000	100.0	2,170,000	100.0
EXPLORATION						
Diamond drilling	1,250,000	11.6	226,000	27.3	1,480,000	12.7
Churn drilling	144,000	1.3	1,890	.2	146,000	1.3
Rotary drilling	6,820,000	63.3	345,000	41.8	7,170,000	61.7
Percussion drilling	901,000	8.4	87,000	10.5	988,000	8.5
Other drilling	1,640,000	15.2	161,000	19.5	1,800,000	15.5
Trenching	24,000	.2	5,700	.7	29,700	.3
Total[1]	10,800,000	100.0	827,000	100.0	11,600,000	100.0
Grand total[1]	12,300,000	XX	1,480,000	XX	13,800,000	XX

XX Not applicable.
[1]Data may not add to totals shown because of independent rounding.
[2]Based on unrounded footage.

Table 14.—Development and exploration in the United States in 1981, by commodity

(Feet)

Commodity	Development					Exploration						
	Shaft and winze sinking	Raising	Drifting, crosscutting, or tunneling	Solution mining	Total[1]	Diamond drilling	Churn drilling	Rotary drilling	Percussion drilling	Other drilling	Trenching	Total[1]
METALS												
Copper	3,420	49,400	150,000	--	203,000	212,000	--	106,000	--	--	70	318,000
Gold	1,580	10,500	55,600	--	67,700	202,000	15,400	392,000	184,000	50,600	19,600	863,000
Iron ore	--	--	1,330	--	1,330	44,400	--	13,500	--	--	--	57,900
Lead	688	2,870	42,400	--	45,900	239,000	119,000	13,600	1,000	177,000	825	551,000
Molybdenum	W	W	W	--	36,200	165,000	3,000	35,500	--	--	--	203,000
Silver	5,830	8,180	66,300	400	80,700	108,000	--	77,500	24,600	2,340	2,450	215,000
Tungsten	W	W	W	--	20,500	W	--	W	W	W	--	25,700
Uranium	8,130	16,300	264,000	714,000	1,000,000	120,000	6,000	5,880,000	687,000	810,000	700	7,500,000
Zinc	6,440	3,340	32,300	--	42,100	94,000	--	--	--	--	--	94,000
Other[2]	1,520	13,500	47,700	15,600	21,600	70,300	--	308,000	4,300	600,000	325	983,000
Total[1]	27,600	104,000	657,000	730,000	1,520,000	1,250,000	144,000	6,820,000	901,000	1,640,000	24,000	10,800,000
NONMETALS												
Barite	--	--	--	--	--	839	--	10,800	85,500	--	--	97,100
Phosphate rock	--	--	6,330	4,430	10,800	10,700	1,890	222,000	--	89,000	--	324,000
Other[3]	2,700	1,380	638,000	--	642,000	215,000	--	112,000	1,520	72,100	5,700	406,000
Total[1]	2,700	1,380	644,000	4,430	653,000	226,000	1,890	345,000	87,000	161,000	5,700	827,000
Grand total[1]	30,300	105,000	1,300,000	734,000	2,170,000	1,480,000	146,000	7,170,000	988,000	1,800,000	29,700	11,600,000

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Data may not add to totals shown because of independent rounding.
[2]Bauxite, beryllium, cobalt, columbium-tantalum, mercury, platinum, rare-earth metals, tin, and vanadium.
[3]Abrasives, asbestos, boron minerals, clays, diatomite, fluorspar, gypsum, perlite, potassium salts, sodium carbonate (natural), sulfur, wollastonite, and zeolite.

Table 15.—Development and exploration in the United States in 1981, by State

(Feet)

State	Development					Exploration							
	Shaft and winze sinking	Raising	Drifting, crosscutting, or tunneling	Solution mining	Total[1]	Diamond drilling	Churn drilling	Rotary drilling	Percussion drilling	Other drilling	Trenching	Total[1]	
Alaska	--	700	4,700	--	5,400	44,900	4,290	--	250	--	3,380	52,800	
Arizona	1,430	43,300	90,300	--	135,000	117,000	--	47,400	10,300	500	4,220	180,000	
California	760	5,440	12,800	--	19,000	14,400	1,080	120,000	5,000	--	800	141,000	
Colorado	540	9,550	59,800	--	69,900	150,000	--	165,000	63,100	9,950	--	387,000	
Florida	--	--	--	--	--	--	--	188,000	--	--	--	188,000	
Idaho	5,700	6,550	21,200	4,430	37,800	49,700	1,890	21,500	520	2,400	--	76,000	
Illinois	W	W	W	--	W	146,000	--	1,200	--	--	--	148,000	
Missouri	495	--	29,700	--	30,100	220,000	119,000	8,640	--	74,700	--	425,000	
Montana	690	173	18,600	400	19,900	140,000	--	54,300	2,550	--	200	197,000	
Nevada	426	5,520	26,700	--	32,700	115,000	13,000	443,000	225,000	49,600	17,400	863,000	
New Mexico	2,370	14,700	220,000	--	237,000	131,000	6,000	1,650,000	613,000	673,000	3,450	3,070,000	
Oregon	--	302	763	--	1,070	17,800	--	18,600	27,400	--	--	63,800	
South Dakota	W	W	W	--	W	20,000	--	549,000	--	--	--	569,000	
Tennessee	--	3,010	22,300	--	25,300	33,900	--	20,000	--	89,000	--	143,000	
Texas	--	--	--	714,000	714,000	1,000	--	1,550,000	--	--	--	1,550,000	
Utah	13,600	3,380	80,100	--	97,100	51,700	--	469,000	28,400	3,590	--	552,000	
Washington	--	W	W	--	W	22,500	--	14,600	--	--	--	37,100	
Wyoming	W	W	W	--	W	19,100	--	1,490,000	--	686	--	1,510,000	
Undistributed[2]	4,270	12,700	714,000	15,600	747,000	184,000	--	354,000	12,400	895,000	250	1,450,000	
Total[1]	30,300	105,000	1,300,000	734,000	2,170,000	1,480,000	146,000	7,170,000	988,000	1,800,000	29,700	11,600,000	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Data may not add to totals shown because of independent rounding.
[2]Includes Alabama, Arkansas, Georgia, Indiana, Kentucky, Maine, Michigan, Minnesota, New Hampshire, New York, North Carolina, Oklahoma, Pennsylvania, South Carolina, and Wisconsin.

Table 16.—Total material (ore and waste) produced by mine development in the United States in 1981, by commodity and State

(Thousand short tons)

	Shaft and winze sinking	Raising	Drifting, crosscutting, or tunneling	Stripping	Total[1]
COMMODITY					
METALS					
Copper	69	117	1,380	117,000	118,000
Gold	12	34	388	9,500	9,930
Iron ore	--	--	W	--	W
Lead	12	7	1,890	--	1,910
Silver	140	62	1,450	--	1,660
Uranium	42	69	1,110	15,700	16,900
Zinc	7	5	754	--	767
Other[2]	56	161	2,710	24,700	27,600
Total[1]	338	455	9,680	167,000	177,000
NONMETALS					
Phosphate rock	--	--	24	27,600	27,600
Talc, soapstone, pyrophyllite	--	--	([3])	97	97
Other[4]	30	16	5,080	985	6,100
Total[1]	30	16	5,100	28,700	33,800
Grand total[1]	368	471	14,800	196,000	211,000
STATE					
Alabama	--	--	--	W	W
Alaska	--	3	32	82	117
Arizona	32	81	775	43,600	44,500
Arkansas	--	--	--	W	W
California	3	20	118	225	366
Colorado	1	85	508	23,700	24,300
Florida	--	--	--	4,580	4,580
Georgia	--	--	--	W	W
Idaho	141	54	275	5,690	6,160
Illinois	W	W	W	--	W
Kentucky	--	W	W	--	W
Missouri	9	--	3,700	--	3,710
Montana	4	1	897	451	1,350
Nevada	2	90	625	11,000	11,700
New Mexico	53	64	903	73,300	74,300
New York	--	W	W	W	W
North Carolina	--	--	--	W	W
Oregon	--	2	4	([3])	6
Pennsylvania	W	W	W	--	W
South Carolina	--	--	--	W	W
South Dakota	W	W	W	--	W
Tennessee	--	9	828	--	838
Utah	47	27	636	112	821
Washington	--	W	W	--	W
Wyoming	W	W	W	W	W
Undistributed	76	36	5,480	33,000	38,600
Total[1]	368	471	14,800	196,000	211,000

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Data may not add to totals shown because of independent rounding.
[2]Bauxite, beryllium, mercury, molybdenum, tungsten, and vanadium.
[3]Less than 1/2 unit.
[4]Abrasives, barite, boron minerals, feldspar, fluorspar, mica (scrap), perlite, sodium carbonate (natural), and vermiculite.

Table 17.—U.S. industrial consumption of explosives

(Thousand pounds)

Year	Coal mining	Metal mining	Quarrying and nonmetal mining	Total mineral industry	Construction work and other uses	Total industrial
1977	2,093,312	446,406	522,678	3,062,396	647,354	3,709,750
1978	[1]2,168,630	[1]574,213	[1]604,955	3,347,798	[2]581,391	3,929,189
1979	[1]2,237,393	[1]612,820	[1]653,033	3,503,246	[2]587,212	4,090,458
1980	[1]2,503,359	[1]559,229	[1]624,184	3,686,772	[2]587,690	4,274,462
1981	[1]2,249,262	[1]695,449	[1]493,771	3,438,482	[2]902,567	4,341,049

[1]Some quantities of this use are included with "Construction work and other uses" to avoid disclosing company proprietary data.

[2]Includes some quantities from coal mining, metal mining, and quarrying and nonmetal mining.

Note: Data for 1977-80 are not comparable to prior years owing to change in reporting by the Institute of Makers of Explosives.

Table 18.—U.S. consumption of explosives in the minerals industry

(Thousand pounds)

Year	Coal mining	Metal mining	Quarrying and nonmetal mining	Total
PERMISSIBLE EXPLOSIVES				
1977	46,663	225	694	47,582
1978	38,530	208	618	39,356
1979	44,891	281	615	45,787
1980	52,476	81	716	53,273
1981	49,814	166	1,638	51,618
OTHER HIGH EXPLOSIVES				
1977	34,407	25,174	63,378	122,959
1978	27,741	25,400	59,974	113,115
1979	25,783	23,699	60,734	110,216
1980	24,912	25,085	50,138	100,135
1981	22,314	23,384	43,223	88,921
WATER GELS AND SLURRIES				
1977	42,406	154,704	75,062	272,172
1978	63,494	234,470	89,322	387,286
1979	74,739	238,738	107,280	420,757
1980	93,916	171,213	99,947	365,076
1981	99,796	174,528	86,671	360,995
AMMONIUM NITRATE: FUEL-MIXED AND UNPROCESSED				
1977	1,969,836	266,303	383,544	2,619,683
1978	2,038,865	314,135	455,041	2,808,041
1979	2,091,980	350,102	484,404	2,926,486
1980	2,332,055	362,850	473,383	3,168,288
1981	2,077,338	497,371	362,239	2,936,948
TOTAL				
1977	2,093,312	446,406	522,678	3,062,396
1978	2,168,630	574,213	604,955	3,347,798
1979	2,237,393	612,820	653,033	3,503,246
1980	2,503,359	559,229	624,184	3,686,772
1981	2,249,262	695,449	493,771	3,438,482

Statistical Summary

By Rose L. Ballard[1]

This chapter summarizes data on crude nonfuel mineral production for the United States, its island possessions, and the Commonwealth of Puerto Rico. Included also are the tables that show the principal nonfuel mineral commodities exported from and imported into the United States and that compare world and U.S. mineral production. The detailed data from which these tables were derived are contained in the individual commodity chapters of volume I and in the State chapters of volume II of this edition of the Minerals Yearbook.

Although crude mineral production may be measured at any of several stages of extraction and processing, the stage of measurement used in this chapter is what is normally termed "mine output." It usually refers to minerals or ores in the form in which they are first extracted from the ground, but customarily includes the output from auxiliary processing at or near the mines.

Because of inadequacies in the statistics available, some series deviate from the foregoing definition. For gold, silver, copper, lead, zinc, and tin, the quantities are recorded on a mine basis (as the recoverable content of ore sold or treated). However, the values assigned to these quantities are based on the average selling price of refined metal, not the mine value. Mercury is measured as recovered metal and valued at the average New York price for the metal.

The weight of volume units shown are those customarily used in the particular industries producing the commodities. Values shown are in current dollars, with no adjustments made to compensate for changes in the purchasing power of the dollar.

[1]Statistical specialist, Office of Geographic Statistics.

Table 1.—Value of crude nonfuel mineral production[1] in the United States, by mineral group

(Million dollars)

	Metals	Nonmetals	Total
1980[r]	8,921	16,213	25,134
1981[r]	8,842	16,385	25,227
1982	5,544	14,147	19,691

[r]Revised.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Nonfuel mineral production[1] in the United States

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
METALS						
Antimony ore and concentrate short tons, antimony content	343	W	646	W	503	W
Bauxite thousand metric tons, dried equivalent	1,559	$22,353	1,510	$26,489	732	$12,334
Copper (recoverable content of ores, etc.) metric tons	1,181,116	2,666,931	1,538,160	2,886,440	1,139,563	1,866,895
Gold (recoverable content of ores, etc.) troy ounces	969,782	594,050	[r]1,379,161	[r]633,918	1,446,905	543,908
Iron ore, usable (excluding byproduct iron sinter) thousand long tons, gross weight	69,562	2,543,484	72,158	2,914,689	35,751	1,491,705
Iron oxide pigments, crude short tons	62,642	[r]3,272	67,214	[r]2,285	67,294	2,702
Lead (recoverable content of ores, etc.) metric tons	550,366	515,189	445,535	358,821	512,425	288,528
Manganiferous ore (5% to 35% Mn) short tons, gross weight	173,887	2,444	[r]174,760	2,889	31,509	293
Mercury 76-pound flasks	30,657	11,939	27,904	11,549	25,760	W
Molybdenum (content of concentrate) thousand pounds	149,311	1,344,181	118,916	945,540	77,789	514,834
Nickel (content of ore and concentrate) short tons	14,653	W	12,099	W	3,203	W
Silver (recoverable content of ores, etc.) thousand troy ounces	32,329	667,278	[r]40,683	[r]427,921	40,239	319,903
Titanium concentrate: Ilmenite short tons, gross weight	593,704	32,041	523,681	37,013	233,063	19,093
Tungsten ore and concentrate thousand pounds of contained W	6,036	50,575	7,815	62,231	3,473	22,062
Vanadium (recoverable in ore and concentrate) short tons	4,806	64,370	5,126	71,496	4,098	52,577
Zinc (recoverable content of ores, etc.) metric tons	317,103	261,671	312,418	306,879	300,274	254,668
Combined value of beryllium, magnesium chloride for magnesium metal, platinum-group metals (1980-81), rare-earth metal concentrate, tin, titanium concentrate (rutile), zircon concentrate, and values indicated by symbol W	XX	141,492	XX	[r]153,902	XX	154,917
Total	XX	[r]8,921,000	XX	[r]8,842,000	XX	5,544,000
NONMETALS (EXCEPT FUELS)						
Abrasive stones[2] short tons	[r]631	[r]1,933	[r]2,501	[r]1,096	1,285	553
Asbestos metric tons	80,079	30,599	75,618	30,685	63,515	24,917
Asphalt and related bitumens, native: Bituminous limestone, sandstone, gilsonite thousand short tons	1,252	25,030	1,261	27,654	W	W
Barite do	2,245	65,957	2,849	102,439	1,845	69,522
Boron minerals do	1,545	366,760	1,481	435,387	1,234	384,597
Bromine thousand pounds	[r]378,200	95,400	[r]377,100	90,200	401,100	102,600
Calcium chloride short tons	581,012	47,950	704,691	61,692	[e]616,513	[e]61,483
Carbon dioxide, natural thousand cubic feet	1,628,424	2,561	1,577,053	2,607	2,067,500	3,399
Cement:						
Masonry thousand short tons	3,040	188,456	2,738	161,819	2,364	145,172
Portland do	71,612	3,613,332	68,197	3,515,600	61,080	3,084,439
Clays do	48,790	898,947	44,379	988,845	35,345	825,064
Diatomite do	689	100,610	687	113,010	613	107,619
Feldspar short tons	[e]710,000	[e]23,200	665,000	21,000	615,000	20,300
Fluorspar do	92,635	12,611	115,404	18,412	77,017	13,293
Garnet (abrasive) do	26,909	[r]1,908	25,451	2,059	27,303	2,321
Gem stones[e]	NA	6,930	NA	7,625	NA	7,150
Gypsum thousand short tons	12,376	103,059	11,497	98,101	10,538	89,131
Helium:						
Crude million cubic feet	299	3,588	175	2,100	W	W
Grade-A do	1,159	26,657	1,223	31,798	[3]1,248	[3]42,432
Lime thousand short tons	19,010	842,922	18,856	884,197	14,075	696,207
Mica: Scrap do	116	6,262	133	8,212	106	6,302
Peat do	788	16,190	757	18,783	730	16,702
Perlite short tons	638,000	16,500	591,000	[r]17,458	506,000	16,044
Phosphate rock thousand metric tons	54,415	1,256,947	53,624	1,437,986	37,414	950,326
Potassium salts (K_2O equivalent) do	2,217	353,862	1,908	328,900	1,784	265,600
Pumice thousand short tons	543	4,267	499	4,311	416	3,750
Pyrites thousand metric tons	847	13,812	797	49,160	676	41,943

See footnotes at end of table.

Table 2.—Nonfuel mineral production[1] in the United States —Continued

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
NONMETALS (EXCEPT FUELS) — Continued						
Salt ________ thousand short tons__	40,352	$656,164	38,907	r$637,568	37,880	$671,096
Sand and gravel:						
Construction __________do____	763,100	1,996,000	e690,000	e1,928,000	597,170	1,683,201
Industrial ___________do____	29,600	293,000	29,980	332,300	28,355	339,725
Sodium sulfate (natural) ____do____	583	36,387	608	43,186	W	W
Stone:[4]						
Crushed _____________do____	r980,305	r3,254,572	r872,600	r3,125,000	p790,030	p2,918,300
Dimension____________do____	r1,315	r138,907	1,331	150,461	p1,330	p145,113
Sulfur, Frasch process thousand metric tons__	7,400	720,511	5,910	715,683	3,598	434,660
Talc and pyrophyllite thousand short tons__	1,473	25,626	1,343	31,497	1,135	27,236
Tripoli ____________short tons__	121,233	676	107,330	617	112,928	653
Vermiculite__ thousand short tons__	337	23,483	320	26,181	316	28,508
Combined value of aplite, emery, graphite (1982), helium (Grade-A, 1982), iodine, kyanite, lithium minerals, magnesite, magnesium compounds, marl (greensand), olivine, sodium carbonate (natural), staurolite, wollastonite, and values indicated by symbol W __________________	XX	941,212	XX	933,515	XX	917,358
Total __________________	XX	r16,213,000	XX	r16,385,000	XX	14,147,000
Grand total ______________	XX	r25,134,000	XX	r25,227,000	XX	19,691,000

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; included in "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Grindstones, pulpstones, grinding pebbles, sharpening stones, and tube mill liners.

[3]Excludes output in New Mexico; withheld to avoid disclosing company proprietary data; included in nonmetals "Combined value" figure for 1982.

[4]Excludes abrasive stone and bituminous limestone and sandstone; all included elsewhere in table.

Table 3.—Nonfuel minerals produced in the United States and principal producing States in 1982

Mineral	Principal producing States, in order of quantity	Other producing States
Antimony ore and concentrate	Idaho and Mont.	
Aplite	Va.	
Asbestos	Calif. and Vt.	
Asphalt (native)	Utah.	
Barite	Nev., Mo., Ark., Ga	Ill., Mont., Tenn., Wash.
Bauxite	Ark., Ala., Ga.	
Beryllium concentrate	Utah, S. Dak., Colo., Wyo.	
Boron minerals	Calif.	
Bromine	Ark. and Mich.	
Calcium chloride	Mich. and Calif.	
Carbon dioxide (natural)	Colo., N. Mex., Calif.	
Cement	Tex., Calif., Pa., Mich	All other States except Alaska, Conn., Del., Mass., N.H., N.J., N. Dak., R.I., Vt.
Clays	Ga., Tex., Wyo., Calif	All other States except Alaska, Del., Hawaii, R.I., Vt., Wis.
Copper (mine)	Ariz., Utah, N. Mex., Mont	Alaska, Calif., Colo., Idaho, Mich., Mo., Nev., Tenn., Wash.
Diatomite	Calif., Nev., Wash., Oreg.	
Emery	N.Y.	
Feldspar	N.C., Conn., Ga., Calif	Okla. and S. Dak.
Fluorspar	Ill., Tex., Nev.	
Garnet, abrasive	Idaho, N.Y., Maine.	
Gold (mine)	Nev., S. Dak., Utah, Mont	Alaska, Ariz., Calif., Colo., Idaho, N. Mex., Oreg., Wash.
Gypsum	Tex., Okla., Iowa, Calif	Ariz., Ark., Colo., Idaho, Ind., Kans., La., Mich., Mont., Nev., N. Mex., N.Y., Ohio, S. Dak., Utah, Va., Wash., Wyo.
Helium	Kans., Tex., N. Mex.	
Iodine	Okla. and Mich.	
Iron ore	Minn., Mich., Calif., Wyo	Colo., Mo., Mont., Nev., N.Y., Tex., Utah, Wis.
Iron oxide pigments (crude)	Mich., Mo., Ga., Va.	
Kyanite	Va. and Ga.	
Lead (mine)	Mo., Idaho, Colo., N.Y	Alaska, Ariz., Calif., Ill., Mont., Nev., N. Mex., Utah, Wash.
Lime	Ohio, Mo., Ky., Pa	All other States except Alaska, Del., Ga., Maine, Miss., N.H., N.J., N.C., R.I., S.C., Vt.
Lithium minerals	N.C. and Nev.	
Magnesite	Nev.	
Magnesium chloride	Tex.	
Magnesium compounds	Mich., Calif., Fla., Tex	Del., Miss., N.J., Utah.
Manganiferous ore	Minn. and S.C.	
Marl, greensand	N.J.	
Mercury	Nev.	
Mica, scrap	N.C., N. Mex., S.C., Ga	Conn., Pa., S. Dak.
Molybdenum	Colo., Ariz., Nev., Utah	Calif. and N. Mex.
Nickel	Oreg.	
Olivine	N.C. and Wash.	
Peat	Mich., Fla., Ind., Ill	Calif., Colo., Ga., Iowa, Maine, Mass., Minn., Mont., N.J., N.Y., N.C., N. Dak., Ohio, Pa., Wash., Wis.
Perlite	N. Mex., Ariz., Calif., Idaho	Colo. and Nev.
Phosphate rock	Fla., Idaho, N.C., Tenn	Ala., Mont., Utah.
Potassium salts	N. Mex., Utah, Calif.	
Pumice	Oreg., N. Mex., Calif., Idaho	Ariz., Hawaii, Kans., Okla.
Pyrites, ore and concentrate	Tenn., Colo., Ariz.	
Rare-earth metal concentrate	Calif. and Fla.	
Salt	La., Tex., N.Y., Ohio	Ala., Ariz., Calif., Colo., Kans., Mich., Nev., N. Mex., N. Dak., Okla., Utah, W. Va.
Sand and gravel:		
Construction	Calif., Tex., Alaska, Ohio	All other States.
Industrial	Ill., Mich., Tex., Calif	All other States except Alaska, Del., Hawaii, Idaho, Ind., Iowa, Maine, Md., Miss., Mont., Nev., N.H., N. Mex., N. Dak., Oreg., S. Dak., Utah, Vt., Va., W. Va., Wyo.
Silver (mine)	Idaho, Ariz., Mont., Utah	Alaska, Calif., Colo., Ill., Mich., Mo., Nev., N. Mex., N.Y., S. Dak., Tenn., Wash.
Sodium carbonate (natural)	Wyo. and Calif.	
Sodium sulfate (natural)	Calif., Tex., Utah.	
Staurolite	Fla.	
Stone:		
Crushed	Tex., Fla., Pa., Ill	All other States except Del. and N. Dak.
Dimension	Ga., Vt., Ind., N.H	All other States except Alaska, Del., Fla., Ky., La., Maine, Miss., Neb., Nev., N. Dak., W. Va., Wyo.
Sulfur (Frasch)	Tex. and La.	
Talc and pyrophyllite	Mont., Vt., Tex., N.Y	Ark., Calif., Ga., N.C., Oreg., Va., Wash.
Tin	Alaska and Colo.	
Titanium concentrate	Fla., N.Y., N.J.	
Tripoli	Ill., Okla., Ark., Pa.	
Tungsten ore and concentrate	Calif., Colo., Nev., Mont	Idaho.
Vanadium	Colo., Utah, Idaho, Ark.	
Vermiculite	Mont., S.C., Va.	
Wollastonite	N.Y. and Calif.	
Zinc (mine)	Tenn., Mo., N.Y., Pa	Colo., Idaho, Ill., Ky., Mont., N.J.
Zircon concentrate	Fla.	

Table 4.—Value of nonfuel mineral production in the United States and principal nonfuel minerals produced in 1982

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	$299,409	21	1.52	Cement, stone (crushed), lime, sand and gravel (construction).
Alaska	112,911	36	.57	Sand and gravel (construction), stone (crushed), gold, tin.
Arizona	1,619,296	1	8.22	Copper, molybdenum, cement, sand and gravel (construction).
Arkansas	256,389	25	1.30	Bromine, cement, stone (crushed), sand and gravel (construction).
California	1,612,193	2	8.19	Cement, boron minerals, sand and gravel (construction), stone (crushed).
Colorado	638,232	10	3.24	Molybdenum, cement, sand and gravel (construction), stone (crushed).
Connecticut	56,076	43	.28	Stone (crushed), sand and gravel (construction), feldspar, sand and gravel (industrial), stone (dimension).
Delaware	[1]3,197	50	.02	Magnesium compounds, sand and gravel (construction).
Florida	1,223,398	4	6.21	Phosphate rock, stone (crushed), cement, sand and gravel (construction).
Georgia	717,973	8	3.65	Clays, stone (crushed), cement, stone (dimension).
Hawaii	46,889	45	.24	Stone (crushed), cement, sand and gravel (construction), lime.
Idaho	300,180	20	1.52	Silver, phosphate rock, lead, gold.
Illinois	389,594	18	1.98	Stone (crushed), cement, sand and gravel (construction), sand and gravel (industrial).
Indiana	215,004	29	1.09	Cement, stone (crushed), sand and gravel (construction), lime.
Iowa	218,637	28	1.11	Stone (crushed), cement, sand and gravel (construction), gypsum.
Kansas	256,016	26	1.30	Cement, salt, stone (crushed), helium (Grade-A).
Kentucky	206,947	30	1.05	Stone (crushed), lime, cement, sand and gravel (construction).
Louisiana	417,667	17	2.12	Sulfur (Frasch), salt, sand and gravel (construction), cement.
Maine	35,439	46	.18	Sand and gravel (construction), cement, stone (crushed), peat.
Maryland	171,457	33	.87	Stone (crushed), cement, sand and gravel (construction), clays.
Massachusetts	89,302	39	.45	Sand and gravel (construction), stone (crushed), lime, stone (dimension).
Michigan	1,035,895	6	5.26	Iron ore, cement, magnesium compounds, salt.
Minnesota	1,110,126	5	5.64	Iron ore, sand and gravel (construction), stone (crushed), stone (dimension).
Mississippi	72,685	42	.37	Sand and gravel (construction), clays, cement, stone (crushed).
Missouri	733,774	7	3.73	Lead, cement, stone (crushed), lime.
Montana	266,594	22	1.35	Copper, silver, gold, cement.
Nebraska	79,557	40	.40	Cement, sand and gravel (construction), stone (crushed), lime.
Nevada	525,900	13	2.67	Gold, molybdenum, barite, diatomite.
New Hampshire	23,294	47	.12	Sand and gravel (construction), stone (dimension), stone (crushed), clays.
New Jersey	132,410	35	.67	Stone (crushed), sand and gravel (industrial), sand and gravel (construction), zinc.
New Mexico	431,813	16	2.19	Potassium salts, copper, cement, gold.
New York	500,353	14	2.54	Stone (crushed), salt, cement, sand and gravel (construction).
North Carolina	257,258	24	1.31	Stone (crushed), phosphate rock, lithium compounds, cement.
North Dakota	12,977	48	.07	Sand and gravel (construction), lime, salt, clays.
Ohio	450,229	15	2.29	Stone (crushed), salt, sand and gravel (construction), lime.
Oklahoma	225,044	27	1.14	Stone (crushed), cement, sand and gravel (construction), sand and gravel (industrial).
Oregon	107,843	38	.55	Stone (crushed), sand and gravel (construction), cement, lime.
Pennsylvania	602,554	12	3.06	Cement, stone (crushed), lime, sand and gravel (construction).
Rhode Island	4,841	49	.02	Sand and gravel (construction), stone (crushed), sand and gravel (industrial), stone (dimension).
South Carolina	194,473	31	.99	Cement, stone (crushed), clays, sand and gravel (construction).
South Dakota	135,673	34	.69	Gold, cement, stone (dimension), sand and gravel (construction).
Tennessee	378,752	19	1.92	Stone (crushed), zinc, pyrites, cement.
Texas	1,554,432	3	7.89	Cement, sulfur (Frasch), stone (crushed), sand and gravel (construction).
Utah	622,499	11	3.16	Copper, gold, potassium salts, cement.
Vermont	50,150	44	.25	Stone (dimension), sand and gravel (construction), stone (crushed), asbestos.
Virginia	263,183	23	1.34	Stone (crushed), cement, lime, sand and gravel (construction).
Washington	172,028	32	.87	Cement, sand and gravel (construction), stone (crushed), diatomite.

See footnotes at end of table.

Table 4.—Value of nonfuel mineral production in the United States and principal nonfuel minerals produced in 1982 —Continued

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
West Virginia	$75,613	41	.38	Cement, stone (crushed), sand and gravel (industrial), salt.
Wisconsin	112,294	37	.57	Stone (crushed), sand and gravel (construction), lime, iron ore.
Wyoming	668,195	9	3.39	Sodium carbonate, clays, iron ore, cement.
Total	19,691,000	XX	100.00	

XX Not applicable.
[1]Incomplete total.

Table 5.—Value of nonfuel mineral production per capita and per square mile in 1982, by State

State	Area (square miles)	1982 population (thousands)	Value of mineral production				
			Total (thousands)	Per square mile		Per capita	
				Dollars	Rank	Dollars	Rank
Alabama	51,609	3,943	$299,409	5,802	26	76	22
Alaska	586,412	438	112,911	193	49	258	9
Arizona	113,909	2,860	1,619,296	14,216	5	566	3
Arkansas	53,104	2,291	256,389	4,828	30	112	16
California	158,693	24,724	1,612,193	10,159	13	65	25
Colorado	104,247	3,045	638,232	6,122	23	210	10
Connecticut	5,009	3,153	56,076	11,195	9	18	47
Delaware	2,057	602	[1]3,197	1,554	44	5	50
Florida	58,560	10,416	1,223,398	20,891	1	117	14
Georgia	58,876	5,639	717,973	12,195	8	127	13
Hawaii	6,450	994	46,889	7,270	18	47	31
Idaho	83,557	965	300,180	3,593	34	311	7
Illinois	56,400	11,448	389,594	6,908	19	34	39
Indiana	36,291	5,471	215,001	5,924	24	39	37
Iowa	56,290	2,905	218,637	3,884	33	75	23
Kansas	82,264	2,408	256,016	3,112	38	106	17
Kentucky	40,395	3,667	206,947	5,123	28	56	27
Louisiana	48,523	4,362	417,667	8,608	16	96	20
Maine	33,215	1,133	35,439	1,067	47	31	40
Maryland	10,577	4,265	171,457	16,210	4	40	36
Massachusetts	8,257	5,781	89,302	10,815	11	15	48
Michigan	58,216	9,109	1,035,895	17,794	2	114	15
Minnesota	84,068	4,133	1,110,126	13,205	7	269	8
Mississippi	47,716	2,551	72,685	1,523	45	28	42
Missouri	69,686	4,951	733,774	10,530	12	148	12
Montana	147,138	801	266,594	1,812	42	333	5
Nebraska	77,227	1,586	79,557	1,030	48	50	29
Nevada	110,540	881	525,900	4,758	31	597	2
New Hampshire	9,304	951	23,294	2,504	40	24	44
New Jersey	7,836	7,438	132,410	16,898	3	18	46
New Mexico	121,666	1,359	431,813	3,549	35	318	6
New York	49,576	17,659	500,353	10,093	14	28	41
North Carolina	52,586	6,019	257,258	4,892	29	43	32
North Dakota	70,665	670	12,977	184	50	19	45
Ohio	41,222	10,791	450,229	10,922	10	42	33
Oklahoma	69,919	3,177	225,044	3,219	36	71	24
Oregon	96,981	2,649	107,843	1,112	46	41	35
Pennsylvania	45,333	11,865	602,554	13,292	6	51	28
Rhode Island	1,214	958	4,841	3,988	32	5	49
South Carolina	31,055	3,203	194,473	6,262	22	61	26
South Dakota	77,047	691	135,673	1,761	43	196	11
Tennessee	42,244	4,651	378,752	8,966	15	81	21
Texas	267,338	15,280	1,554,432	5,814	25	102	18
Utah	84,916	1,554	622,499	7,331	17	401	4
Vermont	9,609	516	50,150	5,219	27	97	19
Virginia	40,817	5,491	263,183	6,448	21	48	30
Washington	68,192	4,245	172,028	2,523	39	41	34
West Virginia	24,181	1,948	75,613	3,127	37	39	38
Wisconsin	56,154	4,765	112,294	2,000	41	24	43
Wyoming	97,914	502	668,195	6,824	20	1,331	1
Total[2] or average	3,615,055	230,904	19,691,000	5,447	XX	85	XX

XX Not applicable.
[1]Incomplete total.
[2]Excludes Washington, D.C. (which has no mineral production), with an area of 67 square miles and a population of 631,000.

Table 6.—Nonfuel mineral production[1] in the United States, by State

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
ALABAMA						
Cement:						
Masonry ----- thousand short tons--	242	$13,012	193	$10,721	150	$9,086
Portland ----------------do----	2,491	108,438	2,270	89,216	2,558	104,461
Clays[2] ------------------do----	2,022	29,832	1,910	25,406	1,323	13,193
Gem stones--------------------	NA	1	NA	1	NA	1
Lime --------- thousand short tons--	1,128	53,685	1,219	59,454	907	42,380
Sand and gravel:						
Construction--------------do----	10,714	23,683	[e]9,503	[e]23,340	7,019	17,226
Industrial ---------------do----	361	1,821	182	864	960	8,096
Stone:						
Crushed-----------------do----	23,433	82,270	20,706	88,377	[p]21,200	[p]89,600
Dimension ---------------do----	11	2,259	7	2,130	[p]8	[p]2,341
Combined value of asphalt (native, 1980-81), bauxite, clays (bentonite), mica (scrap, 1980), phosphate rock, and salt -------	XX	13,373	XX	14,288	XX	13,025
Total--------------------	XX	328,374	XX	[r]313,797	XX	299,409
ALASKA						
Gem stones--------------------	NA	$50	NA	$60	NA	$60
Gold (recoverable content of ores, etc.) troy ounces--	12,881	7,890	[r]26,531	[r]12,195	30,513	11,470
Lead---------------- metric tons--	31	29	W	W	W	W
Sand and gravel (construction) thousand short tons--	44,911	85,214	[e]41,000	[e]75,600	40,832	74,895
Silver (recoverable content of ores, etc.) thousand troy ounces--	8	172	2	25	2	17
Stone (crushed) --- thousand short tons--	3,990	19,978	5,359	26,855	[p]5,100	[p]25,200
Tin ---------------- metric tons--	W	W	136	1,200	W	W
Combined value of barite (1980), copper (1982), platinum-group metals (1980-81), tungsten ore and concentrate (1980-81), and values indicated by symbol W --------	XX	1,983	XX	265	XX	1,269
Total--------------------	XX	115,316	XX	[r]116,200	XX	112,911
ARIZONA						
Clays --------- thousand short tons--	151	$1,151	148	$1,105	143	$998
Copper (recoverable content of ores, etc.) metric tons--	770,118	1,738,908	1,040,813	1,953,142	769,974	1,261,415
Gem stones--------------------	NA	3,100	NA	3,250	NA	2,800
Gold (recoverable content of ores, etc.) troy ounces--	79,631	48,779	100,339	46,120	61,050	22,949
Gypsum-------- thousand short tons--	209	2,017	213	2,594	175	1,205
Lead (recoverable content of ores, etc.) metric tons--	162	152	993	800	359	202
Lime --------- thousand short tons--	514	23,904	538	29,913	326	17,080
Molybdenum (content of concentrate) thousand pounds--	35,668	341,965	35,808	254,345	22,099	100,673
Pumice -------- thousand short tons--	9	13	1	3	1	7
Sand and gravel:						
Construction--------------do----	24,229	71,838	[e]20,990	[e]63,340	19,124	58,375
Industrial ---------------do----	170	1,936	179	2,455	107	1,617
Silver (recoverable content of ores, etc.) thousand troy ounces--	6,268	129,363	8,055	84,728	6,301	50,090
Stone:						
Crushed------ thousand short tons--	6,205	24,780	6,315	26,263	[p]5,200	[p]22,200
Dimension ---------------do----	W	45	W	578	W	[p]580
Zinc ---------------- metric tons--	W	W	138	135	--	--
Combined value of asbestos (1980-81), barite (1981), cement, perlite, pyrites, salt, tungsten ore and concentrate (1980-81), vanadium (1980-81), and value indicated by symbol W --------------------	XX	83,037	XX	93,009	XX	79,105
Total--------------------	XX	2,470,988	XX	[r]2,561,780	XX	1,619,296

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
ARKANSAS						
Abrasives short tons	280	$1,686	W	W	1,085	$469
Bauxite thousand metric tons	1,299	19,252	1,242	$22,185	W	W
Clays thousand short tons	1,150	14,402	880	9,333	629	6,658
Gem stones	NA	140	NA	200	NA	200
Lime thousand short tons	175	7,785	149	8,102	W	W
Sand and gravel:						
Construction do	12,518	30,599	e9,146	e22,400	7,076	19,056
Industrial do	500	3,964	642	8,236	881	11,370
Stone:						
Crushed do	20,666	61,399	13,834	47,260	p13,100	p48,500
Dimension do	8	355	7	411	p5	p290
Talc do	W	W	W	W	13	92
Combined value of barite, bromine, cement, gypsum, tripoli, vanadium, and values indicated by symbol W	XX	153,061	XX	153,721	XX	169,754
Total	XX	292,643	XX	r271,848	XX	256,389
CALIFORNIA						
Boron minerals thousand short tons	1,545	$366,760	1,481	$435,387	1,234	$384,597
Cement, portland do	8,797	542,487	7,896	518,966	6,464	401,883
Clays do	2,558	17,766	2,309	19,118	1,762	15,642
Diatomite do	W	W	W	W	340	68,139
Gem stones	NA	200	NA	300	NA	250
Gold (recoverable content of ores, etc.) troy ounces	4,078	2,498	6,271	2,882	10,547	3,965
Gypsum thousand short tons	1,644	12,763	1,456	13,948	1,088	10,614
Lime do	554	29,444	472	26,834	364	23,000
Mercury 76-pound flasks	226	88	85	35	--	--
Perlite thousand short tons	W	W	36	1,044	W	W
Pumice do	58	1,340	98	1,501	59	1,285
Sand and gravel:						
Construction do	112,493	336,045	e107,200	e352,100	81,147	270,995
Industrial do	2,169	27,859	2,150	28,269	2,317	28,703
Silver (recoverable content of ores, etc.) thousand troy ounces	49	1,017	53	560	34	271
Stone:						
Crushed thousand short tons	37,760	118,140	34,560	118,698	p28,500	p105,400
Dimension do	36	1,967	29	1,909	p29	p1,895
Talc do	100	1,863	111	5,855	85	1,699
Combined value of asbestos, calcium chloride, carbon dioxide, cement (masonry, 1982), copper, feldspar, iron ore, lead, magnesium compounds, molybdenum, peat, potassium salts, pyrophyllite (1981), rare-earth metal concentrate, salt, sodium carbonate, sodium sulfate, tungsten ore and concentrate, wollastonite (1981-82), zinc (1981), and values indicated by symbol W	XX	411,619	XX	446,310	XX	293,855
Total	XX	1,871,856	XX	r1,973,716	XX	1,612,193
COLORADO						
Clays thousand short tons	336	$2,223	276	$1,734	201	$1,124
Copper (recoverable content of ores, etc.) metric tons	461	1,041	W	W	575	941
Gem stones	NA	70	NA	80	NA	80
Gold (recoverable content of ores, etc.) troy ounces	39,447	24,164	51,069	23,473	64,584	24,278
Gypsum thousand short tons	227	3,409	203	2,346	184	1,571
Lead (recoverable content of ores, etc.) metric tons	10,272	9,615	11,431	9,207	W	W
Molybdenum thousand pounds	102,498	915,304	73,615	636,037	41,691	360,626
Peat thousand short tons	29	327	33	299	47	275
Sand and gravel:						
Construction do	27,433	74,452	e23,500	e73,300	19,591	60,780
Industrial do	W	W	W	W	222	3,266
Silver (recoverable content of ores, etc.) thousand troy ounces	2,987	61,653	3,009	31,650	1,934	15,378

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
COLORADO—Continued						
Stone:						
Crushed ------ thousand short tons--	W	W	6,969	$24,083	[p]6,900	[p]$27,800
Dimension --------------do----	6	$259	1	64	[p]1	[p]64
Zinc (recoverable content of ores, etc.) metric tons--	13,823	11,406	W	W	W	W
Combined value of beryllium concentrate (1982), carbon dioxide, cement, iron ore, lime, perlite, pyrites, salt, tin, tungsten ore and concentrate, vanadium, and values indicated by symbol W --------------	XX	160,592	XX	164,493	XX	142,049
Total --------------------	XX	1,264,515	XX	[r]966,766	XX	638,232
CONNECTICUT						
Clays --------- thousand short tons--	92	$482	73	$391	56	$329
Lime -----------------do----	19	1,352	16	1,190	8	568
Sand and gravel:						
Construction -------------do----	7,103	18,692	[e]6,500	[e]15,400	4,920	16,388
Industrial -------------do----	W	W	W	W	80	1,746
Stone:						
Crushed ---------------do----	7,977	40,283	[r]6,837	[r]36,745	[p]6,100	[p]32,700
Dimension --------------do----	15	723	19	910	[p]20	[p]1,046
Combined value of feldspar, gem stones, mica (scrap), and values indicated by symbol W -	XX	4,231	XX	3,985	XX	3,299
Total -------------------	XX	65,763	XX	[r]58,621	XX	56,076
DELAWARE						
Sand and gravel (construction) thousand short tons--	1,075	$2,398	[e]1,205	[e]$2,959	1,300	$3,197
Total -------------------	XX	2,398	XX	2,959	XX	3,197
FLORIDA						
Cement:						
Masonry ----- thousand short tons--	285	$22,074	288	$20,757	231	$16,267
Portland ---------------do----	3,574	182,590	3,518	199,064	2,651	136,190
Clays -----------------do----	614	[2]24,164	731	[2]35,319	672	[2]31,339
Gem stones --------------------	NA	5	NA	6	NA	6
Lime --------- thousand short tons--	195	12,434	191	11,343	103	5,828
Peat -----------------do----	154	2,398	157	2,885	120	1,575
Sand and gravel:						
Construction -------------do----	14,412	28,766	[e]14,910	[e]30,600	13,749	30,481
Industrial -------------do----	W	W	349	4,419	341	4,257
Stone (crushed) ------------do----	66,209	215,972	65,067	226,192	[p]53,100	[p]182,300
Combined value of clays (kaolin), magnesium compounds, phosphate rock, rare-earth metal concentrate, staurolite, titanium concentrates (ilmenite and rutile), zircon concentrates, and value indicated by symbol W ---------------------	XX	1,020,855	XX	1,197,304	XX	815,155
Total -------------------	XX	1,509,258	XX	[r]1,727,889	XX	1,223,398
GEORGIA						
Cement:						
Masonry ----- thousand short tons--	89	$5,464	89	$4,392	W	W
Portland ---------------do----	1,231	55,463	1,150	45,423	W	W
Clays -----------------do----	8,283	500,555	8,029	553,726	6,773	$475,768
Gem stones --------------------	NA	20	NA	20	NA	20
Sand and gravel:						
Construction --- thousand short tons--	4,858	11,898	[e]3,364	[e]8,308	3,166	8,361
Industrial -------------do----	W	W	W	W	541	6,793
Stone:						
Crushed ---------------do----	40,884	162,642	35,730	153,751	[p]34,800	[p]153,500
Dimension --------------do----	231	17,466	268	17,894	[p]271	[p]18,510
Talc -----------------do----	25	116	26	182	20	141
Combined value of barite, bauxite, feldspar, iron oxide pigments (crude), kyanite, mica, peat, and values indicated by symbol W --	XX	17,663	XX	17,067	XX	54,880
Total -------------------	XX	771,287	XX	[r]800,763	XX	717,973

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
HAWAII						
Cement:						
Masonry ----- thousand short tons--	13	$960	10	$807	6	$554
Portland ---------------do----	358	23,722	302	23,024	227	18,122
Sand and gravel (construction) ----do----	1,035	2,855	e459	e1,198	449	1,221
Stone:						
Crushed ----------------do----	W	W	6,036	31,403	p4,500	p26,600
Dimension --------------do----	W	11	(3)	4	(3)	p4
Combined value of gem stones, lime, pumice, salt (1980), and value indicated by symbol W	XX	32,169	XX	589	XX	388
Total	XX	59,717	XX	r57,025	XX	46,889
IDAHO						
Antimony ore and concentrate, antimony content -------short tons--	83	W	432	W	294	W
Clays --------- thousand short tons--	27	$301	26	$288	8	$101
Copper (recoverable content of ores, etc.) metric tons--	3,103	7,006	4,245	7,966	3,074	5,035
Gem stones	NA	60	NA	75	NA	75
Lead (recoverable content of ores, etc.) metric tons--	38,607	36,139	38,397	30,923	W	W
Phosphate rock -- thousand metric tons--	4,991	100,873	5,361	108,964	W	W
Sand and gravel (construction) thousand short tons--	5,299	14,203	e3,063	e7,329	2,340	6,258
Silver (recoverable content of ores, etc.) thousand troy ounces--	13,695	282,663	16,546	174,033	14,830	117,901
Stone (crushed) --- thousand short tons--	2,007	7,240	1,437	6,206	p1,200	p6,000
Zinc (recoverable content of ores, etc.) metric tons--	27,722	22,876	W	W	W	W
Combined value of cement, garnet (abrasives), gold, gypsum, lime, perlite, pumice, sand and gravel (industrial), stone (dimension), tungsten ore and concentrate, vanadium, and values indicated by symbol W--	XX	50,734	XX	89,093	XX	164,810
Total	XX	522,095	XX	r424,877	XX	300,180
ILLINOIS						
Cement, portland -- thousand short tons--	1,649	$75,315	1,574	$61,536	1,757	$78,444
Clays[2] ------------------do----	459	1,919	322	1,540	455	2,305
Gem stones	NA	15	NA	15	NA	15
Peat ---------- thousand short tons--	79	1,505	46	1,502	W	W
Sand and gravel:						
Construction ------------do----	27,094	78,510	e25,150	e68,970	21,557	59,149
Industrial -------------do----	4,631	43,822	4,646	49,186	3,989	45,665
Stone:						
Crushed ----------------do----	53,309	180,656	44,159	165,218	p42,900	p148,300
Dimension --------------do----	2	103	2	85	p2	p98
Combined value of barite, cement (masonry), clays (fuller's earth), fluorspar, lead, lime, silver, tripoli, zinc, and value indicated by symbol W	XX	61,436	XX	79,434	XX	55,618
Total	XX	443,281	XX	r427,486	XX	389,594
INDIANA						
Cement:						
Masonry ----- thousand short tons--	W	W	252	$10,972	W	W
Portland ---------------do----	1,769	$73,049	1,538	59,344	1,523	$58,055
Clays ------------------do----	932	1,930	691	1,602	501	1,221
Gem stones	--	--	NA	1	NA	1
Peat ---------- thousand short tons--	84	1,414	105	3,140	89	2,112
Sand and gravel:						
Construction ------------do----	21,772	51,738	e15,870	e41,330	13,097	34,579
Industrial -------------do----	259	1,201	257	1,179	W	W
Stone:						
Crushed ----------------do----	30,910	92,106	25,349	79,910	p20,300	p65,500
Dimension --------------do----	161	14,046	145	13,672	p135	p13,337

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
INDIANA—Continued						
Combined value of abrasives (natural), gypsum, lime, and values indicated by symbol W	XX	$52,986	XX	$40,212	XX	$40,199
Total	XX	288,470	XX	[r]251,362	XX	215,004
IOWA						
Cement:						
Masonry ----- thousand short tons	48	$3,340	41	$3,227	W	W
Portland ----- do	1,998	101,008	1,779	92,099	1,622	$82,225
Clays ----- do	754	2,555	476	2,375	437	2,392
Gem stones	--	--	NA	1	NA	1
Gypsum ----- thousand short tons	1,468	13,136	1,383	12,706	1,177	11,345
Peat ----- do	11	276	10	453	W	W
Sand and gravel (construction) ----- do	12,683	32,722	[e]10,330	[e]29,080	10,064	25,618
Stone:						
Crushed ----- do	26,542	92,603	22,424	82,891	[p]22,600	[p]88,800
Dimension ----- do	10	509	W	W	W	W
Combined value of lime, sand and gravel (industrial), and values indicated by symbol W	XX	5,727	XX	6,559	XX	8,256
Total	XX	251,876	XX	[r]229,391	XX	218,637
KANSAS						
Cement:						
Masonry ----- thousand short tons	60	$3,310	51	$2,835	46	$2,628
Portland ----- do	1,835	86,103	1,641	81,792	1,549	79,558
Clays ----- do	886	2,325	915	4,756	664	3,656
Gem stones	--	--	NA	1	NA	1
Helium (Grade-A) ----- million cubic feet	W	W	W	W	790	26,860
Salt[4] ----- thousand short tons	1,572	64,276	1,410	60,148	1,588	71,826
Sand and gravel:						
Construction ----- do	12,124	23,817	[e]10,500	[e]21,000	9,720	20,612
Industrial ----- do	W	W	W	W	331	3,635
Stone:						
Crushed ----- do	17,398	54,731	14,143	45,738	[p]14,400	[p]41,100
Dimension ----- do	18	937	14	605	[p]11	[p]395
Combined value of gypsum, helium (crude, 1980-81), lime, pumice, salt (brine), and values indicated by symbol W	XX	26,094	XX	32,185	XX	5,745
Total	XX	261,593	XX	249,060	XX	256,016
KENTUCKY						
Clays ----- thousand short tons	748	$3,692	490	$2,395	579	$2,039
Gem stones	NA	1	NA	1	NA	1
Sand and gravel:						
Construction ----- thousand short tons	7,767	17,637	[e]6,939	[e]16,070	6,499	15,936
Industrial ----- do	W	W	W	247	7	116
Stone (crushed) ----- do	W	W	32,433	108,257	[p]29,500	[p]104,300
Combined value of cement, clays (ball clay), lime, zinc (1981-82), and values indicated by symbol W	XX	182,970	XX	81,559	XX	84,555
Total	XX	204,300	XX	[r]208,529	XX	206,947
LOUISIANA						
Clays ----- thousand short tons	380	$5,841	[2]380	[2]$6,338	326	[2]$6,216
Gem stones	--	--	NA	1	NA	1
Salt ----- thousand short tons	12,662	132,182	12,565	[r]114,476	12,172	117,569
Sand and gravel:						
Construction ----- do	18,152	62,568	[e]17,240	[e]53,550	16,558	50,966
Industrial ----- do	353	3,845	293	4,026	378	4,590
Sulfur (Frasch) ----- thousand metric tons	2,590	W	2,235	W	1,239	W
Combined value of cement, clays (bentonite, 1981-82), gypsum, lime, stone (crushed), and values indicated by symbol W	XX	379,330	XX	[r]388,005	XX	238,325
Total	XX	583,766	XX	[r]566,396	XX	417,667

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
MAINE						
Clays thousand short tons	78	$174	57	$166	37	$76
Peat do	8	534	W	W	W	W
Sand and gravel (construction) do	6,978	15,434	[e]7,500	[e]19,400	6,701	15,118
Stone (crushed) do	1,130	3,969	1,375	5,532	[p]1,200	[p]4,000
Combined value of other nonmetals and values indicated by symbol W	XX	16,856	XX	18,271	XX	16,245
Total	XX	36,967	XX	[r]43,369	XX	35,439
MARYLAND						
Clays[2] thousand short tons	733	$2,267	597	$1,984	405	$1,346
Gem stones	--	--	NA	2	NA	2
Lime thousand short tons	12	497	9	441	7	396
Peat do	4	W	W	W	--	--
Sand and gravel (construction) do	10,732	33,625	[e]9,500	[e]31,800	9,720	32,386
Stone:						
Crushed do	18,945	77,431	16,485	74,289	[p]15,100	[p]73,500
Dimension do	15	612	34	1,002	[p]32	[p]1,001
Combined value of cement, clays (ball clay), and values indicated by symbol W	XX	71,703	XX	65,937	XX	62,826
Total	XX	186,135	XX	[r]175,455	XX	171,457
MASSACHUSETTS						
Clays thousand short tons	210	$870	259	$1,322	210	$1,115
Lime do	180	10,806	170	10,793	135	9,414
Sand and gravel:						
Construction do	13,925	34,459	[e]12,500	[e]31,300	12,003	34,438
Industrial do	W	W	87	W	140	1,615
Stone:						
Crushed do	7,316	36,804	7,997	41,037	[p]6,900	[p]33,500
Dimension do	51	7,018	50	8,616	[p]51	[p]9,158
Combined value of gem stones, peat, and values indicated by symbol W	XX	1,254	XX	1,669	XX	62
Total	XX	91,211	XX	[r]94,737	XX	89,302
MICHIGAN						
Cement:						
Masonry thousand short tons	206	$14,292	173	$10,584	136	$8,752
Portland do	4,651	224,685	3,871	180,641	3,254	149,533
Clays do	1,982	7,212	1,610	5,862	1,022	4,370
Gem stones	NA	10	NA	15	NA	15
Gypsum thousand short tons	1,383	8,605	1,066	6,762	682	5,150
Iron ore (usable) thousand long tons, gross weight	15,895	634,355	14,193	W	W	W
Lime thousand short tons	836	36,750	807	36,800	571	26,823
Peat do	253	4,739	237	4,540	241	4,917
Salt do	2,406	104,842	2,321	103,293	2,002	106,303
Sand and gravel:						
Construction do	32,536	73,166	[e]28,100	[e]68,050	20,567	47,726
Industrial do	4,062	25,188	4,393	29,787	2,920	21,934
Stone:						
Crushed do	32,121	91,727	30,013	94,324	[p]20,700	[p]67,100
Dimension do	7	144	6	129	[p]4	[p]110
Combined value of bromine, calcium chloride, copper, iodine, iron oxide pigments (crude), magnesium compounds, silver, and values indicated by symbol W	XX	259,435	XX	899,618	XX	593,162
Total	XX	1,485,150	XX	[r]1,440,405	XX	1,035,895
MINNESOTA						
Clays thousand short tons	94	$1,206	84	$1,077	W	W
Gem stones	NA	5	NA	5	NA	$5
Iron ore (usable) thousand long tons, gross weight	45,472	1,686,839	50,176	2,062,118	23,715	1,021,056
Lime thousand short tons	162	3,562	155	3,818	133	4,694

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
MINNESOTA—Continued						
Manganiferous ore short tons	119,029	W	139,571	W	16,307	W
Peat thousand short tons	25	$1,140	25	$940	W	W
Sand and gravel:						
Construction do	25,110	49,180	e23,950	e49,770	20,276	$44,222
Industrial do	W	W	W	W	694	5,903
Stone:						
Crushed do	8,606	21,731	6,995	18,438	p7,100	p20,900
Dimension do	44	14,189	41	14,298	p40	p11,940
Combined values of items indicated by symbol W	XX	r4,158	XX	r4,297	XX	1,406
Total	XX	r1,782,010	XX	r2,154,761	XX	1,110,126
MISSISSIPPI						
Clays thousand short tons	1,596	$21,714	1,218	$23,309	805	$21,181
Lime do	31	707	--	--	--	--
Sand and gravel (construction) do	11,710	31,606	e10,480	e29,260	9,455	27,115
Combined value of cement, magnesium compounds (1980), sand and gravel (industrial), and stone (crushed)	XX	49,913	XX	r39,682	XX	24,389
Total	XX	103,940	XX	r92,251	XX	72,685
MISSOURI						
Barite thousand short tons	117	$5,570	185	$9,725	107	$5,703
Cement:						
Masonry do	62	3,117	103	5,495	88	4,855
Portland do	3,515	156,368	3,732	168,567	3,205	120,339
Clays do	1,817	16,798	1,747	18,414	2 1,383	2 13,409
Copper (recoverable content of ores, etc.) metric tons	13,576	30,655	8,411	15,783	7,941	13,010
Gem stones	NA	15	NA	10	NA	10
Gold (recoverable content of ores, etc.) troy ounces	W	W	--	--	--	--
Iron ore thousand long tons	W	W	W	W	717	W
Lead (recoverable content of ores, etc.) metric tons	497,170	465,393	389,721	313,870	474,460	267,150
Lime thousand short tons	1,667	63,733	W	W	W	W
Sand and gravel:						
Construction do	8,178	19,255	e7,500	e16,900	6,359	14,477
Industrial do	722	7,498	778	8,602	750	8,997
Silver (recoverable content of ores, etc.) thousand troy ounces	2,357	48,653	1,837	19,322	2,241	17,817
Stone (crushed) thousand short tons	48,296	130,254	40,910	116,297	p38,600	p113,300
Zinc (recoverable content of ores, etc.) metric tons	62,886	51,893	52,904	51,966	63,680	54,009
Combined value of asphalt (native, 1980), gold (1980), iron oxide pigments (crude), stone (dimension), and values indicated by symbol W	XX	r54,862	XX	r130,317	XX	100,698
Total	XX	r1,054,064	XX	r875,268	XX	733,774
MONTANA						
Antimony short tons	260	W	214	W	209	W
Clays thousand short tons	626	$22,200	601	$23,111	2 218	2 $8,064
Copper (recoverable content of ores, etc.) metric tons	37,749	85,236	62,485	117,257	57,086	93,521
Gem stones	NA	90	NA	100	NA	225
Gold (recoverable content of ores, etc.) troy ounces	48,366	29,627	54,267	24,943	75,171	28,258
Lead (recoverable content of ores, etc.) metric tons	295	276	194	157	661	372
Lime thousand short tons	223	9,001	194	7,621	45	2,331
Sand and gravel (construction) do	6,639	16,057	e5,640	e12,910	5,338	12,794
Silver (recoverable content of ores, etc.) thousand troy ounces	2,024	41,773	2,989	31,437	6,169	49,041

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
MONTANA—Continued						
Stone (crushed) thousand short tons	1,962	$6,302	1,582	$5,137	p1,400	p$4,700
Talc do	312	11,310	W	W	W	W
Zinc (recoverable content of ores, etc.) metric tons	71	59	25	24	W	W
Combined value of barite, cement, clays (fire clay, 1982), graphite (1982), gypsum, iron ore (1981-82), peat, phosphate rock, sand and gravel (industrial), stone (dimension), tungsten ore and concentrate, vermiculite, and values indicated by symbol W	XX	57,619	XX	80,384	XX	67,288
Total	XX	279,550	XX	r303,081	XX	266,594
NEBRASKA						
Clays thousand short tons	154	$456	136	$409	134	$392
Gem stones	NA	W	NA	W	NA	W
Sand and gravel:						
Construction thousand short tons	10,514	22,798	e11,770	e28,310	11,282	28,128
Industrial do	24	183	19	144	14	105
Stone (crushed) do	3,775	16,301	3,139	14,024	p3,100	p14,300
Combined value of cement, lime, and values indicated by symbol W	XX	40,736	XX	36,718	XX	36,632
Total	XX	80,474	XX	r79,605	XX	79,557
NEVADA						
Barite thousand short tons	1,918	$47,800	2,482	$79,716	1,575	$52,727
Clays do	64	2,082	73	2,948	103	2,640
Gem stones	NA	900	NA	1,000	NA	1,200
Gold (recoverable content of ores, etc.) troy ounces	278,495	170,595	524,802	241,220	738,321	277,542
Gypsum thousand short tons	852	8,276	778	6,914	656	4,523
Iron ore thousand long tons	W	W	99	1,490	77	1,119
Lead (recoverable content of ores, etc.) metric tons	26	24	W	W	W	W
Mercury 76-pound flasks	30,431	11,851	27,819	11,514	25,760	W
Molybdenum pounds	--	--	--	--	W	W
Perlite thousand short tons	6	92	W	W	W	W
Sand and gravel (construction) do	8,439	18,360	e7,065	e15,770	6,027	11,724
Silver (recoverable content of ores, etc.) thousand troy ounces	940	19,402	3,039	31,970	3,142	24,981
Stone (crushed) thousand short tons	W	W	1,343	5,664	p1,300	p4,500
Zinc (recoverable content of ores, etc.) metric tons	2	2	W	W	--	--
Combined value of cement (portland), copper, diatomite, fluorspar, lime, lithium compounds, magnesite, salt, sand and gravel (industrial), talc (1980), tungsten ore and concentrate, and values indicated by symbol W	XX	114,846	XX	r108,453	XX	144,944
Total	XX	394,230	XX	r506,659	XX	525,900
NEW HAMPSHIRE						
Sand and gravel (construction) thousand short tons	6,334	$15,837	e4,528	e$12,990	4,332	$12,593
Stone:						
Crushed do	590	2,281	665	2,599	p600	p3,100
Dimension do	103	7,167	89	6,889	p107	p7,500
Combined value of other nonmetals	XX	121	XX	122	XX	101
Total	XX	25,406	XX	r22,600	XX	23,294
NEW JERSEY						
Clays thousand short tons	63	$525	62	$563	63	$566
Gem stones	NA	1	NA	1	NA	1
Peat thousand short tons	20	564	26	1,476	W	W

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
NEW JERSEY—Continued						
Sand and gravel:						
Construction ___ thousand short tons__	5,829	$18,578	e9,756	e$26,050	7,940	$25,722
Industrial ____do____	2,766	26,957	2,305	26,438	2,140	28,151
Stone (crushed) ____do____	11,830	61,886	10,434	57,819	p10,700	p57,800
Zinc (recoverable content of ores, etc.) metric tons__	28,859	23,814	16,198	15,911	16,800	14,248
Combined value of iron ore (1981), magnesium compounds, marl (greensand), stone (dimension), titanium concentrate (ilmenite), and value indicated by symbol W___	XX	17,123	XX	20,404	XX	5,922
Total ____	XX	149,448	XX	r148,662	XX	132,410
NEW MEXICO						
Clays[2] ____ thousand short tons__	60	$114	64	$119	60	$112
Copper (recoverable content of ores, etc.) metric tons__	149,394	337,328	154,114	289,204	W	W
Gem stones ____	NA	150	NA	200	NA	200
Gold (recoverable content of ores, etc.) troy ounces__	15,847	9,707	65,749	30,221	W	W
Gypsum ____ thousand short tons__	182	1,688	166	2,256	198	887
Lead (recoverable content of ores, etc.) metric tons__	--	--	W	W	W	W
Manganiferous ore (5% to 35% Mn) short tons__	35,198	W	12,741	W	--	--
Peat ____ thousand short tons__	2	40	--	--	--	--
Perlite ____do____	539	14,404	489	14,983	408	13,355
Potassium salts __ thousand metric tons__	1,869	289,011	1,601	261,200	1,497	204,600
Pumice ____ thousand short tons__	84	814	93	919	97	809
Sand and gravel (construction) ____do____	7,050	17,676	e6,496	e19,780	5,616	17,670
Silver (recoverable content of ores, etc.) thousand troy ounces__	W	W	1,632	17,170	805	6,397
Stone:						
Crushed ____ thousand short tons__	2,581	9,473	4,162	12,485	p2,800	p13,700
Dimension ____do____	18	91	26	173	p18	p138
Combined value of barite (1980), carbon dioxide, cement, clays (fire clay), helium (Grade-A), lime, mica (scrap), molybdenum, salt, sand and gravel (industrial, 1982), vanadium (1980-81), zinc (1980-81), and values indicated by symbol W ____	XX	85,113	XX	r47,697	XX	173,945
Total ____	XX	765,609	XX	r696,407	XX	431,813
NEW YORK						
Clays[2] ____ thousand short tons__	596	$2,479	597	$2,310	352	$897
Gem stones ____	NA	20	NA	30	NA	30
Lead (recoverable content of ores, etc.) metric tons__	876	820	968	780	974	549
Peat ____ thousand short tons__	43	917	39	811	W	W
Salt ____do____	5,509	99,395	5,597	103,668	6,205	117,718
Sand and gravel:						
Construction ____do____	21,918	53,276	e18,280	e45,560	17,524	47,799
Industrial ____do____	W	W	55	W	45	512
Silver (recoverable content of ores, etc.) thousand troy ounces__	21	427	29	303	27	212
Stone:						
Crushed ____ thousand short tons__	34,483	120,764	30,681	117,689	p28,700	p132,800
Dimension ____do____	25	2,414	21	2,291	p22	p2,293
Zinc (recoverable content of ores, etc.) metric tons__	33,629	27,750	36,889	36,235	49,351	41,855
Combined value of cement, clays (ball clay), emery, garnet (abrasive), gypsum, iron ore, lime, talc, titanium concentrate (ilmenite), wollastonite, and values indicated by symbol W ____	XX	187,526	XX	171,554	XX	155,688
Total ____	XX	495,788	XX	r481,231	XX	500,353

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
NORTH CAROLINA						
Clays[2] ---- thousand short tons	2,852	$7,308	2,110	$6,838	1,573	$5,243
Feldspar ---- short tons	e499,600	e15,062	462,864	13,517	428,755	12,255
Gem stones	NA	40	NA	50	NA	50
Mica, scrap ---- thousand short tons	77	4,647	92	6,398	67	4,793
Sand and gravel:						
Construction ---- do	7,837	20,910	e6,294	e18,330	5,198	15,395
Industrial ---- do	1,472	7,825	1,236	10,440	716	4,878
Stone:						
Crushed ---- do	34,764	125,019	28,833	117,092	p27,500	p117,600
Dimension ---- do	55	4,536	30	2,773	p30	p2,814
Talc and pyrophyllite ---- do	W	W	[5]104	[5]825	83	1,266
Combined value of cement, clays (kaolin), lithium compounds, olivine, peat (1982), phosphate rock, and value indicated by symbol W	XX	194,986	XX	196,397	XX	92,964
Total	XX	380,333	XX	r372,660	XX	257,258
NORTH DAKOTA						
Gem stones	NA	$2	NA	$2	NA	$2
Peat ---- thousand short tons	W	31	W	36	W	W
Sand and gravel (construction) ---- do	5,173	14,457	e3,000	e6,500	2,347	4,873
Combined value of clays, lime, salt, and values indicated by symbol W	XX	7,886	XX	r8,310	XX	8,102
Total	XX	22,376	XX	r14,848	XX	12,977
OHIO						
Cement:						
Masonry ---- thousand short tons	126	$8,549	105	$7,129	86	$6,170
Portland ---- do	1,625	77,696	1,461	69,517	1,326	59,598
Clays ---- do	2,718	11,516	2,217	10,411	1,451	6,100
Gypsum ---- do	136	1,346	148	1,566	109	1,335
Lime ---- do	2,786	122,817	2,767	127,751	1,666	76,370
Peat ---- do	10	166	10	191	5	144
Salt ---- do	3,228	87,371	3,608	90,254	3,514	90,572
Sand and gravel:						
Construction ---- do	35,462	97,690	e32,240	e95,570	26,311	83,684
Industrial ---- do	1,510	16,601	1,487	20,893	1,223	17,816
Stone:						
Crushed ---- do	42,441	136,929	36,950	125,588	p30,300	p105,200
Dimension ---- do	35	1,558	W	W	W	W
Combined value of abrasives, gem stones, and values indicated by symbol W	XX	101	XX	3,290	XX	3,240
Total	XX	562,340	XX	r552,160	XX	450,229
OKLAHOMA						
Clays ---- thousand short tons	972	$2,249	838	$2,064	752	$1,907
Gem stones	--	--	NA	2	NA	2
Gypsum ---- thousand short tons	1,326	11,230	1,177	9,870	1,254	10,089
Helium:						
Grade A ---- million cubic feet	349	8,027	49	1,274	--	--
Crude ---- do	23	276	22	264	--	--
Pumice ---- thousand short tons	1	W	1	W	1	W
Sand and gravel:						
Construction ---- do	10,294	23,395	e9,000	e21,700	7,490	17,733
Industrial ---- do	1,587	13,767	1,500	14,317	1,222	13,114
Stone:						
Crushed ---- do	28,173	76,267	29,930	83,407	p30,100	p84,200
Dimension ---- do	16	678	18	738	p18	p968
Combined value of cement, feldspar, iodine, lime, salt, tripoli, and values indicated by symbol W	XX	88,244	XX	100,876	XX	97,031
Total	XX	224,133	XX	r234,512	XX	225,044

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
OREGON						
Clays thousand short tons	172	$321	176	$300	149	$212
Gem stones	NA	450	NA	600	NA	500
Gold (recoverable content of ores, etc.) troy ounces	W	W	2,830	1,301	W	W
Nickel (content of ores and concentrates) short tons	14,653	W	12,099	W	3,203	W
Pumice thousand short tons	219	1,318	W	W	W	W
Sand and gravel (construction) do	16,005	47,300	e12,000	e35,100	9,513	30,629
Silver (recoverable content of ores, etc.) thousand troy ounces	1	17	7	79	--	--
Stone:						
Crushed thousand short tons	19,251	49,606	16,482	46,055	p14,200	p41,900
Dimension do	15	231	(3)	5	(3)	p5
Talc and soapstone do	W	W	W	W	(3)	82
Combined value of cement, copper (1981), diatomite, lead (1981), lime, and values indicated by symbol W	XX	52,727	XX	56,107	XX	34,515
Total	XX	151,970	XX	r139,547	XX	107,843
PENNSYLVANIA						
Cement:						
Masonry thousand short tons	324	$20,298	293	$14,799	256	$14,048
Portland do	5,570	237,684	5,150	215,883	4,800	212,945
Clays[2] do	1,650	12,112	1,246	7,497	931	5,616
Gem stones	--	--	NA	5	NA	5
Lime thousand short tons	1,768	84,291	1,690	85,418	1,297	70,902
Mica (scrap) do	3	W	3	134	W	W
Peat do	26	552	25	647	27	669
Sand and gravel:						
Construction do	14,554	55,883	e14,000	e61,100	13,081	55,527
Industrial do	1,049	12,374	W	W	969	13,589
Stone:						
Crushed do	61,143	218,231	53,258	207,821	p50,400	p200,900
Dimension do	65	6,397	51	7,193	p48	p6,354
Tripoli short tons	W	W	1,263	W	W	W
Zinc (recoverable content of ores, etc.) metric tons	22,556	18,613	24,732	24,293	24,762	21,001
Combined value of clays (kaolin) and values indicated by symbol W	XX	1,171	XX	13,966	XX	998
Total	XX	667,606	XX	r638,756	XX	602,554
RHODE ISLAND						
Sand and gravel:						
Construction thousand short tons	2,506	$4,945	e1,332	e$3,985	1,146	$3,671
Industrial do	--	--	W	W	5	52
Stone (crushed) do	203	1,208	141	1,116	p130	p1,100
Combined value of other nonmetals and value indicated by symbol W	XX	17	XX	63	XX	18
Total	XX	6,170	XX	5,164	XX	4,841
SOUTH CAROLINA						
Cement, portland thousand short tons	1,704	$74,539	1,765	$79,407	1,624	$66,385
Clays[2] do	2,211	25,169	1,632	28,600	1,535	28,166
Gem stones	NA	5	NA	10	NA	10
Manganiferous ore thousand short tons	20	W	r22	W	15	W
Sand and gravel:						
Construction do	4,737	13,227	e5,131	e13,240	4,727	13,170
Industrial do	819	9,628	803	10,531	720	10,902
Stone:						
Crushed do	16,107	49,207	14,825	49,830	p14,000	p53,000
Dimension do	12	703	18	1,109	p14	p904
Combined value of cement (masonry), clays (fuller's earth), copper (1981), gold (1981), mica (scrap), silver (1981), vermiculite, and values indicated by symbol W	XX	22,301	XX	22,989	XX	21,936
Total	XX	194,779	XX	r205,716	XX	194,473

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
SOUTH DAKOTA						
Cement:						
Masonry ----- thousand short tons--	6	$377	6	$454	4	$383
Portland ---------------do----	459	23,042	450	23,290	520	27,978
Clays[2] ------------------do----	169	283	116	209	128	346
Gem stones---------------------	NA	50	NA	70	NA	70
Gold (recoverable content of ores, etc.) troy ounces--	267,642	163,947	278,162	127,854	185,038	69,558
Mica, scrap------ thousand short tons--	([3])	4	W	W	W	W
Sand and gravel (construction) ----do----	4,209	8,243	[e]4,285	[e]9,224	3,816	8,604
Silver (recoverable content of ores, etc.) thousand troy ounces--	51	1,058	56	587	26	209
Stone:						
Crushed------ thousand short tons--	3,151	8,942	2,985	9,085	[p]2,600	[p]7,400
Dimension ---------------do----	42	15,035	50	17,543	[p]48	[p]16,270
Combined value of beryllium (1981-82), clays (bentonite), feldspar, gypsum, iron ore (1980), lime, and values indicated by symbol W -------------------------	XX	6,873	XX	6,382	XX	4,855
Total--------------------	XX	227,854	XX	[r]194,698	XX	135,673
TENNESSEE						
Cement:						
Masonry ----- thousand short tons--	132	$7,241	66	$3,209	W	W
Portland ---------------do----	1,304	58,827	974	39,378	763	$36,689
Clays ------------------do----	1,188	22,844	1,047	23,134	766	20,107
Gem stones---------------------	NA	1	NA	5	NA	5
Phosphate rock -- thousand metric tons--	1,582	12,765	1,328	16,201	897	11,596
Sand and gravel:						
Construction--- thousand short tons--	8,676	22,824	[e]8,830	[e]24,130	5,051	15,917
Industrial ---------------do----	244	2,106	1,142	5,610	468	4,826
Stone:						
Crushed----------------do----	38,584	126,993	W	W	W	W
Dimension ---------------do----	10	883	11	1,063	[p]10	[p]1,012
Zinc (recoverable content of ores, etc.) metric tons--	111,754	92,218	117,684	115,597	121,306	102,882
Combined value of barite, copper, gold (1981), lime, pyrites, silver, and values indicated by symbol W ------------------	XX	47,133	XX	[r]192,822	XX	185,718
Total -------------------	XX	393,835	XX	[r]421,149	XX	378,752
TEXAS						
Cement:						
Masonry ----- thousand short tons--	241	$18,310	229	$15,699	236	$16,440
Portland ---------------do----	9,517	535,690	10,262	567,391	9,732	545,679
Clays ------------------do----	3,763	27,022	4,172	29,135	4,193	26,497
Gem stones---------------------	NA	160	NA	200	NA	200
Gypsum-------- thousand short tons--	1,681	14,124	1,783	14,900	1,954	16,681
Helium (Grade-A)---- million cubic feet--	35	805	238	6,188	458	15,572
Lime --------- thousand short tons--	1,515	67,075	1,393	67,158	1,125	62,277
Salt ------------------do----	9,978	93,414	8,397	84,240	7,421	82,805
Sand and gravel:						
Construction---------------do----	44,651	139,892	[e]46,000	[e]150,000	45,527	154,515
Industrial ---------------do----	2,054	31,684	2,242	36,992	2,623	45,007
Stone:						
Crushed----------------do----	76,483	220,265	72,454	219,086	[p]68,000	[p]205,000
Dimension ---------------do----	37	7,095	42	5,543	[p]50	[p]5,822
Sulfur (Frasch) -- thousand metric tons--	4,810	W	3,674	W	2,360	W
Talc and pyrophyllite thousand short tons--	401	4,295	282	4,127	205	3,024
Combined value of asphalt (native, 1980-81), fluorspar (1981-82), helium (crude), iron ore, magnesium chloride, magnesium compounds, sodium sulfate, and values indicated by symbol W ---------------	XX	574,820	XX	[r]551,751	XX	374,913
Total--------------------	XX	1,734,651	XX	[r]1,752,410	XX	1,554,432

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
UTAH						
Clays thousand short tons	365	$1,517	290	$2,296	[2]183	[2]$994
Copper (recoverable content of ores, etc.) metric tons	157,775	356,251	211,276	396,471	189,090	309,778
Gem stones	NA	70	NA	80	NA	80
Gold (recoverable content of ores, etc.) troy ounces	179,538	109,978	227,706	104,663	174,940	65,762
Gypsum thousand short tons	287	2,612	300	2,705	231	2,363
Iron ore (usable) thousand long tons, gross weight	1,307	18,540	691	W	W	W
Lead (recoverable content of ores, etc.) metric tons	W	W	1,662	1,338	W	W
Lime thousand short tons	259	13,293	333	16,679	286	15,121
Perlite do	(3)	2	(3)	4	--	--
Salt do	1,157	19,373	1,072	21,775	1,227	23,210
Sand and gravel:						
Construction do	8,906	17,234	e8,212	e54,550	7,579	14,920
Industrial do	W	W	22	286	W	W
Silver (recoverable content of ores, etc.) thousand troy ounces	2,203	45,476	2,883	30,321	4,342	34,522
Stone:						
Crushed thousand short tons	2,954	12,123	2,840	12,157	p2,500	p9,800
Dimension do	3	272	3	280	p3	p280
Zinc (recoverable content of ores, etc.) metric tons	W	W	1,576	1,548	--	--
Combined value of asphalt (native), beryllium concentrate, carbon dioxide (natural, 1980-81), cement, clays (fuller's earth, 1982), magnesium compounds, molybdenum, phosphate rock, potassium salts, sodium sulfate, tungsten ore and concentrate (1980-81), vanadium, and values indicated by symbol W	XX	166,883	XX	174,729	XX	145,669
Total	XX	763,624	XX	r819,882	XX	622,499
VERMONT						
Sand and gravel (construction) thousand short tons	1,900	$4,171	e3,196	e$7,254	3,218	$6,854
Stone:						
Crushed do	1,320	4,787	1,319	5,144	p1,200	p5,300
Dimension do	169	23,649	207	30,756	p202	p29,446
Talc do	318	2,753	W	W	W	W
Combined value of other nonmetals and values indicated by symbol W	XX	7,277	XX	10,919	XX	8,550
Total	XX	42,637	XX	r54,073	XX	50,150
VIRGINIA						
Clays thousand short tons	762	$3,172	502	$2,016	422	$2,237
Gem stones	NA	15	NA	20	NA	20
Iron oxide pigments short tons	W	W	W	W	1,269	372
Lead (recoverable content of ores, etc.) metric tons	1,563	1,463	1,607	1,294	--	--
Lime thousand short tons	824	33,872	804	35,984	641	29,118
Sand and gravel (construction) do	8,264	29,508	e7,109	e24,470	6,978	28,522
Stone:						
Crushed do	44,615	167,839	37,071	152,630	p35,200	p142,300
Dimension do	27	2,287	4	1,130	p4	p1,130
Zinc (recoverable content of ores, etc.) metric tons	12,038	9,934	9,731	9,558	--	--
Combined value of aplite, cement, gypsum, kyanite, sand and gravel (industrial), talc, vermiculite, and values indicated by symbol W	XX	57,216	XX	r52,178	XX	59,484
Total	XX	305,306	XX	r279,280	XX	263,183

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
WASHINGTON						
Cement:						
Masonry ----- thousand short tons--	W	W	15	$1,284	W	W
Portland ---------------do----	1,546	$89,208	1,560	100,845	1,154	$75,988
Clays -------------------do----	[2]301	[2]1,571	[2]263	[2]1,524	251	1,829
Gem stones----------------------	NA	150	NA	200	NA	200
Sand and gravel:						
Construction--- thousand short tons--	19,019	46,731	[e]16,870	[e]42,130	15,190	40,295
Industrial ---------------do----	W	W	304	3,358	242	2,809
Silver -------- thousand troy ounces--	W	W	67	709	W	W
Stone:						
Crushed------ thousand short tons--	11,085	W	9,516	25,619	[p]8,600	[p]23,800
Dimension --------------do----	6	248	15	2,378	[p]14	[p]2,375
Talc --------------------do----	--	--	--	--	8	20
Combined value of barite (1982), clays (fire clay, 1980-81), copper (1981-82), diatomite, gold, gypsum, lead (1980 and 1982), lime, olivine, peat, stone (1980), tungsten ore and concentrate (1981), and values indicated by symbol W --------------------	XX	69,454	XX	30,461	XX	24,712
Total--------------------	XX	207,362	XX	[r]208,508	XX	172,028
WEST VIRGINIA						
Clays[3]--------- thousand short tons--	291	$642	220	$502	210	$583
Sand and gravel (construction)----do----	2,728	11,454	[e]651	[e]2,601	751	3,392
Stone (crushed) ------------do----	9,766	36,305	7,885	28,399	[p]5,900	[p]22,700
Combined value of cement, clays (fire clay), lime, salt, sand and gravel (industrial) ---	XX	57,885	XX	56,046	XX	48,938
Total--------------------	XX	106,286	XX	[r]87,548	XX	75,613
WISCONSIN						
Iron ore (usable)----- thousand long tons, gross weight--	679	W	W	W	263	W
Lime --------- thousand short tons--	357	$17,287	326	$17,548	312	$17,685
Peat ----------------------do----	11	535	10	535	9	W
Sand and gravel:						
Construction-------------do----	21,067	38,025	[e]18,210	[e]34,522	14,515	29,218
Industrial ---------------do----	947	9,546	1,100	13,180	788	9,662
Stone:						
Crushed----------------do----	20,603	49,245	15,189	39,962	[p]11,400	[p]36,100
Dimension --------------do----	45	4,501	40	4,259	[p]37	[p]2,644
Combined value of abrasive stone, cement, clays (1980), peat (1982), and values indicated by symbol W ---------------	XX	33,151	XX	41,749	XX	16,985
Total--------------------	XX	152,290	XX	[r]151,755	XX	112,294
WYOMING						
Clays --------- thousand short tons--	3,081	$71,512	3,855	$100,926	2,561	$73,696
Gem stones----------------------	NA	190	NA	250	NA	250
Gypsum-------- thousand short tons--	312	2,731	299	2,625	283	2,805
Sand and gravel:						
Construction-------------do----	5,454	12,523	[e]3,680	[e]10,120	3,382	10,279
Industrial ---------------do----	W	W	--	--	--	--
Stone (crushed) --------------do----	4,374	14,835	3,224	9,858	[p]2,300	[p]7,300
Combined value of beryllium concentrate (1982), cement, iron ore, lead (1981), lime, silver (1981), sodium carbonate, zinc (1981), and value indicated by symbol W ------	XX	658,755	XX	644,279	XX	573,865
Total--------------------	XX	760,546	XX	[r]768,058	XX	668,195

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; value included in "Combined value" figure.

[3]Less than 1/2 unit.

[4]Excludes salt in brines; value included in "Combined value" figure.

[5]Excludes talc; value included in "Combined value" figure.

Table 7.—Mineral production[1] in the islands administered by the United States

(Thousand short tons and thousand dollars)

Area and mineral	1980		1981		1982	
	Quantity	Value	Quantity	Value	Quantity	Value
American Samoa: Stone	11	199	6	127	NA	NA
Guam: Stone	529	2,163	332	W	NA	NA
Virgin Islands: Stone	W	W	W	W	NA	NA

NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 8.—Mineral production[1] in the Commonwealth of Puerto Rico

(Thousand short tons and thousand dollars)

Mineral	1980		1981		1982	
	Quantity	Value	Quantity	Value	Quantity	Value
Cement	1,482	102,872	1,226	105,420	986	81,822
Clays	291	677	200	474	162	298
Lime	27	4,131	34	3,884	37	1,906
Sand and gravel	NA	NA	NA	NA	NA	NA
Stone	24,046	104,179	20,578	98,263	NA	NA
Total[2]	XX	211,859	XX	208,041	XX	84,026

NA Not available. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Total does not include value of items not available.

Table 9.—U.S. exports of principal minerals and products, excluding mineral fuels

Mineral	1981		1982	
	Quantity	Value (thousands)	Quantity	Value (thousands)
METALS				
Aluminum:				
Ingots, slabs, crude short tons	344,161	$526,646	401,174	$476,186
Scrap do	r241,161	236,204	214,299	157,666
Plates, sheets, bars, etc do	263,672	625,181	193,837	440,373
Castings and forgings do	8,930	40,482	7,180	41,156
Aluminum sulfate metric tons	25,296	3,439	6,121	1,280
Other aluminum compounds do	48,049	37,174	36,329	26,663
Antimony, metals and alloys, crude short tons	324	908	830	1,711
Bauxite including bauxite concentrate thousand metric tons	41	8,090	49	8,545
Beryllium pounds	78,189	3,094	134,013	3,696
Bismuth, metals and alloys do	78,703	708	52,758	371
Cadmium metric tons	239	332	11	126
Chromium:				
Ore and concentrate:				
Exports thousand short tons	71	5,893	8	1,574
Reexports do	67	9,575	57	9,172
Ferrochromium do	14	10,361	5	5,081
Cobalt (content) thousand pounds	834	16,462	596	7,690
Copper:				
Ore, concentrate, composition metal, unrefined (copper content) metric tons	166,293	231,181	200,157	225,261
Scrap do	50,078	70,106	54,419	63,484
Refined copper and semimanufactures do	127,613	517,950	115,147	438,219
Other copper manufactures do	18,451	37,464	17,591	32,787
Ferroalloys not elsewhere listed:				
Ferrophosphorus short tons	7,463	2,031	4,031	1,402
Ferroalloys, n.e.c do	6,358	8,439	4,980	8,481
Gold:				
Ore and base bullion troy ounces	1,199,421	570,549	1,333,210	498,139
Bullion, refined do	5,237,585	2,501,337	1,637,184	590,947
Iron ore thousand long tons	5,546	244,685	3,178	150,522
Iron and steel:				
Pig iron short tons	16,274	1,960	54,333	3,784
Iron and steel products (major):				
Steel mill products do	2,903,863	2,275,267	1,842,313	1,601,431
Other steel products do	443,796	1,138,745	342,406	913,111
Iron and steel scrap:				
Ferrous scrap including rerolling materials, ships, boats, other vessels for scrapping thousand short tons	6,524	653,118	6,925	622,711

See footnotes at end of table.

Table 9.—U.S. exports of principal minerals and products, excluding mineral fuels —Continued

Mineral	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
METALS —Continued				
Lead:				
Ore and concentrate ---metric tons	33,043	$18,958	29,104	$10,135
Pigs, bars, anodes, sheets, etc ---do	23,320	25,996	55,629	48,818
Scrap ---do	59,419	22,388	51,752	17,254
Magnesium, metal and alloys, scrap, semimanufactured forms, n.e.c ---short tons	34,855	90,853	39,613	104,845
Manganese:				
Ore and concentrate ---do	65,064	5,132	28,560	2,510
Ferromanganese ---do	14,925	12,477	10,311	7,517
Silicomanganese ---do	3,941	2,172	2,952	1,532
Metal ---do	2,523	3,980	2,948	3,861
Molybdenum:				
Ore and concentrate (molybdenum content) thousand pounds	51,350	406,816	49,783	232,214
Metals and alloys, crude and scrap ---do	2,641	9,763	697	2,317
Wire ---do	543	9,030	632	9,072
Semimanufactured forms, n.e.c ---do	165	4,768	190	4,762
Powder ---do	270	2,820	426	2,356
Ferromolybdenum ---do	455	2,983	255	1,035
Compounds ---do	7,328	40,686	12,441	41,806
Nickel:				
Alloys and scrap including unwrought metal, ingots, bars, sheets, anodes, etc ---short tons	37,671	259,712	49,729	257,182
Catalysts ---do	3,890	25,601	2,874	19,654
Wire ---do	660	8,262	481	6,011
Semifabricated forms, n.e.c ---do	r4,615	40,093	3,945	32,248
Platinum-group metals:				
Ore and scrap ---troy ounces	212,426	61,409	423,576	84,095
Palladium, rhodium, iridium, osmiridium, ruthenium, osmium (metal and alloys including scrap) ---do	259,745	61,136	262,764	41,057
Platinum (metal and alloy) ---do	391,194	179,344	175,805	57,682
Rare earths: Ferrocerium and alloys ---short tons	11	117	27	264
Selenium ---thousand pounds	133	668	259	749
Silicon:				
Ferrosilicon ---short tons	15,768	12,136	14,932	11,996
Silicon carbide, crude and in grains (includes reexports) do	r11,510	11,148	6,979	8,374
Silver:				
Ore, concentrate, waste, sweepings thousand troy ounces	12,772	151,090	12,594	102,768
Bullion, refined ---do	15,131	181,380	12,876	105,977
Tantalum:				
Ore, metal, other forms ---thousand pounds	303	20,520	618	20,113
Powder ---do	97	19,999	115	16,231
Tin:				
Ingots, pigs, bars, etc.:				
Exports ---metric tons	2,361	31,053	5,769	84,454
Reexports ---do	3,719	55,505	3,311	47,896
Tinplate and terneplate ---do	345,718	220,993	217,841	118,870
Titanium:				
Ore and concentrate ---short tons	7,297	2,099	21,682	1,280
Unwrought and scrap metal ---do	3,595	9,506	4,496	8,192
Intermediate mill shapes and mill products, n.e.c ---do	6,049	159,454	3,600	100,608
Pigments and oxides ---do	62,432	66,402	74,122	82,068
Tungsten (tungsten content):				
Ore and concentrate ---thousand pounds	175	1,150	672	3,387
Carbide powder ---do	1,213	18,158	1,214	14,059
Alloy powder ---do	2,138	32,207	1,327	17,239
Vanadium:				
Ore and concentrate (vanadium content) ---do	111	575	114	626
Pentoxide, etc ---do	692	2,012	3,163	6,808
Ferrovanadium ---do	869	4,397	653	3,436
Zinc:				
Slabs, pigs, or blocks ---metric tons	323	812	341	547
Sheets, plates, strips, other forms, n.e.c ---do	1,500	3,226	995	2,351
Waste, scrap, dust (zinc content) ---do	35,049	25,452	19,059	13,818
Semifabricated forms, n.e.c ---do	1,538	3,230	1,891	3,549
Ore and concentrate ---do	54,232	29,280	77,289	32,534
Zirconium:				
Ore and concentrate ---thousand pounds	23,260	3,838	22,023	3,268
Oxide ---do	1,565	2,254	2,033	5,420
Metals, alloys, other forms ---do	1,361	35,015	1,756	43,952
NONMETALS				
Abrasives (includes reexports):				
Industrial diamond, natural or synthetic:				
Powder or dust ---thousand carats	28,471	65,777	30,625	66,934
Other ---do	2,297	30,978	1,930	22,525
Diamond grinding wheels ---do	694	7,706	473	5,714
Other natural and artificial metallic abrasives and products	NA	113,016	NA	101,631

See footnotes at end of table.

Table 9.—U.S. exports of principal minerals and products, excluding mineral fuels —Continued

Mineral	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
NONMETALS —Continued				
Asbestos:				
Exports:				
Unmanufactured metric tons	64,126	$21,349	58,525	$19,543
Products do	NA	144,531	NA	126,704
Reexports:				
Unmanufactured do	293	159	246	170
Products do	NA	599	NA	1,163
Barite: Natural barium sulfate short tons	62,187	9,947	48,533	6,510
Boron:				
Boric acid do	46,184	24,602	35,030	19,082
Sodium borates, refined do	227,543	[e]58,000	193,096	[e]50,000
Calcium:				
Other calcium compounds including precipitated calcium carbonate do	25,659	11,713	31,282	15,613
Chloride do	32,794	13,004	55,057	11,065
Dicalcium phosphate do	55,862	33,434	61,308	36,454
Cement: Hydraulic and clinker do	302,777	31,564	202,366	27,456
Clays:				
Kaolin or china clay thousand short tons	1,412	155,999	1,296	146,989
Bentonite do	862	64,537	668	54,713
Other do	877	72,378	655	65,998
Diatomite do	162	32,933	141	29,863
Feldspar, leucite, nepheline syenite thousand pounds	28,050	1,110	21,600	989
Fluorspar short tons	11,261	1,194	10,573	1,084
Gem stones (includes reexports):				
Diamond thousand carats	3,215	854,100	2,683	638,655
Pearls	NA	5,856	NA	4,247
Other	NA	101,649	NA	106,105
Graphite, natural short tons	11,344	4,433	10,335	4,099
Gypsum:				
Crude, crushed or calcined thousand short tons	157	14,590	123	13,319
Manufactures, wallboard and plaster articles	NA	20,844	NA	16,231
Helium million cubic feet	389	17,084	378	19,735
Lithium compounds:				
Lithium carbonate[1] thousand pounds	NA	NA	10,910	13,506
Lithium hydroxide do	6,040	9,542	5,250	8,931
Other lithium compounds do	22,946	29,415	8,738	12,791
Lime short tons	28,429	3,996	22,541	3,199
Magnesium compounds:				
Magnesite, dead-burned do	20,926	4,727	12,869	2,721
Magnesite, crude, caustic-calcined, lump or ground do	36,683	14,559	23,125	10,925
Mica:				
Sheet, waste, scrap, ground do	10,920	3,437	11,147	3,182
Manufactured	NA	7,000	NA	5,499
Mineral-earth pigments, iron oxide, natural and synthetic short tons	4,967	11,704	9,065	17,795
Nitrogen compounds (major) thousand short tons	8,371	1,397,786	7,806	1,178,740
Phosphate rock thousand metric tons	10,554	419,999	9,735	383,554
Phosphatic fertilizers:				
Superphosphates do	[r]1,520	245,341	1,148	158,140
Ammonium phosphates do	3,942	789,770	3,707	678,685
Elemental phosphorus metric tons	[r]27,946	[r]42,749	15,084	25,125
Pigments and compounds: Zinc oxide (metal content) thousand metric tons	1	1,112	--	--
Potash:				
Potassium chloride metric tons	700,420	[r]80,680	691,040	56,710
Potassium sulfate do	79,600	16,095	140,000	27,648
Pumice and pumicite short tons	[e]1,000	NA	[e]1,000	NA
Quartz, crystal:				
Cultured thousand pounds	125	4,600	115	3,500
Natural do	[e]127	[e]490	69	380
Salt:				
Crude and refined thousand short tons	[r]1,046	[r]17,429	1,001	16,647
Shipments to noncontiguous territories do	71	9,145	65	8,451
Sand and gravel:				
Construction:				
Sand do	613	6,298	631	5,397
Gravel do	652	2,454	497	2,680
Industrial: Sand do	1,132	27,984	818	26,320
Sodium compounds:				
Sodium sulfate do	124	12,980	111	12,162
Sodium carbonate do	1,051	121,107	1,109	140,616
Stone:				
Crushed do	3,598	25,949	2,065	19,026
Dimension do	[r]NA	[r]20,698	NA	18,678
Sulfur, crude thousand metric tons	1,392	187,407	961	122,143
Talc, crude and ground thousand short tons	311	15,095	232	12,957
Total	XX	[r]17,618,070	XX	12,769,065

[e]Estimated. [r]Revised. NA Not available. XX Not applicable.
[1]Before 1982, lithium carbonate exports were included with "Other lithium compounds."

Table 10.—U.S. imports for consumption of principal minerals and products, excluding mineral fuels

Mineral	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
METALS				
Aluminum:				
Metal ---- short tons	710,656	$990,869	679,375	$858,017
Scrap ---- do	81,994	79,141	74,338	54,240
Plates, sheets, bars, etc ---- do	142,512	308,677	214,343	416,033
Aluminum oxide (alumina) thousand metric tons	3,978	837,932	3,183	770,444
Antimony:				
Ore and concentrate (antimony content) short tons	5,168	9,095	2,769	4,289
Sulfide including needle or liquated ---- do	106	249	88	188
Metal ---- do	2,631	6,569	1,900	3,893
Oxide ---- do	12,170	19,922	10,433	18,045
Arsenic:				
White (As_2O_3 content) ---- do	18,958	13,126	16,092	15,241
Metallic ---- do	323	2,079	150	1,044
Bauxite, crude ---- thousand metric tons	12,802	NA	10,122	NA
Beryllium ore ---- short tons	2,138	2,002	2,652	3,215
Bismuth, metal and alloys, gross weight ---- pounds	2,436,249	4,883	2,026,245	3,206
Cadmium: Metal ---- metric tons	3,090	13,369	2,305	4,684
Calcium:				
Metal ---- pounds	235,436	751	333,054	967
Chloride ---- short tons	86,865	4,088	60,623	3,010
Cesium compounds ---- pounds	24,415	1,049	16,647	799
Chromium:				
Ore and concentrate (Cr_2O_3 content) thousand short tons	368	49,948	209	29,670
Ferrochromium (gross weight) ---- do	428	213,611	141	77,495
Ferrochromium-silicon ---- do	11	[r]5,224	7	3,322
Metal ---- do	4	24,626	2	10,078
Cobalt:				
Metal ---- thousand pounds	13,906	238,820	11,610	137,652
Oxide (gross weight) ---- do	444	5,375	362	2,560
Salts and compounds (gross weight) ---- do	1,249	4,969	1,340	2,650
Columbium ore ---- do	1,882	10,102	910	2,765
Copper (copper content):				
Ore and concentrate ---- metric tons	39,132	56,548	118,055	141,478
Matte ---- do	2,718	3,232	4,042	3,609
Blister ---- do	30,124	68,083	97,374	142,249
Refined in ingots, etc ---- do	330,625	582,085	258,439	394,654
Scrap ---- do	27,002	40,705	28,076	35,281
Ferroalloys not elsewhere listed, includes spiegeleisen short tons	7,055	38,730	7,115	21,896
Gallium ---- kilograms	5,536	2,472	5,199	1,958
Germanium ---- do	22,350	12,328	12,459	9,287
Gold:				
Ore and base bullion ---- troy ounces	487,675	214,927	682,661	242,885
Bullion ---- do	4,164,476	1,942,560	4,237,669	1,650,719
Hafnium ---- pounds	5,310	126	--	--
Indium ---- thousand troy ounces	461	3,152	686	2,186
Iron ore ---- thousand long tons	28,328	947,977	14,501	470,847
Iron and steel:				
Pig iron ---- short tons	468,125	71,013	321,702	48,940
Iron and steel products (major):				
Steel mill products ---- do	19,898,371	10,247,660	16,536,292	8,947,132
Other products ---- do	822,396	954,618	744,790	1,342,878
Scrap including tinplate ---- thousand short tons	556	62,126	468	37,572
Lead:				
Ore, flue dust, matte (lead content) ---- metric tons	27,206	20,196	18,945	8,784
Base bullion (lead content) ---- do	449	340	19	28
Pigs and bars (lead content) ---- do	100,108	87,026	94,855	58,633
Reclaimed scrap, etc. (lead content) ---- do	2,661	2,220	4,834	1,755
Sheet, pipe, shot ---- do	474	726	467	694
Magnesium:				
Metal and scrap ---- short tons	6,122	10,182	3,652	5,732
Alloys (magnesium content) ---- do	625	2,652	955	3,889
Sheets, tubing, ribbons, wire, other forms (magnesium content) ---- do	150	4,804	177	5,982
Manganese:				
Ore (35% or more contained manganese) ---- do	639,141	42,643	237,759	16,160
Ferromanganese ---- do	671,178	226,618	492,708	154,490
Ferrosilicon-manganese (manganese content) do	[r]84,900	49,754	41,121	21,471
Metal ---- do	8,343	8,419	5,226	5,213
Mercury:				
Compounds ---- pounds	37,258	273	37,974	269
Metal ---- 76-pound flasks	12,408	5,005	8,916	3,003

See footnotes at end of table.

Table 10.—U.S. imports for consumption of principal minerals and products, excluding mineral fuels —Continued

Mineral	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
METALS —Continued				
Molybdenum:				
Ore and concentrate (molybdenum content) thousand pounds	1,988	$9,911	3,115	$13,429
Waste and scrap (gross weight) do	NA	2,674	NA	1,474
Metal:				
Unwrought (molybdenum content) do	153	2,893	67	1,370
Wrought (gross weight) do	93	2,557	79	1,959
Ferromolybdenum (gross weight) do	1,175	6,353	1,665	6,308
Material in chief value molybdenum (molybdenum content) do	1,651	9,574	2,749	12,143
Compounds (gross weight) do	5,164	18,052	4,772	13,030
Nickel:				
Ore short tons	513	42	--	--
Pigs, ingots, shot, cathodes do	123,141	747,920	82,297	446,850
Plates, bars, etc do	3,864	36,897	5,120	50,348
Slurry do	r94,786	223,060	58,568	105,633
Scrap do	5,226	17,496	4,300	13,349
Powder and flakes do	14,124	93,325	12,132	72,845
Ferronickel do	69,853	119,321	21,352	28,215
Oxide do	4,330	21,779	3,144	13,461
Platinum-group metals:				
Unwrought:				
Grains and nuggets (platinum) troy ounces	1,891	862	3,298	1,120
Sponge (platinum) do	888,995	424,780	689,647	305,356
Sweepings, waste, scrap do	235,379	58,462	339,095	42,236
Iridium do	11,110	6,203	19,402	9,242
Palladium do	1,114,313	142,180	1,039,210	98,285
Rhodium do	73,738	45,847	68,968	36,284
Ruthenium do	180,438	6,833	133,798	5,395
Other platinum-group metals do	44,337	16,455	23,429	7,501
Semimanufactured:				
Platinum do	179,321	83,972	114,028	42,515
Palladium do	116,548	13,717	60,760	5,159
Rhodium do	1,733	657	1,005	459
Other platinum-group metals do	1,814	288	1,066	384
Rare-earth metals:				
Ferrocerium and other cerium alloys short tons	92	1,249	95	1,092
Monazite do	8,233	3,158	7,940	3,070
Metals including scandium and yttrium pounds	3,750	168	7,094	139
Rhenium:				
Metal including scrap do	580	574	176	88
Ammonium perrhenate do	9,089	3,297	5,193	803
Selenium and selenium compounds (selenium content) do	686,887	7,766	765,731	7,711
Silicon:				
Metal (over 96% silicon content) short tons	29,636	58,034	26,338	52,195
Ferrosilicon do	155,648	80,317	76,732	40,343
Silver:				
Ore and base bullion thousand troy ounces	9,769	100,422	12,530	91,638
Bullion do	75,921	837,174	96,917	786,154
Sweepings, waste, doré do	8,425	90,853	8,010	49,287
Tantalum ore thousand pounds	1,952	57,726	1,297	16,286
Tellurium (tellurium content) pounds	83,671	1,811	36,600	906
Thallium do	882	87	2,827	103
Tin:				
Concentrate (tin content) metric tons	232	2,975	1,961	21,544
Dross, skimmings, scrap, residue, tin alloys, n.s.p.f. do	2,583	3,387	3,068	4,364
Tinfoil, powder, flitters, etc	NA	8,666	NA	12,288
Tin scrap and other tin-bearing material excluding tinplate scrap	NA	rNA	NA	NA
Tin compounds metric tons	170	2,098	321	2,667
Titanium:				
Ilmenite[1] short tons	505,042	36,215	596,211	41,630
Rutile do	202,373	59,024	163,325	39,610
Metal do	11,637	139,801	3,713	40,680
Ferrotitanium and ferrosilicon titanium do	615	1,582	152	263
Pigments do	124,906	127,396	138,922	146,569
Tungsten ore and concentrate (tungsten content) thousand pounds	11,752	91,195	7,778	46,748
Vanadium (vanadium content):				
Ferrovanadium do	1,968	13,288	1,339	8,065
Vanadium pentoxide do	669	3,344	238	1,063
Vanadium-bearing materials do	4,870	11,751	2,225	5,194

See footnotes at end of table.

Table 10.—U.S. imports for consumption of principal minerals and products, excluding mineral fuels —Continued

Mineral	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
METALS —Continued				
Zinc:				
Ore (zinc content) metric tons	245,710	$110,253	66,809	$27,132
Blocks, pigs, slabs do	612,007	549,326	456,233	370,773
Sheets, etc. do	332	472	700	694
Fume (zinc content) do	184	61	11	6
Waste and scrap do	5,782	2,578	2,653	1,232
Dross and skimmings do	7,629	4,090	7,104	3,134
Dust, powder, flakes do	7,993	9,519	5,864	6,925
Manufactures	NA	438	NA	540
Zirconium:				
Ore including zirconium sand short tons	91,108	8,378	68,465	6,144
Metal, scrap, compounds do	1,647	22,122	1,243	15,431
NONMETALS				
Abrasives:				
Diamond (industrial) thousand carats	20,404	110,510	19,127	85,837
Other	NA	188,667	NA	159,211
Asbestos metric tons	337,618	103,893	241,737	64,925
Barite:				
Crude and ground thousand short tons	1,946	108,599	2,344	120,518
Witherite short tons	99	87	333	126
Chemicals do	22,309	11,938	23,857	13,163
Boron:				
Boric acid do	1,124	763	4,362	1,903
Calcium borate, crude[2] do	98,100	15,202	39,000	6,386
Cement: Hydraulic and clinker thousand short tons	3,997	151,240	2,929	110,886
Clays short tons	33,314	7,895	24,245	4,514
Cryolite do	7,188	4,679	6,218	4,266
Feldspar:				
Crude do	108	44	48	24
Ground and crushed do	98	18	--	--
Fluorspar do	826,783	104,938	543,723	67,665
Gem stones:				
Diamond thousand carats	r4,409	2,201,262	4,636	1,917,612
Emeralds do	2,298	131,560	2,167	120,809
Other	NA	433,428	NA	346,031
Graphite short tons	68,708	23,998	56,491	20,712
Gypsum:				
Crude, ground, calcined thousand short tons	7,595	39,605	6,720	36,285
Manufactures	NA	12,115	NA	17,361
Iodine, crude thousand pounds	6,099	36,231	4,728	27,709
Lime:				
Hydrated short tons	65,717	3,471	60,108	3,305
Other do	438,623	18,092	288,266	13,503
Lithium:				
Ore do	(3)	(3)	15	5
Compounds do	280	1,845	133	568
Magnesium compounds:				
Crude magnesite do	12	r2,236	3	306
Lump, ground, caustic-calcined magnesia do	12,065	2,177	13,959	2,055
Refractory magnesia, dead-burned, fused magnesite, dead-burned dolomite do	76,810	23,114	59,519	14,588
Compounds do	35,382	6,241	44,797	7,965
Mica:				
Uncut sheet and punch thousand pounds	11,558	2,747	7,185	1,790
Scrap do	r(4)	23	992	47
Manufactures do	664	3,059	724	2,936
Mineral-earth pigments, iron oxide pigments:				
Ocher, crude and refined short tons	r152	r83	31	20
Siennas, crude and refined do	98	42	112	46
Umber, crude and refined do	5,919	944	3,768	649
Vandyke brown do	1,070	340	423	153
Other natural and refined do	r969	r967	880	576
Synthetic do	31,453	16,539	20,641	11,886
Nepheline syenite:				
Crude do	2,780	25	316	16
Ground, crushed, etc do	503,320	11,504	455,280	13,735
Nitrogen compounds (major) including urea thousand short tons	4,844	610,574	4,841	681,368
Peat:				
Fertilizer-grade short tons	291,732	37,955	309,467	38,605
Poultry- and stable-grade do	50,198	6,845	60,533	7,752
Phosphates, crude thousand metric tons	r16	r673	(4)	1,302
Phosphatic materials:				
Fertilizer and fertilizer materials do	16	3,112	8	1,672
Elemental phosphorus do	(4)	1,247	(4)	1,017
Other do	92	r15,471	41	6,459

See footnotes at end of table.

Table 10.—U.S. imports for consumption of principal minerals and products, excluding mineral fuels —Continued

Mineral	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
NONMETALS —Continued				
Pigments and salts:				
Lead pigments and compounds ----- metric tons--	15,186	$15,233	12,904	$10,613
Zinc pigments and compounds---------- do----	38,615	33,501	35,721	30,932
Potash -------------------------- do----	7,903,300	750,400	6,337,900	575,400
Pumice:				
Crude or unmanufactured --------- short tons--	2,954	70	2,887	102
Wholly or partly manufactured--------- do----	89,329	601	118,228	699
Manufactured, n.s.p.f --------------------	NA	126	NA	104
Quartz crystal (Brazilian pebble) -- thousand pounds--	389	233	417	245
Salt----------------- thousand short tons--	r4,319	r44,523	5,451	56,184
Sand and gravel:				
Industrial sand----------------- do----	r4	621	89	2,523
Other sand and gravel -------------- do----	333	1,987	185	1,479
Sodium compounds:				
Sodium bicarbonate ----------------- do----	3	680	7	1,360
Sodium carbonate ------------------ do----	12	1,625	18	2,410
Sodium sulfate ------------------- do----	275	19,135	394	28,758
Stone:				
Crushed ----------------------- do----	r3,036	r8,896	1,664	10,570
Dimension ------------------------	NA	r132,904	NA	169,908
Calcium carbonate fines --- thousand short tons--	270	4,577	192	5,811
Strontium:				
Mineral ------------------- short tons--	49,699	3,206	33,075	2,057
Compounds --------------------- do----	r4,644	r3,730	1,943	1,850
Sulfur and compounds, sulfur ore and other forms, n.e.s ---------- thousand metric tons--	2,522	209,766	1,905	164,885
Talc, unmanufactured ------ thousand short tons--	27	4,562	27	5,215
Total --------------------------	XX	r28,810,755	XX	24,399,414

rRevised. NA Not available. XX Not applicable.
[1]Includes titanium slag averaging about 70% TiO_2. For detail, see Titanium chapter.
[2]Owing to a change of reporting, 1982 calcium borate, crude, imports are not comparable with those of previous years.
[3]Revised to zero.
[4]Less than 1/2 unit.

Table 11.—Comparison of world and U.S. production of selected nonfuel mineral commodities

(Thousand short tons unless otherwise specified)

Mineral	1981 World production[1]	1981 U.S. production	1981 U.S. percent of world production	1982[p] World production[1]	1982[p] U.S. production	1982[p] U.S. percent of world production
METALS, MINE BASIS						
Antimony (content of ore and concentrate) short tons	63,356	646	1	59,304	503	1
Arsenic trioxide[2] do	30,912	W	NA	29,465	W	NA
Bauxite[3] thousand metric tons	85,474	1,510	2	74,441	732	1
Beryl[2] short tons	3,257	W	NA	3,158	W	NA
Bismuth thousand pounds	7,457	W	NA	7,161	W	NA
Chromite	11,736	--	--	10,907	--	--
Cobalt (content of ore and concentrate) short tons	33,372	--	--	27,650	--	--
Columbium-tantalum concentrate (gross weight) thousand pounds	78,413	NA	NA	75,715	NA	NA
Copper (content of ore and concentrate) thousand metric tons	8,175	1,538	19	7,964	1,140	14
Gold (content of ore and concentrate) thousand troy ounces	41,227	1,379	3	42,713	1,447	3
Iron ore (gross weight) thousand long tons	843,204	73,174	9	783,032	35,433	5
Lead (content of ore and concentrate) thousand metric tons	3,343	446	13	3,451	512	15
Manganese ore (35% or more Mn, gross weight)	25,952	--	--	24,754	--	--
Mercury thousand 76-pound flasks	214	28	13	204	26	13
Molybdenum (content of ore and concentrate) thousand pounds	241,097	139,900	58	200,339	83,050	41
Nickel (content of ore and concentrate)	785	12	2	670	3	([4])
Platinum-group metals[2] thousand troy ounces	6,923	7	([4])	6,454	8	([4])
Silver (content of ore and concentrate) do	362,308	40,683	11	372,528	40,239	11
Tin (content of ore and concentrate) metric tons	252,575	W	NA	241,114	W	NA
Titanium concentrates (gross weight):						
Ilmenite	4,010	509	13	3,371	228	7
Rutile	409	W	NA	381	W	NA
Tungsten ore and concentrate (contained tungsten) thousand pounds	108,481	7,948	7	98,926	3,354	3
Vanadium (content of ore and concentrate) short tons	38,683	5,126	13	36,498	4,098	11
Zinc (content of ore and concentrate) thousand metric tons	5,657	312	6	6,047	300	5
METALS, SMELTER BASIS						
Aluminum (primary only)	16,614	4,948	30	14,626	3,609	25
Cadmium metric tons	17,242	1,603	9	16,140	1,007	6
Cobalt short tons	28,237	447	2	21,706	508	2
Copper smelter (primary and secondary)[5] thousand metric tons	8,297	1,378	17	8,153	1,021	13
Iron, pig	557,333	73,755	13	500,026	43,342	9
Lead, smelter (primary and secondary)[6] thousand metric tons	5,029	1,139	23	5,075	1,088	21
Magnesium (primary only)	326	143	44	273	99	36
Nickel[7]	769	49	6	683	45	7
Selenium[8] thousand pounds	2,871	555	19	2,684	536	20
Steel, raw	777,359	[9]120,828	16	708,269	[9]74,577	11
Tellurium[8] thousand pounds	230	W	NA	213	W	NA
Tin metric tons	247,260	[10]2,000	1	241,164	[10]3,500	1
Zinc (primary and secondary) thousand metric tons	6,112	397	6	5,881	302	5
NONMETALS						
Asbestos do	4,480	76	2	4,311	64	1
Barite	9,057	[11]2,849	31	7,887	[11]1,845	23
Boron minerals	2,820	1,481	53	2,530	1,234	49
Bromine thousand pounds	753,494	[11]377,097	50	837,790	[11]401,100	48
Cement, hydraulic	983,250	[12]72,932	7	982,670	[12]64,341	7
Clays:						
Bentonite[8]	7,474	[11]4,947	66	5,717	[11]3,245	57
Fuller's earth[8]	2,123	[11]1,656	78	2,200	[11]1,683	77
Kaolin[2]	22,695	[11]7,660	34	21,041	[11]6,362	30
Corundum	24	--	--	21	--	--
Diamond thousand carats	42,557	--	--	45,166	--	--

See footnotes at end of table.

Table 11.—Comparison of world and U.S. production of selected nonfuel mineral commodities —Continued

(Thousand short tons unless otherwise specified)

Mineral	1981			1982[p]		
	World production[1]	U.S. production	U.S. percent of world production	World production[1]	U.S. production	U.S. percent of world production
NONMETALS —Continued						
Diatomite	1,627	[11]687	42	1,531	[11]613	40
Feldspar[2]	3,463	665	19	3,416	615	18
Fluorspar	5,568	115	2	5,003	77	2
Graphite	633	--	--	607	W	NA
Gypsum	84,076	11,497	14	80,616	10,538	13
Iodine, crude thousand pounds	26,516	W	NA	25,955	W	NA
Lime (sold or used)	129,426	[12]18,890	15	123,404	[12]14,112	11
Magnesite	12,356	W	NA	12,268	W	NA
Mica (including scrap and ground) thousand pounds	737,895	500,000	68	624,602	404,000	65
Nitrogen, N content of ammonia	81,573	15,619	19	80,078	12,742	16
Peat	387,226	686	([4])	408,190	721	([4])
Perlite	1,572	[11]591	38	1,481	[11]506	34
Phosphate rock thousand metric tons	137,524	53,624	39	122,633	37,414	31
Potash (K_2O equivalent) do	27,046	2,156	8	26,230	1,784	7
Pumice[8]	13,734	499	4	12,871	416	3
Salt	187,781	[11 12]38,915	21	186,005	[11 12]37,896	20
Sodium compounds, natural and manufactured:						
Sodium carbonate	30,895	8,281	27	30,572	7,819	26
Sodium sulfate	6,056	1,077	18	5,784	895	15
Strontium[8] short tons	131,016	--	--	122,158	--	--
Sulfur, all forms thousand metric tons	53,563	12,145	23	50,660	9,787	19
Talc and pyrophyllite	7,955	1,343	17	7,595	1,135	15
Vermiculite[8]	576	320	56	564	316	56

[p]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data.

[1]For those commodities for which U.S. data are withheld to avoid disclosing company proprietary data, the world total excludes U.S. output and the U.S. percent of world production cannot be reported.

[2]World total does not include an estimate for output in China.

[3]U.S. figures represent dried bauxite equivalent of crude ore; to the extent possible, individual country figures that are included in the world total are also on the dried bauxite equivalent basis, but for some countries, available data are insufficient to permit this adjustment.

[4]Less than 0.5%.

[5]Primary and secondary blister and anode copper, including electrowon refined copper that is not included as blister or anode.

[6]Includes bullion.

[7]Refined nickel plus nickel content of ferronickel, and nickel oxide.

[8]World total does not include estimates for output in the U.S.S.R. or China.

[9]Data from American Iron and Steel Institute. Excludes production of castings by companies that do not report steel ingot.

[10]Includes tin content of alloys made directly from ore.

[11]Quantity sold or used by producers.

[12]Includes Puerto Rico.

Abrasive Materials

By J. Fletcher Smoak[1]

CONTENTS

Consumption of abrasive materials in the United States decreased 23% in value from that of 1981 to $262 million, of which 53% was manufactured abrasive, 39% was industrial diamond (natural and synthetic), and 8% was natural abrasive.

Production of natural abrasives, excluding industrial diamond, appeared to be stable when compared with that of 1981. Production of tripoli, a porous siliceous rock, increased slightly after decreasing steadily over the three previous years. The production increase of garnet, an abundant iron-aluminum silicate, was attributed to increased output from one plant that had completed an expansion program in late

Table 1.—Salient abrasives statistics in the United States

	1978	1979	1980	1981	1982
Natural abrasives production by producers:					
Tripoli (crude) short tons	138,311	127,878	121,233	107,330	112,928
Value thousands	$849	$831	$676	$617	$653
Special silica stone[1] short tons	[r]675	[r]594	[r]631	[r] [2]2,501	[2]1,285
Value thousands	[r]$2,338	[r]$1,764	[r]$1,933	[r] [2]$1,096	[r] [2]$553
Garnet[3] short tons	20,822	21,240	26,909	25,451	27,303
Value thousands	$1,310	$1,535	$1,908	$2,059	$2,321
Emery short tons	W	10,005	W	W	W
Value thousands	W	$204	W	W	W
Manufactured abrasives[4] short tons	550,877	712,733	614,963	[5]586,915	418,224
Value thousands	$172,554	$230,024	$216,946	[5]$225,503	$167,471
Foreign trade (natural and artificial abrasives):					
Exports (value) do	$138,659	$185,587	$193,679	$189,719	$174,126
Reexports (value) do	$41,016	$42,922	$47,521	$27,758	$22,648
Imports for consumption (value) do	$231,720	$270,599	$268,842	[r]$301,695	$245,048

[r]Revised. W Withheld to avoid disclosing company proprietary data.
[1]Includes grindstones, oilstones, and whetstones. Excludes grinding pebbles and tube-mill liners.
[2]The large increase in quantity and decrease in value was caused by changes in reporting procedures. In 1978-80, quantity and value were for finished products; 1981-82 data were for crude mined quantity and first marketable value. Finished product data are shown in table 7.
[3]Primary garnet—denotes first marketable product.
[4]Includes Canadian production of crude silicon carbide and fused aluminum oxide and shipments of metallic abrasives by U.S. producers.
[5]Excludes U.S. and Canadian production and value of aluminum-zirconium oxide.

1981. The special silica stone survey was expanded in 1982 to include many additional whetstone cutting facilities that had not been previously canvassed. Production of emery, an impure aluminum oxide, remained approximately the same as that of 1981, which was 30% below the 1980 level.

Production of nonmetallic manufactured abrasive materials plus shipments of metallic abrasive materials decreased 29% in quantity and 26% in value. This was the lowest level of production reported for manufactured abrasives since 1963 and reflected the worldwide economic decline, especially in the industrial segment. Nonmetallic abrasives consisted of fused aluminum oxide and crude silicon carbide produced in the United States and Canada and accounted for 60% of the value of manufactured abrasives. Metallic abrasives shipments included chilled and annealed iron shot and grit, steel shot and grit, plus cut wire, aluminum, and stainless steel shot.

A potentially large Australian mining operation was scheduled to begin production of diamonds at its alluvial deposits in 1983 with annual output projected at 2 million carats and to begin mining of its kimberlite pipe in 1985 with an initial annual production rate of 15 to 20 million carats. Approximately 75% of the production from the kimberlite pipe was expected to be of industrial quality.

Total imports of abrasive materials decreased 19% in value compared with that of 1981. Imports of industrial diamond decreased 22% in value and 6% in quantity. The decrease in value was partly attributed to the reduction of the unit value of imported industrial diamond stone, which accounted for most of the total value. Total exports and reexports of abrasive materials decreased 10% in value.

Domestic Data Coverage.—Domestic production data for abrasive materials were developed by the Bureau of Mines from six separate, voluntary surveys in 1982. A total of 57 operations were canvassed by these 6 surveys. All responded, representing the total production shown in tables 1, 6, 7, 9, 16, 17, and 18.

FOREIGN TRADE

Imports of abrasive materials in 1982 decreased 19% in value from that of 1981, and exports plus reexports decreased 10% in value from that of 1981 and 18% in value from that of 1980. Net imports, the excess of imports over exports and reexports, were valued at $48.2 million.

Industrial diamond imports totaled 19.1 million carats of loose material valued at $86 million, a decrease of 6% in quantity and 22% in value from that of 1981. Ireland, the largest U.S. source of imported industrial diamonds in terms of quantity, shipped to the United States a total of 8.6 million carats, mostly synthetic and valued at $22.5 million, a decrease of 8% in quantity but an increase of 17% in value from that of 1981. The share of imports from Ireland was 45% of the total quantity and 26% of the total value. Of the 8.6 million carats from Ireland, 7.3 million carats were synthetic powder and dust with an average value of $2.16 per carat.

The Republic of South Africa, the largest U.S. source of imported industrial diamonds in terms of value, shipped to the United States a total of 4.2 million carats valued at $32.0 million, an increase of 5% in quantity but a decrease of 31% in value from that of 1981. The share of imports from the Republic of South Africa was 22% of the total quantity and 37% of the total value. Of the 4.2 million carats, 2.4 million carats were industrial diamond stones with an average value of $11.56 per carat, a decrease of 21% in unit value from that of 1981.

Exports plus reexports of industrial diamond, loose, increased 6% to 32.6 million carats but decreased 8% in value to $89.5 million compared with that of 1981. The diamond content in diamond wheels, exported and reexported, was 473,000 carats, a decrease of 32%; the declared value was $5.7 million, a decrease of 26%. The value of imported diamond wheels increased to $6.1 million from $5.6 million in 1981.

Table 2.—U.S. exports of abrasive materials, by kind

(Thousands)

Kind	1981 Quantity	1981 Value	1982 Quantity	1982 Value
NATURAL ABRASIVES				
Industrial diamond, natural or synthetic, powder or dust ____ carats__	27,887	$64,166	29,588	$63,666
Industrial diamond, natural or synthetic, other ____ do____	450	5,331	415	3,826
Emery, natural corundum, pumice in blocks ____ pounds__	35,585	1,099	10,403	781
MANUFACTURED ABRASIVES				
Artificial corundum (fused aluminum oxide) ____ do____	32,326	17,046	58,709	17,083
Silicon carbide, crude or in grains ____ do____	22,979	11,137	13,957	8,365
Carbide abrasives, n.e.c. ____ do____	684	1,481	616	1,138
Other refined abrasives ____ do____	36,419	8,688	25,191	11,575
Grinding and polishing wheels and stones:				
Diamond ____ carats__	682	7,547	470	5,590
Polishing stones, whetstones, oilstones, hones, similar stone ____ number__	844	2,501	714	2,320
Wheels and stones, n.e.c ____ pounds__	5,813	26,361	4,928	23,837
Abrasive paper and cloth, coated with natural or artificial abrasive materials ____ do____	16,462	35,497	11,259	28,521
Grit and shot, including wire pellets ____ do____	27,608	8,865	23,053	7,424
Total ____	XX	189,719	XX	174,126

XX Not applicable.

Table 3.—U.S. reexports of abrasive materials, by kind

(Thousands)

Kind	1981 Quantity	1981 Value	1982 Quantity	1982 Value
NATURAL ABRASIVES				
Industrial diamond, natural or synthetic, powder or dust ____ carats__	584	$1,611	1,037	$3,268
Industrial diamond, natural or synthetic, other ____ do____	1,847	25,647	1,515	18,699
Emery, natural corundum, pumice in blocks ____ pounds__	73	16	13	42
MANUFACTURED ABRASIVES				
Artificial corundum (fused aluminum oxide) ____ do____	--	--	18	6
Silicon carbide, crude or in grains ____ do____	41	11	(1)	9
Grinding and polishing wheels and stones:				
Diamond ____ carats__	12	159	3	124
Wheels and stones, n.e.c.[1] ____ pounds__	35	139	64	294
Abrasive paper and cloth, coated with natural or artificial abrasive materials ____ do____	62	172	71	206
Grit and shot, including wire pellets ____ do____	11	3	--	--
Total ____	XX	27,758	XX	22,648

XX Not applicable.

[1]Includes value of hones, whetstones, pulpstones, oilstones, polishing stones, and quantity and value of other abrasive wheels.

Table 4.—U.S. imports for consumption of abrasive materials (natural and artificial), by kind

(Thousands)

Kind	1981 Quantity	1981 Value	1982 Quantity	1982 Value
Emery, flint, rottenstone, tripoli, crude or crushed ___short tons__	9	$529	4	$273
Silicon carbide, crude ___do____	80	33,602	63	27,453
Aluminum oxide, crude ___do____	188	61,762	116	42,849
Other crude artificial abrasives ___do____	1	254	1	140
Abrasives, ground grains, pulverized or refined:				
Rottenstone and tripoli ___do____	(1)	5	(1)	1
Silicon carbide ___do____	5	8,611	4	7,325
Aluminum oxide ___do____	9	7,784	9	7,295
Emery, corundum, flint, garnet, other, including artificial abrasives ___do____	2	4,554	1	2,309
Papers, cloths, other materials wholly or partly coated with natural or artificial abrasives	(2)	45,304	(2)	39,935
Hones, whetstones, oilstones, polishing stones ___number__	464	490	776	927
Abrasive wheels and millstones:				
Burrstones manufactured or bound up into millstones short tons__	(1)	1	(1)	4
Solid natural stone wheels ___number__	22	150	116	101
Diamond ___do____	92	5,607	97	6,121
Abrasive wheels bonded with resins ___pounds__	5,215	8,728	4,135	7,213
Other	(2)	7,335	(2)	8,592
Articles not specifically provided for:				
Emery or garnet	(2)	17	(2)	102
Natural corundum or artificial abrasive materials	(2)	1,235	(2)	3,681
Other, n.s.p.f	(2)	2,211	(2)	2,460
Grit and shot, including wire pellets ___pounds__	10,512	2,518	9,813	1,958
Diamond, natural and synthetic:				
Diamond dies ___number__	11	488	7	472
Crushing bort ___carats__	12	55	146	234
Natural industrial diamond stones ___do____	4,638	70,998	3,683	51,564
Miners' diamond ___do____	1,310	11,858	(3)984	7,418
Powder and dust, synthetic ___do____	10,874	20,215	10,990	20,179
Powder and dust, natural ___do____	3,570	7,384	3,324	6,442
Total	XX	r301,695	XX	245,048

rRevised. XX Not applicable.
[1]Less than 1/2 unit.
[2]Quantity not reported.
[3]Includes 48,000 carats of synthetic miners' diamond.

TRIPOLI

Fine-grained, porous silica materials are grouped together under the category tripoli because they have similar properties and end uses. Production of crude tripoli, table 1, increased in quantity and value in 1982 because several producers increased crude inventories. However, processed tripoli, sold or used, table 6, remained essentially unchanged in quantity. The decrease in production of processed tripoli in 1981 and 1982 was attributed to depressed general economic conditions that had persisted since 1980. Of processed tripoli, 61% was used for fillers in 1982 and 39% was used for abrasives, slightly changed from that of 1981. Since tripoli grains lack distinct edges and corners, it was used as a mild abrasive in toothpaste and industrial soaps, and as a buffing and polishing compound in lacquer finishing in the automobile industry. The mineral was also used as a filler and extender in paint, plastic, rubber, and enamels. Advantages of its use in paint include its chemical inertness for corrosion-resistant coatings; a low surface moisture, which allows it to be mixed into ambient-moisture-cured systems without predrying; good wettability and dispersion properties in a solvent base; a General Electric brightness of 85% to 90% and low oil absorption, allowing high pigment loading without appreciable increases in viscosity; and a relatively high Mohs' scale hardness of 6.5 to 7, which provides resistance to abrasion.[2]

The six tripoli producers in 1982 were Malvern Minerals Co., Garland County, Ark., which produced crude and finished material; Midwestern Minerals Corp., which produced crude material in Ottawa County, Okla., and finished material in Benton County, Ark.; American Tripoli Co., which produced crude material in Ottawa County, Okla., and finished material in Newton County, Mo.; Illinois Minerals Co. and Tammsco, Inc., both in Alexander County, Ill., which produced crude and finished amorphous (microcrystalline) silica; and Keystone Filler and Manufacturing Co., in Northumberland County, Pa., which processed rottenstone, a decomposed fine-grained siliceous limestone or shale. The producer list had not changed since 1975.

The Carborundum Co. sold its American Tripoli Co. Div. in Seneca, Mo., to a group of investors in April 1982. American Tripoli was expected to operate as a completely separate entity with no changes in operations or personnel. Midwestern Minerals, Rogers, Ark., permanently discontinued its tripoli mining and processing operation in 1982. Midwestern Minerals processed and planned to continue to process other materials of higher economic value that could become contaminated by tripoli. Malvern Minerals, Hot Springs, Ark., reported that the expansion announced in 1981 was underway.

Table 5.—Quoted prices for tripoli and amorphous silica

Tripoli, paper bags, carload lots, f.o.b., in cents per pound:	
White, Elco, Ill.: Air floated through 200 mesh	3.55
Rose and cream, Seneca, Mo., and Rogers, Ark.:	
Once ground	2.90
Double ground	2.90
Air float	3.15
Amorphous silica, 50-pound, paper bags, f.o.b., in dollars per ton:	
Elco, Ill.:	
Through 200 mesh, 90% to 95%	$71.00
Through 200 mesh, 96% to 99%	72.00
Through 325 mesh, 90% to 95%	73.00
Through 325 mesh, 96% to 98%	69.50
Through 325 mesh, 98% to 99.4%	78.00
Through 325 mesh, 99.5%	95.00
Through 400 mesh, 99.9%	128.00
Below 15 micrometers, 99%	137.00
Below 10 micrometers, 99%	164.00
Below 8 micrometers, 99%	196.00

Source: Engineering and Mining Journal, December 1982.

Table 6.—Processed tripoli[1] sold or used by producers in the United States, by use[2]

Use		1978	1979	1980	1981	1982
Abrasives	short tons	75,574	53,600	39,352	34,494	35,798
Value	thousands	$3,709	$2,468	$2,253	$2,206	$2,477
Filler	short tons	36,505	62,409	59,909	56,932	55,314
Value	thousands	$2,220	$3,811	$4,025	$4,393	$4,557
Other	short tons	[e]2,190	--	--	--	--
Value	thousands	[e]$97	--	--	--	--
Total[3]	short tons	114,269	116,009	99,261	91,426	91,111
Total value[3]	thousands	$6,026	$6,279	$6,277	$6,600	$7,034

[e]Estimated.
[1]Includes amorphous silica and Pennsylvania rottenstone.
[2]Partly estimated.
[3]Data may not add to totals shown because of independent rounding.

SPECIAL SILICA STONE PRODUCTS

Special silica stone products produced in 1982 included oilstones and whetstones from Arkansas and Indiana, grindstones from Ohio, and deburring media from Ohio and Wisconsin.

Four main grades of whetstone were produced ranging from the high-quality Arkansas Stone with porosity of 0.07% and characterized by a waxy luster down to the Washita Stone with a porosity of 16% and resembling unglazed porcelain. The four main grades were:

Trade name	Use
Washita Stone	Rapid sharpening.
Soft Arkansas	General purpose.
Hard Arkansas	Polishing blades to a very fine edge.
Black Hard Arkansas	Polishing the most perfect edge possible.

The much coveted Black Hard Arkansas Stone was relatively expensive at more than $30 for an 8- by 2- by 1-inch stone. Only about 5% of the blocks quarried end up as finished whetstone, and the producers were seeking uses for the rejected material. Some was used in the production of silica-brick refractories, grinding media, lightweight aggregates, a wet abrasive blasting medium, and as a filler-extender.[3]

Arkansas finished stone production accounted for 79% of the total value and 65% of the total quantity of special silica stone products sold or used by U.S. producers.

The survey of oilstone and whetstone producers was expanded in 1982 to include many additional producers of finished stone that purchased crude material from producers with quarrying operations. Grinding pebbles and tube-mill liners were eliminated from the survey because of lack of accurate data.

Table 7.—Special silica stone finished products sold or used in the United States[1]

Year	Quantity (short tons)	Value (thousands)
1978[r]	675	$2,338
1979[r]	594	1,764
1980[r]	631	1,933
1981[r]	523	[2]3,928
1982[3]	713	[2]5,360

[r] Revised.
[1] Includes grindstones, oilstones, and whetstones. Excludes grinding pebbles and tube-mill liners.
[2] Large increase in value because nonquarrying finished stone producers were included.
[3] Large increase in quantity and value because the survey was expanded to include many more nonquarrying finished stone producers.

Table 8.—Producers of special silica stone products in 1982

Company and location	Type of operation	Product
American Trails Whetstone Co.:		
Glenwood, Ark	Stone cutting and finishing	Whetstone and oilstones.
Arkansas Abrasives, Inc.:		
Hot Springs, Ark	do	Do.
Arkansas Whetstone Co., Inc.:		
Hot Springs, Ark	do	Do.
Do	Quarry	Crude novaculite.
Baraboo Quartzite Co., Inc.:		
Baraboo, Wisc	Crushing and sizing	Deburring media.
Do	Quarry	Crude silica stone.
Buffalo Stone Corp:		
Hot Springs, Ark	Tumbling and sizing novaculite.	Metal finishing media and deburring media.
Cleveland Quarries Co.:		
Amherst, Ohio	Stone cutting and finishing	Grindstones.
Do	Quarry	Crude silica stone.
Dans Whetstone Cutting Co., Inc.:		
Royal, Ark	Stone cutting and finishing	Whetstones and oilstones.
Do	Quarry	Crude novaculite.
Frontier Whetstone Cutting Co.:		
Hot Springs, Ark	Stone cutting and finishing	Whetstones and oilstones.
Halls Arkansas Oilstones, Inc.:		
Pearcy, Ark	do	Do.
Hindostan Whetstone Co.:		
Bedford, Ind	do	Cuticle stones.
Do	Quarry	Crude silica stone.
Hiram A. Smith Whetstone Co., Inc.:		
Hot Springs, Ark	Stone cutting and finishing	Whetstones and oilstones.
Do	Quarry	Crude novaculite.
Natural Hones, Inc.:		
Malvern, Ark	Stone cutting and finishing	Whetstones and oilstones.
Norton Co. Oilstones, Norton Pike Div.:		
Littleton, N.H	do	Do.
Hot Springs, Ark	Quarry	Crude novaculite.
Pioneer Whetstone Co.:		
Hot Springs, Ark	Stone cutting and finishing	Whetstones and oilstones.
Poor Boy Whetstones:		
Hot Springs, Ark	do	Do.
Wallis Whetstone:		
Malvern, Ark	do	Do.
Wallis Whetstone, Inc.:		
Malvern, Ark	Quarry	Crude novaculite.
Washita Mountain Whetstone Co.:		
Lake Hamilton, Ark	Stone cutting and finishing	Whetstones and oilstones.

GARNET

The United States continued to account for about 75% of the world's garnet production; the remainder was produced primarily in India, Australia, and the U.S.S.R. Four producers were active in 1982, two in New York and one each in Idaho and Maine. Barton Mines Corp., Warren County, N.Y., sold garnet for use in coated abrasives, glass grinding and polishing, and metal lapping. The NYCO Div. of Processed Minerals, Inc., Essex County, N.Y., reported that its garnet was used mostly in sandblasting and in bonded abrasives. Emerald Creek Garnet Milling Co. operated two mines in Benewah County, Idaho, and reported that its garnet was used chiefly in sandblasting and water filtration. Industrial Garnet Extractives, Inc., near Rangeley in Oxford County, Maine, produced almandine garnet and a garnet-containing utility grit that was used largely in sandblasting and water filtration.

Several producers reported significant decreases in shipments in 1982. However, the producer in Maine had completed a plant expansion in late 1981 and reported substantial increases in production and shipments that more than offset the decreases.

Table 9.—Garnet sold or used by producers in the United States

Year	Quantity (short tons)	Value (thousands)
1978	22,058	$3,918
1979	23,303	4,647
1980	26,550	4,934
1981	25,519	5,204
1982	26,660	5,549

CORUNDUM AND EMERY

Corundum.—No reported sustained domestic production of abrasive-grade corundum, an aluminum oxide, has occurred since 1906, although small quantities were mined and sold during World War I. Efforts to establish a domestic corundum industry in 1943-44 resulted in negligible output, and development was discontinued in 1945. No imports of abrasive-grade corundum occurred during 1980-82. Demand was met by withdrawal from stocks. Despite the removal of the United Nations embargo against Zimbabwean corundum, the United States had not imported corundum directly from Zimbabwe since 1968. In recent years, the domestic supply had consisted almost entirely of material imported from Zimbabwe through the Republic of South Africa by one firm in Massachusetts. Another Massachusetts firm accounted for one-half of the total domestic consumption. Corundum was used in grinding and polishing optical components.

The latest prices quoted in Engineering and Mining Journal for crystal corundum were $170 to $187 per short ton of crude material, c.i.f. U.S. ports, in March 1981. This is the same price quoted in December 1980.

Table 10.—Natural corundum: World production, by country[1]

(Short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
India	1,193	1,002	1,603	1,107	1,650
South Africa, Republic of	20	82	155	100	[3]68
U.S.S.R.[e]	9,400	9,400	9,500	9,500	9,500
Uruguay[e]	246	250	206	240	250
Zimbabwe	8,120	18,329	20,592	13,450	[3]9,605
Total	18,979	29,063	32,056	24,397	21,073

[e]Estimated. [p]Preliminary.
[1]Table includes data available through May 25, 1983.
[2]In addition to the countries listed, Argentina may have produced minor quantities of this commodity, but available information is inadequate for formulation of reliable estimates of output levels.
[3]Reported figure.

Emery.—Two companies, De Luca Emery Mine, Inc., and John Leardi Emery Mine, operated emery mines in 1982, both near Peekskill in Westchester County, N.Y. The crude material, a gray rock and an impure corundum containing magnesium-aluminum silicates, was processed by two companies—Washington Mills Abrasive Co., North Grafton, Mass., and Emeri-Crete, Inc., New Castle, N.H. Domestic emery was used mostly as a nonslip additive for floors, pavements, and stair treads. Minor uses for domestic emery were as coated abrasives and tumbling or deburring media.

World production of emery was principally from Greece and Turkey. In 1981, production of emery in Greece was estimated to be 10,000 tons. Production of emery in Turkey in 1981 was reported to be 44,135 tons.

Prices quoted for emery by domestic suppliers in December 1982 ranged from $145 per ton for the lowest grade nonskid flooring material to $520 per ton for specialized industrial abrasive grade, in truckload quantities, f.o.b. plant.

INDUSTRIAL DIAMOND

Domestic production of synthetic industrial diamond in 1982 was estimated to be 53 million carats, a 7% decrease from that of 1981 and the first production decrease since 1962. Secondary production, salvage from used diamond tools and from wet and dry diamond-containing waste, was estimated to be 1.8 million carats in 1982. The five companies producing synthetic diamond in the United States were: E. I. du Pont de Nemours & Co., Inc., Industrial Diamond Div., Gibbstown, N.J.; General Electric Co., Specialty Materials Department, Worthington, Ohio; Megadiamond Industries, Inc., Provo, Utah; U.S. Synthetics Corp., Orem, Utah; and Valdiamant International, Div. of Valeron Corp., Ann Arbor, Mich.

The Government stockpile inventory as of December 31, 1982, was reduced to 22.2 million carats of crushing bort and 16.5 million carats of stone, still exceeding the respective goals of 22.0 million carats and 7.7 million. Available for disposal from prior enabling legislation were 0.2 million carats of bort and 2.5 million carats of stone. The inventory of small diamond dies was 25,473 pieces; the goal was 60,000 pieces.

The United States remained the largest consumer of natural industrial diamond stones but was totally dependent on foreign sources, importing approximately 4.7 million carats. Owing to political instability, supplies from Zaire and other areas remained in potential danger of disruption. Output was largely dependent on the output of gem diamond, which was limited by economic and other factors not directly related to the demand for industrial stones. World reserves are only marginally sufficient to meet world demand for industrial stones through the year 2000. However, discovery of a large deposit of diamond predominantly of industrial quality in Australia may substantially improve the supply by 1986. Increased use of synthetic polycrystalline diamond compacts and other synthetic products could also alleviate any supply shortfall.

Exports and reexports of industrial diamond dust and powder, including synthetics, totaled 30.6 million carats valued at $66.9 million. Exports and reexports of stones totaled 2.0 million carats valued at $22.5 million.

More than 90 kimberlite occurrences were known in the Colorado-Wyoming State line district and the Iron Mountain district of Wyoming. Microdiamonds have been recovered from some of the State line diatremes near Tie Siding, Wyo. Exploration continued and the National Aeronautics and Space Administration recently granted $35,500 to the Geological Survey of Wyoming for a study on rapid detection and analysis of diamondiferous kimberlites.[4] This area may have potential for industrial stones, but full-scale mining is at least 5 years away.

Table 11.—U.S. imports for consumption of industrial diamond (excluding diamond dies)

(Thousand carats and thousand dollars)

Year	Quantity	Value
1980	21,848	110,566
1981	20,404	110,510
1982	19,127	85,837

Table 12.—U.S. imports for consumption of industrial diamond, by country[1]

(Thousand carats and thousand dollars)

Country	Natural industrial diamond stones (including glazers' and engravers' diamond, unset)				Miners' diamond[2]				Powder and dust, synthetic				Powder and dust, natural			
	1981		1982		1981		1982		1981		1982		1981		1982	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Australia	6	51	13	106	5	76	4	47	--	--	--	--	2	11	--	--
Belgium-Luxembourg	648	6,226	273	3,343	17	80	(3)	32	60	179	33	70	563	830	159	309
Canada	9	78	13	72	34	76	--	--	24	30	22	31	16	39	25	13
Congo	152	2,430	243	7,205	--	--	--	--	--	--	--	--	--	--	3	5
Finland	--	--	--	--	--	--	--	--	632	790	705	1,053	--	--	--	--
France	(3)	4	--	--	--	--	(3)	5	--	--	--	--	2	3	--	--
Germany, Federal Republic of	19	225	2	61	--	--	(3)	1	90	216	148	289	58	116	204	384
Ghana	2	71	1	78	--	--	(3)	3	--	--	--	--	--	--	--	--
Greece	1	3	--	--	--	--	--	--	305	343	362	410	6	4	--	--
Hong Kong	(3)	14	33	634	--	--	--	--	1	1	73	48	--	--	10	8
Ireland	18	138	12	98	11	82	646	5,113	8,198	16,414	7,256	15,653	1,067	2,652	673	1,651
Israel	39	1,327	8	876	--	--	--	--	1	1	--	--	2	3	--	--
Japan	42	1,966	45	2,084	--	--	--	--	801	779	1,017	689	4	16	1	6
Liberia	--	--	--	--	1	29	--	--	(3)	8	--	--	--	--	--	--
Mexico	--	--	--	--	6	56	(3)	40	--	--	--	--	--	--	26	15
Netherlands	33	1,177	34	1,272	--	--	(3)	9	5	9	65	20	20	47	79	40
South Africa, Republic of	2,968	43,322	2,443	28,234	94	366	56	149	252	451	667	1,152	679	2,189	1,066	2,508
Switzerland	30	908	7	303	--	--	--	--	165	315	242	440	244	268	333	498
U.S.S.R.	--	--	--	--	--	--	--	--	2	8	278	96	--	--	18	9
United Kingdom	547	9,033	411	3,969	3	34	1	5	176	262	69	99	439	769	532	838
Venezuela	36	1,023	1	56	2	279	3	82	--	--	--	--	--	--	--	--
Zaire	3	78	78	652	1,131	10,460	273	1,915	--	--	--	--	455	410	150	93
Other Africa, n.e.c	56	2,762	38	2,272	(3)	(3)	--	--	--	--	--	--	--	--	8	2
Other	30	162	27	250	7	317	1	16	162	409	53	127	12	27	38	64
Total[4]	4,638	70,998	3,683	51,564	1,310	11,858	984	7,418	10,874	20,215	10,990	20,179	3,570	7,384	3,324	6,442

[1]Excludes 12,072 carats of crushing bort in 1981 from the Republic of South Africa, Zaire, and the United Kingdom, and 145,000 carats from Ghana, Japan, the Republic of South Africa, and the Central African Republic in 1982.
[2]Includes 48,000 carats of synthetic miners' diamond in 1982.
[3]Less than 1/2 unit.
[4]Data may not add to totals shown because of independent rounding.

WORLD REVIEW

Australia.—The Government of Western Australia signed an agreement with Ashton Joint Venture (AJV) for development of the groups' Argyle diamond deposits in the northern Kimberley region and marketing of the diamonds. Drilling had indicated reserves of 500 million carats of diamond in the main AK-1 kimberlite body and another 8 million carats at least in the alluvial deposits.[5] The kimberlite body, with a surface area of 111 acres, contains about 5% gem, 25% near gem, and 70% industrial-grade diamond.[6] Yearend evaluation indicated a grade of 6.5 carats per ton from the main AK-1 pipe, 4.18 carats per ton from the Upper Smoke Creek alluvial deposits, and an average of 3.33 carats per ton from all of the alluvial deposits.[7] Production from the alluvial deposits started in December 1982 at a scheduled annual rate of 2 to 3 million carats. It was likely that an additional plant would be installed in early 1983, which would increase the production rate to 5 million carats per year.[8] This was to be continued until 1985. Final design of the main kimberlite processing plant was scheduled for completion by late 1983 followed by construction completion by 1985. The plant was designed to produce initially 20 million carats per year. Approximately $500 million was to be invested by the time full operations are achieved.[9]

AJV was superseded after production started with the formation of Argyle Diamond Mines Joint Venture and the Ashton Exploration Joint Venture. The development agreement became effective in November 1982, and Argyle Diamond Mines was to represent all three owners, Conzinc Riotinto of Australia Ltd. (CRA), 56.8%; Ashton Mining Ltd., 38.2%; and Northern Mining Corp. Ltd., 5%. Ashton Mining and CRA agreed to have the De Beers Central Selling Organization (CSO) market all gem-quality diamonds and 75% of the near gem quality and industrial diamonds during the first 5 years of full production from the AK-1 pipe. The two mining companies have formed Argyle Diamond Sales Ltd.[10] For the first time De Beers agreed to let a producer sell some diamonds independently under this agreement.[11] Northern Mining announced that it would sell its diamond production from the operations through the Antwerp, Belgium, diamond merchandising firm of Arslanian Fréres.[12] Argyle Diamond Mines announced it was negotiating with an independent London diamond dealer for the establishment of a staff of valuers in Perth. This would give the venture independent assessments of valuations made by De Beers' CSO.[13]

The joint venture group was obliged under an agreement with the Western Australian Government to establish sorting facilities in Perth and to strive for maximum local processing, including cutting. The group was to pay the State government royalties equal to 22.5% of pretax profits. If profits were to fall below a certain level, the royalty would change to 7.5%.[14] Work on a $11.3 million water project was reported on schedule. A 34.5-kilometer pipeline was being laid from Lake Argyle to the diamond minesite.[15]

During the year, 15 companies explored for diamonds at 45 sites in South Australia,[16] and Freeport of Australia Pty. Inc., started a limited bulk sampling program near Carrieton, South Australia, to investigate certain fossil gravel horizons occurring within the Wirrenda drainage complex.[17]

Botswana.—Evaluation by De Beers Botswana of Kimberlite 2424 DK-2 at Lethakane continued with drilling and sinking of vertical shafts with horizontal development. Drilling in the northeast lobe was completed in October, ending the final stage of the initial evaluation program.[18]

The Jwaneng Mine started commercial production in June on schedule and within its budget at an annual rate of 3.0 million carats, which was expected to increase to an annual rate of 4.5 million carats by 1985. Harry Oppenheimer, chairman of De Beers Consolidated Mines Ltd. and 50% owner of De Beers Botswana, stated that "Jwaneng is probably the most important kimberlite pipe discovered anywhere in the world since the original discoveries at Kimberley Mine more than a century ago."[19]

China.—The Minerals Bureau of the Republic of South Africa reported that there are probably several diamond mining centers in China, although only one, near Changte in the north of Hunan Province, has been confirmed. The recovery grade of the mine was estimated to be 0.25 carat per ton of ore. Deposits where diamond or kimberlite pipes have been discovered include Liasoning, Shandong, Guangxi, Gujzhou, and Xizang. It was estimated that production of natural diamond had risen to 1.8 to 2.8 million carats by 1980, of which 80% was of industrial quality.

The first synthetic diamond grit was produced in 1963 by the explosion method, and by 1973, grit larger than 1 millimeter was being made. By 1980, six synthetic diamond production units were in operation producing grit for the drilling, diamond tool, and wire drawing industries.[20]

Guinea.—Four joint ventures between the Government and various foreign companies were involved in diamond exploration. The principal deposits were found in the region of Kerowane, Beyla, Moeenta, Guekedou, and Kissidougou. Total reserves were estimated at 30 million carats, of which 30% were industrial grade diamond.

Aredour, one of the joint ventures between the Government (50%), Bridge Oil Pty. Ltd. of Australia (45%), Industrial Diamond Co. of the United Kingdom (2.5%), and Simonius Vischer of Switzerland (2.5%), arranged financing to develop a large deposit in Kissidougou region. Initial production was expected to be 200,000 carats per year by early 1984, with plans to increase output to 500,000 carats per year. Approximately 30% of the diamond is of industrial quality, and total reserves were expected to last about 15 years.[21]

Ireland.—De Beers Industrial Diamond Div., Shannon, Ireland, announced a $170 million expansion of its three synthetic diamond plants, in Ireland, Sweden, and the Republic of South Africa, respectively, which will double its synthetic diamond production by 1985. De Beers estimated world consumption by the year 2000 at 300 million carats of industrial diamond based on an annual growth rate of 5% to 6%.[22]

Lesotho.—The Letseng Mine had always been difficult to operate because of its remote location and exceptionally low ore grade, 2.8 carats per 100 tons, one of the world's lowest. These factors, combined with the depressed state of the diamond market, particularly for the larger high-quality stones produced by this mine, forced De Beers Lesotho Mining Co. to close the mine. Letseng was virtually the only mining operation in the country and one of the largest industrial employers. Its closure was expected to be a severe blow to the country's economy.[23]

Sierra Leone.—The National Diamond Mining Co. announced that it will proceed with the development of underground mining of the Kono kimberlite diamond project. The project, estimated to cost $118 million, was designed to allow production of 240,000 carats per year by 1986.[24]

South Africa, Republic of.—The Octha diamond group announced plans to expand operations at a total cost of $160 million. The investment programs were expected to create an integrated diamond mining, cutting, marketing, and retailing operation with a wide international network. Most of the money was to be spent on the reestablishment of four old mines recently acquired by Octha in the Kimberley area. Each was expected to require about $40 million for shaft sinking, development of underground operations, and infrastructure. These undertakings should increase annual production tenfold to about 1 million carats per year by 1986, of which 50% would be industrial grade.[25]

De Beers Consolidated Mines was forced to make production adjustments as a result of the poor market for diamonds in 1982. Production from the Koffiefontein Mine was suspended, production from Annex Kleinzee was transferred to the Tweepad plant, and production from the Finsch Mine was reduced by about 20% to 3.5 million carats per year. The Finsch production is scheduled to resume after the Koffiefontein Mine is closed.[26]

U.S.S.R.—The diamond industry has been centered in Yakutiya, where about 20 deposits have been discovered. Included among the known producers were the Mirnyy open pit, the Aykhal open pit, the Udachnaya placer mine, and the Irelyakh placer mine. Small quantities of gems and industrial stones were produced from the Vishera River region.

A substantial quantity of synthetic diamond was produced in Kiev, Moscow, Poltava, Tashkent, and Yerevan.[27]

The development of the first underground mine was reported to have begun in the Yakut area near Mirnyy. The melting of permafrost created some initial problems; however, artificial freezing apparently stabilized the area.[28]

Zaire.—Société Minière de Bakwanga (Miba), mining operation in Zaire, was affected by the declining grade of its deposits reducing output from a record 18 million carats in 1961 to about 6 million carats in 1981. Miba, in an effort to reverse this trend, requested a $40 million loan from the International Finance Corp. to increase its treatment capacity and to buy two dredges to mine deposits in the riverbed and adjoining flats.[29] A new $5 million dredge, the first to be designed specifically to recover diamonds from river gravel, was delivered. The

Table 13.—Diamond (natural): World production, by country[1]

(Thousand carats)

Country	1978 Gem	1978 Industrial	1978 Total	1979 Gem	1979 Industrial	1979 Total	1980 Gem	1980 Industrial	1980 Total	1981[p] Gem	1981[p] Industrial	1981[p] Total	1982[e] Gem	1982[e] Industrial	1982[e] Total
Angola	488	162	650	630	211	841	1,110	370	1,480	1,050	350	1,400	1,000	400	1,400
Australia	--	--	--	--	--	--	--	48	48	21	184	205	70	487	[2]557
Botswana	420	2,379	2,799	659	3,735	4,394	765	4,336	5,101	744	4,217	4,961	1,165	6,604	[2]7,769
Brazil[e 3]	236	384	620	236	384	620	253	414	667	163	926	1,089	175	975	1,150
Central African Republic	199	85	284	205	110	315	227	115	342	209	103	312	186	91	[2]277
China[e]	NA	NA	NA	NA	NA	NA	360	1,440	1,800	380	1,520	1,900	400	1,600	2,000
Ghana	142	1,281	1,423	125	1,128	1,253	126	1,132	1,258	85	751	836	68	612	[2]680
Guinea[e]	25	55	80	27	58	85	12	26	38	12	26	38	13	27	40
Guyana	7	10	17	6	10	16	4	6	10	4	6	10	5	6	[2]11
India	14	2	16	14	2	16	12	2	14	14	2	16	12	2	14
Indonesia[e]	3	12	15	3	12	15	3	12	15	3	12	15	3	12	15
Ivory Coast	22	23	45	24	24	48	--	--	--	--	--	--	--	--	--
Lesotho	62	5	67	48	4	52	50	4	54	49	4	53	39	3	[2]42
Liberia	128	180	308	170	132	302	123	175	298	132	204	336	170	263	[2]433
Namibia	1,803	95	1,898	1,570	83	1,653	1,482	78	1,560	1,186	62	1,248	963	51	[2]1,014
Sierra Leone	353	426	779	[r]434	[r]451	[r]885	317	275	592	208	97	305	[2]203	[2]87	[2]290
South Africa, Republic of:															
Finsch Mine	403	2,227	2,630	465	2,120	2,585	465	2,442	2,907	1,002	3,463	4,465	847	3,003	3,850
Premier Mine	380	1,603	1,983	468	1,613	2,081	407	1,632	2,039	510	1,530	2,040	615	1,845	2,460
Other De Beers properties[4]	1,254	1,395	2,649	1,850	1,370	3,220	1,550	1,489	3,039	1,603	1,069	2,672	1,359	906	2,265
Other	320	145	465	403	95	498	390	145	535	314	35	349	521	58	579
Total	2,357	5,370	7,727	3,186	5,198	8,384	2,812	5,708	8,520	3,429	6,097	9,526	3,342	5,812	[2]9,154
Tanzania	141	141	282	157	157	314	137	137	274	110	107	217	100	120	220
U.S.S.R.[e]	2,150	8,400	10,550	2,200	8,500	10,700	2,250	8,600	10,850	2,100	8,500	10,600	2,100	8,500	10,600
Venezuela	271	549	820	247	556	803	238	483	721	102	388	490	100	400	500
Zaire	640	10,603	11,243	294	8,440	8,734	345	9,890	10,235	450	8,550	9,000	450	8,550	9,000
World total	9,461	30,162	39,623	[r]10,235	[r]29,195	[r]39,430	10,626	33,251	43,877	10,451	32,106	42,557	10,564	34,602	45,166

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.

[1]Table includes data available through June 3, 1983. Total diamond output (gem plus industrial) for each country is actually reported except where indicated by a footnote to be estimated. In contrast, the detailed separate production data for gem diamond and industrial diamond are Bureau of Mines estimates in the case of every country except Australia (1980-82), Central African Republic (1978-81), Liberia (1978-82), Sierra Leone (1978-82), Republic of South Africa (1978-79), and Venezuela (1978-81), for which source publications give details on grade as well as totals. The estimated distribution of total output between gem and industrial diamond is conjectural, and for most countries, is based on the best available data at time of publication.

[2]Reported figure.

[3]Figures represent officially reported output plus official Brazilian estimates of output by nonreporting mines; officially reported output was as follows, in thousand carats: 1978—86, 1979—83, 1980—158, 1981—136.

[4]Other De Beers Group output from the Republic of South Africa includes Kimberley Pool, Koffiefontein Mine, and the Namaqualand Mines.

dredge has a processing capacity of 1 million cubic meters per year and was to be placed in operation in 1983.[30]

The Government of Zaire in 1982 introduced more liberal laws designed to reduce illicit mining and to cut down smuggling. Independent buying offices were established, and these have been reasonably successful in reducing the smuggling.

In early 1983, Société Zairoise de Commercialisation des Minerais announced that, effective immediately, a 2-year contract had been signed with De Beers giving the De Beers' CSO exclusive rights to manage the sale of rough diamonds from Miba. This agreement does not affect the new independent buying offices. Zaire's return to the CSO was probably brought about by the collapse of industrial diamond prices during 1981-82. The Miba Mine produced about 70% industrial diamond and 25% near gem diamond, which are probably more suitable for industrial purposes.[31]

TECHNOLOGY

A patent was issued that described a process for the production of dense metastable phases of carbon that had characteristics similar to diamond. Particulates of the metastable carbon were produced by reacting silicon carbide, or a silicon carbide precursor such as a silane or silicon metal, with a fluorocarbon such as carbon tetrafluoride at 900° C to 1,200° C. The reaction could be carried out in a high voltage electrical discharge, or other plasma, or in a furnace. The presence of a "promotor" metal, such as nickel or iron, increased the reaction rate and the quantity of the metastable carbon phases. Relatively large quantities of these diamond-like particulates were produced for possible use in commercial diamond applications such as cutting elements.[32]

A new method was developed to bond diamonds to metal at the Los Alamos National Laboratory. Diamond grit was placed in a sulfur hexafluoride plasma. The fluorine atoms reacted with the surfaces of the diamond, producing fluorinated surfaces. The fluorinated diamonds were mixed with a Teflon emulsion to produce a paste that was then dried. The resulting powder was applied to a soft aluminum surface. Applying a pressure of 20,000 pounds per square inch at 325° C caused the Teflon to melt and form a chemical bond between the aluminum surface and the diamonds. The pressure also forced the diamonds into the aluminum surface while the heat treatment hardened the aluminum. The result was a tough diamond wheel that could easily cut ceramics and metals.[33]

An ultrafine-grained, less than 1 micrometer, sintered diamond tool material was developed that is highly wear resistant and allows high dimensional precision for tool blanks and wire drawing dies. The dies have 2 to 15 times greater life than natural single crystal diamond dies in steel wire drawing tests on 0.18- to 1.3-millimeter-diameter dies.[34]

A large increase in the use of particleboard and medium-density fiberboard had occurred in recent years. The abrasiveness of these materials caused excessive wear of high-speed steel and sintered tungsten carbide tools, thereby offsetting some of the advantages of these composites. Synthetic polycrystalline diamond tool blanks specifically designed for these woodworking applications were shown to have 200 times greater life than traditional tooling, with cost savings of 18% to 94%.[35]

A new synthetic polycrystalline diamond drill bit was compared with surface-set mined-diamond bits in extensive core-drilling tests in southwestern West Virginia and southwestern Pennsylvania coalfields. Penetration rates averaged 10 inches per minute for the polycrystalline drill diamond versus 6 inches per minute for the mined diamond. Drill life averaged over 2,500 feet of hole for the polycrystalline drill diamond compared with 1,200 feet with the mined diamond. Drilling bit costs were reduced by 30%.[36]

Abstracts relative to diamond materials and machines, including patents, were published monthly in the Industrial Diamond Review. Each 1982 monthly report contained from 18 to 37 pages of abstracts and patent information.

MANUFACTURED ABRASIVES

Manufactured abrasives operations were severely depressed in 1982. The manufacturers support heavy industries such as the steel, foundry, and automotive industries and are reliable indicators of the economic condition of the industrial segment of the economy both nationally and worldwide. Production was reported at its lowest level for silicon carbide since 1963, for fused aluminum oxide since 1958, and for metallic abrasives since 1964. Permanent and temporary plant closures occurred during the year, and many of the manufacturers operated with a reduced work force and/or an abbreviated workweek.

Five firms produced crude fused alumina in the United States and Canada at eight plants (table 14). Production was only 40% of furnace capacity of U.S. and Canadian plants. Reported 1982 production of white high-purity material decreased 60% to 14,800 tons, and production of regular material decreased 30% in quantity and 33% in value to 116,700 tons and $37.6 million, respectively. Almost all of the combined output of white and regular material was for abrasive application. One company reported shipping a small quantity of regular material for refractory manufacture. Stocks reported totaled 21,100 tons as of December 31, 1982.

A new plant was completed and production was started by 3M at its Chemolite facility near Hasting, Minn., of its newly developed synthetic alumina abrasive, Cubitron. The proprietary process involved a controlled crystallization of alumina from a solution followed by filtration, roasting, and grading.[37]

Dresser Industries, Inc., purchased part of the assets of the Abrasives Div. of Bendix Corp. The abrasive grain processing plants at Chester and Westfield, Mass., were to be integrated into General Abrasives Div., Niagara Falls, N.Y., and the bonded abrasives plants in Chester, Mass., and North Manchester, Ind., were to be integrated into Bay State Abrasives, both of which are subsidiaries of Dresser.[38]

Unicorn Abrasives of Canada Ltd.'s Div. of Fusion du Suguenay, Arvida, Quebec, Canada, permanently closed and dismantled its fused aluminum oxide plant. The plant previously had an annual furnace capacity of approximately 17,000 tons and represented 5% of the total furnace capacity of the U.S. plus Canadian industry. However, several plants completed minor expansions or changed product mix to effectively offset this loss.

Three firms produced fused alumina-zirconia abrasive (table 14), two with plants in both Canada and the United States. All production was used for abrasive applications. Output decreased in both tonnage and value in 1982 and was only 33% of furnace capacity.

Seven firms in the United States and Canada produced silicon carbide in eight plants (table 14) in 1982. The companies produced crude material for abrasives, refractories, and other nonabrasive uses. Total production was only 53% of furnace capacity. Capacity utilization would have been lower except that one company dismantled its reserve silicon carbide plant in Canada. Output during the year decreased 28% to 112,000 tons and value decreased 21%. Abrasive use decreased 31% and accounted for 36% of output. Metallurgical applications use decreased 25% and accounted for 46% of the output. Refractory applications use decreased 22% and accounted for 16% of the total output. Stocks totaled 15,200 tons as of December 31, 1982.

General Electric Co. established a new operation in Houston, Tex., to manufacture and sell parts made of silicon carbide. Initially, parts were to be manufactured for critical wear components for pumps, valves, compressors, and other devices used in the energy and chemical process industries.

In the Stockpile Report to the Congress by the General Services Administration, December 31, 1982, the inventory of crude fused aluminum oxide in 1982 was approximately 250,000 tons, and the stocks of aluminum oxide abrasive grain were about 51,000 tons. The stocks of silicon carbide crude were 80,550 tons, and the goal was 29,000 tons.

Metallic abrasives were produced by 11 firms in 13 plants in the United States in 1982 (table 15). Steel shot and grit comprised 88% of the total quantity of metallic abrasives sold or used; chilled iron shot and grit, annealed iron shot and grit, and other, the remainder. Three States supplied 80% of the total sold or used—Pennsylvania, 32%; Ohio, 28%; and Michigan, 20%. Other large suppliers operated in Indiana and Virginia. The total quantity, sold or used, decreased 27% from that of 1981, and the value decreased 25%.

Shipments of chilled and annealed iron shot and grit decreased moderately in quantity and value when compared with that of 1981. Jumbo Manufacturing, Inc., had started producing chilled iron shot and grit in Tippecanoe, Ind., in 1981 and expanded into malleable (annealed iron) shot and grit in early December 1982 with the startup of a new furnace and production line.

TECHNOLOGY

A sequence of operations was developed for the closed die hot forging of coarse-grained vitrified bonded abrasives. The process offered substantial savings in energy and materials handling over the conventional heat bonding process, which required high temperatures for extended time. In a commercial operation, hot forging should reduce the time and temperature required and minimize the scrap loss because high dimensional precision could be achieved. Properties of forged abrasive samples were comparable to those of the conventionally made product. A specific amount of heating prior to thermomechanical processing of the sample and a post-forge annealing were necessary to achieve standard physical properties. Dilative behavior occurred in the deforming process.[39]

Major improvements in the components of coated abrasive belts—abrasive, backing material, and joints—have made possible the switch from the use of grinding wheels to belts for cylindrical grinding of rolls and tubes. Cost saving of 20% to 60% were reported because (1) metal removal rates were three times faster with belts than with wheels; (2) quick belt changes, from coarse to fine grits, permitted faster finishing operations; and (3) continuous free cutting action could be achieved with no loading or glazing.[40]

Superior Graphite Co. continued pilot development of a proprietary continuous furnacing operation for the production of microcrystalline beta silicon carbide. Initially only a grade of 60% to 70% silicon carbide was produced, but an improved process reportedly produced a grade of 95%. A commercial-size furnace, 10 times larger than the pilot furnace, was scheduled for operation in February 1983. The company reported that this process meets all environmental standards. It was reported that material testing was underway in several areas of application that require fine-grained silicon carbide.[41]

A blast furnace bosh with a composite lining, silicon carbide brick on the hot face and high-thermal-conductivity carbon brick against the shell, and external spray cooling was installed in the Sparrows Point K furnace of Bethlehem Steel Corp. Radioactive-isotope measurements of the lining after 3.5 years of operation indicated that the composite lining had twice the thickness of an anthracite-based carbon brick lining operated for a similar period of time.[42]

A study showed that rhombohedral boron nitride (BN), a layer structure with a three-layered stacking sequence, may be converted to cubic BN when explosive shock-compressed at 40, 60, and 100 gigapascals. Hexagonal BN was converted to wurzite-type BN under the same conditions. These results indicate that the transformation proceeded by a diffusionless mechanism in which the stacking sequence of the BN layers in the starting materials was retained during the process.[43]

A study showed that when cubic boron nitride wheels were used for sharpening tool steel hobs the depth of cut was 10 times greater and the total sharpening time was 80% less than when using aluminum oxide wheels. Only 72 passes were required to sharpen all flutes on the hob compared with a minimum of 720 passes on a conventional machine with aluminum oxide wheels.[44]

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Table 14.—Crude artificial abrasives manufacturers in 1982

Company	Location	Product
Carborundum Electro Minerals Co., Div. of Standard Oil of Ohio.	Niagara Falls, N.Y	Fused aluminum oxide (high purity).
	Vancouver, Wash	Silicon carbide.
	Niagara Falls, Ontario, Canada	Fused aluminum oxide (regular).
	Shawinigan, Quebec, Canada	Silicon carbide.
ESK Corp	Hennedin, Ill	Do.
The Exolon Co	Thorold, Ontario, Canada	Fused aluminum oxide (regular), aluminum-zirconium oxide, silicon carbide.
Ferro Corp., Abrasive Div	Cap-de-la-Madeleine, Quebec, Canada	Silicon carbide.
General Abrasives, Div. of Dresser Industries	Niagara Falls, N.Y	Fused aluminum oxide (high purity) and aluminum zirconium oxide.
	Niagara Falls, Ontario, Canada	Fused aluminum oxide (regular) and silicon carbide.
Norton Co	Huntsville, Ala	Fused aluminum oxide (high purity).
	Worcester, Mass	General abrasive processing.
	Cap-de-la-Madeleine, Quebec, Canada	Silicon carbide.
	Chippewa, Ontario, Canada	Fused aluminum oxide (regular and high purity) and aluminum-zirconium oxide.
Satellite Alloy Corp	Springfield, Pa	Silicon carbide.
Washington Mills Abrasives Co	Niagara Falls, Ontario, Canada	Fused aluminum oxide (regular).

Table 15.—Producers of metallic abrasives in 1982[1]

Company	Location	Product (shot and/or grit)
Abrasive Materials, Inc	Hillsdale, Mich	Cut wire.
Durasteel Co	Pittsburgh, Pa	Steel.
Ervin Industries, Inc	Adrian, Mich	Do.
Do	Butler, Pa	Do.
Globe Steel Abrasives Co	Mansfield, Ohio	Do.
Jumbo Manufacturing Inc	Tippecanoe, Ind	Chilled iron.
Metal Tec Steel Abrasives Co	Canton, Mich	Steel.
National Metal Abrasive Co	Wadsworth, Ohio	Do.
The Pangborn Co	Butler, Pa	Do.
Pellets, Inc	Tonawanda, N.Y	Cut wire.
Steel Abrasives, Inc	Fairfield, Ohio	Chilled iron.
Wheelabrator-Frye Inc	Mishawaka, Ind	Steel.
Do	Bedford, Va	Do.

[1]Excludes secondary (salvage) producers.

Table 16.—Crude manufactured abrasives produced in the United States and Canada, by kind

(Thousand short tons and thousand dollars)

Kind	1978	1979	1980	1981	1982
Silicon carbide[1]	182	[e]196	170	156	112
Value	$51,371	[e]$62,702	$64,346	$68,839	$54,507
Aluminum oxide (abrasive grade)[1]	142	[e]225	193	203	132
Value	$46,633	[e]$67,511	$63,881	$73,712	$45,975
Aluminum-zirconium oxide	23	28	19	W	8
Value	$14,668	$14,893	$8,438	W	$4,600
Metallic abrasives[2]	204	264	233	228	166
Value	$59,882	$84,918	$80,281	$82,952	$62,389
Total	551	[e]713	615	[3]587	418
Total value	$172,554	[e]$230,024	$216,946	[3]$225,503	$167,471

[e] Estimated. W Withheld to avoid disclosing company proprietary data.
[1]Figures include material used for refractories and other nonabrasive purposes.
[2]Shipments for U.S. plants only.
[3]Excludes U.S. and Canadian production and value of aluminum-zirconium oxide.

Table 17.—End uses of crude silicon carbide and aluminum oxide (abrasive grade) in the United States and Canada, as reported by producers

Use	1981			1982		
	Quantity (short tons)	Value (thousands)	Yearend stocks (short tons)	Quantity (short tons)	Value (thousands)	Yearend stocks (short tons)
SILICON CARBIDE						
Abrasives	58,920	$28,395	4,883	40,367	$22,917	4,955
Metallurgical	68,440	25,866	6,576	51,251	20,596	8,551
Refractories	23,596	12,896	1,319	18,371	9,980	1,399
Other	4,957	1,683	1,881	2,225	1,014	248
Total	155,913	[1]68,839	14,659	112,214	54,507	15,153
ALUMINUM OXIDE						
Regular: Abrasives plus refractories[2]	[r]166,162	[r]55,796	[r]11,169	116,727	37,506	19,726
High purity	37,003	17,916	5,339	14,846	8,470	1,382
Total	203,165	73,712	16,508	131,573	[1]45,975	21,108

[r]Revised.
[1]Data do not add to total shown because of independent rounding.
[2]Abrasives combined with refractories to avoid disclosing individual company proprietary data.

Table 18.—Production, shipments, and annual capacities of metallic abrasives in the United States, by product[1]

Product	Production		Sold or used		Annual capacity[2] (short tons)
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	
1981:					
Chilled iron shot and grit	16,375	$4,394	13,606	$3,672	19,500
Annealed iron shot and grit	5,162	1,591	5,216	1,610	7,300
Steel shot and grit	206,832	65,700	208,638	76,520	273,000
Other	342	845	377	1,150	1,800
Total	228,711	72,530	227,837	82,952	XX
1982:					
Chilled iron shot and grit	W	W	W	W	W
Annealed iron shot and grit	W	W	W	W	W
Steel shot and grit	149,741	54,571	146,910	55,448	273,000
Other[3]	20,394	7,181	19,530	6,941	36,000
Total	170,135	61,752	166,440	62,389	XX

W Withheld to avoid disclosing company proprietary data, included with "Other." XX Not applicable.
[1]Excludes secondary (recycle) producers.
[2]Total quantity of the various types of metallic abrasives that a plant could have produced during the year, working three 8-hour shifts per day, 7 days per week, allowing for usual interruptions, and assuming adequate fuel, labor, and transportation.
[3]Includes chilled iron shot and grit, annealed iron shot and grit, cut wire, aluminum, and stainless steel shot.

Aluminum

By Frank X. McCawley[1] and Pamela A. Stephenson[2]

As a result of weak demand, domestic production of primary aluminum fell to 3.61 million short tons, the lowest annual rate since 1968. By yearend 1982, the rate of primary aluminum production declined to 58% of annual capacity. Annual demand, as measured by net shipments of ingot and mill products to domestic industries, decreased 10% to 5.5 million tons, as a result of depressed demands in all markets except the containers and packaging market. Producer inventories of aluminum ingot, mill products, and scrap aluminum decreased. Exports of crude, semifabricated, and scrap aluminum fell while imports of these items increased. In 1982, the value of imports exceeded the value of exports of crude, semifabricated, and scrap aluminum by about $170 million, compared to a net export value of $100 million in 1981.

Consumption of new and old purchased scrap decreased slightly. A decline in die-cast alloys accounted for most of the decrease in production of secondary aluminum alloys.

Announced plans for the construction of new smelters in many countries were deferred as world demand for aluminum decreased and producers sustained financial losses throughout the year.

Domestic Data Coverage.—Domestic data for aluminum are developed by the Bureau of Mines from two separate, voluntary surveys of U.S. operations. Typical of these surveys is the Aluminum Scrap survey. Of the 912 survey requests sent monthly and annually to 142 companies or operations, 67% responded, representing 76% of the total new and old aluminum scrap consumed shown in tables 2 and 4. Consumption data for the nonrespondents were estimated based on prior monthly or annual consumption levels.

Table 1.—Salient aluminum statistics

(Thousand short tons and thousand dollars unless otherwise specified)

	1978	1979	1980	1981	1982
United States:					
Primary production	4,804	5,023	5,130	4,948	3,609
Value	$5,191,064	$6,130,302	$7,346,410	$7,520,841	$5,485,121
Price: Producer list, ingot, average cents per pound	54.0	61.0	71.6	76.0	76.0
Secondary recovery	1,323	1,401	1,389	r1,537	1,616
Exports (crude and semicrude)	520	773	1,483	867	824
Imports for consumption (crude and semicrude)	1,080	840	713	935	968
Aluminum industry shipments[1]	6,839	6,922	6,003	6,054	p5,455
Consumption, apparent	6,045	5,888	5,065	r5,087	4,818
World: Production	r15,577	r16,065	r16,955	p16,614	e14,626

eEstimated. pPreliminary. rRevised.
[1]To domestic industry.

Legislation and Government Programs.—On April 6, a three-judge panel of the Federal Appeals Court in San Francisco, Calif., ruled that public utilities, not industries, should have the first rights to nonfirm power provided by the Bonneville Power Administration (BPA). The 20-year electric power contracts between BPA and six aluminum producers, serviced by the Direct Service Industries (DSI) and signed in 1981, were declared invalid. Under the BPA-DSI contracts, the aluminum industry customers had first access to nonfirm power.

In response to an electric power rate increase of 50% announced in October by BPA, DSI customers filed appeals in the U.S. Ninth Circuit Court of Appeals in San Francisco, Calif., and to the Federal Energy Regulatory Commission to determine jurisdiction over BPA rate proposals to the industry customers. The complaint in Federal court charged that procedures used by BPA in establishing the October rate violated provisions of existing legislation.

DOMESTIC PRODUCTION

Primary.—Production capacity of Martin-Marietta Aluminum Co.'s Goldendale, Wash., plant was increased by 65,000 tons per year. Noranda Aluminum Inc. increased the New Madrid, Mo., smelter's annual production capacity with an 85,000-ton potline in November, but operation of the new section was not started. Intalco Aluminum Co.'s Ferndale, Wash., and Ormet Corp.'s Hannibal, Ohio, smelters increased production capacities by upgrading the efficiencies of existing potlines. In May 1982, Aluminum Co. of America (Alcoa) announced the permanent closing of the 160,000-ton-per-year Point Comfort, Tex., smelter. This high-operating-cost plant utilized natural gas-fueled power and had been temporarily closed since 1978.

During 1982, 964,550 tons of annual primary aluminum production capacity was shut down owing to a continuing decline in general economic conditions and a weak aluminum market. The shutdowns occurred throughout the year, and by yearend, the operating rate of primary smelters was 58% of capacity. During the year, Alcoa cut back production at its smelters at Alcoa, Tenn., and Rockdale, Tex., and at the experimental plant at Palestine, Tex. Cutbacks also occurred at Reynolds Metals Co. plants at Listerhill, Ala., Troutdale, Oreg., and Longview, Wash., and at Kaiser Aluminum and Chemical Corp. plants at Chalmette, La., Spokane (Mead), Wash., and Ravenswood, W. Va. Other cutbacks included Arco Metals Co., formerly Anaconda Aluminum Co., smelters at Sebree, Ky., and Columbia Falls, Mont.; at the Consolidated Aluminum Corp. smelter, New Johnsonville, Tenn.; at Eastalco Aluminum Co. smelter, Frederick, Md.; and at Martin-Marietta Aluminum smelters at The Dalles, Oreg., and Goldendale, Wash. Production cutbacks were also made at National Southwire Aluminum Co. smelter, Hawesville, Ky.; at Noranda Aluminum smelter, New Madrid, Mo.; at Ormet smelter, Hannibal, Ohio; and at Revere Copper and Brass Co. Inc. smelter at Scottsboro, Ala. At the end of 1982, status of the U.S. primary aluminum industry was as follows: 2 smelters permanently closed, 5 temporarily shut down, 20 operating at reduced capacity, and 6 operating at full capacity.

In the last week of October, Revere announced that it filed a petition to reorganize under chapter 11 of the Federal bankruptcy laws. Revere indefinitely suspended all operations at the 117,000-ton-per-year Scottsboro, Ala., smelter in June owing to depressed aluminum markets. The smelter reportedly had the highest operating costs in the United States.

Kaiser shut down the last operating potline at the 163,000-ton-per-year Ravenswood, W. Va., smelter in January after employees at Ravenswood rejected Kaiser's offer to keep the 40,750-ton-per-year potline in operation providing the workers agreed to changes in work practices and seniority provisions. Kaiser reportedly maintained the work changes were necessary if the Ravenswood plant was to be competitive.

In August, BPA announced that the electric power rate for direct service industrial customers, which included the aluminum smelters in the Pacific Northwest, would increase from 17.3 to 25.9 mills per kilowatt hour effective October 1. The rate was later changed to 24.5 mills per kilowatt hour.

In November, the labor contract between hourly workers and Arco, at its Sebree, Ky., 180,000-ton-per-year smelter expired. Negotiations between Arco and the Aluminum, Brick, and Glass Workers International Union continued through the end of the year with no agreement concluded. Despite a reported vote by the local union to strike when the old pact expired, operation of the plant continued at a 64% operating rate. The impasse between Arco and the workers centered on economic issues. The Sebree contract was the only labor contract to expire in 1982 at a primary smelter.

Secondary.—Used beverage can scrap (UBC) continued to be the major source of old scrap for both primary and secondary producers. UBC toll-treated for primary producers is included in the Bureau of Mines consumption tabulation for secondary producers. UBC that was recycled totaled 520,000 tons in 1982 or about 46.5% of the 1.12 million tons of aluminum beverage cans used in the United States.[3] While the total can scrap that was recycled increased in 1982, the percentage of cans recycled decreased from the 49.2% (revised) in 1981 because 4.1 billion more new aluminum beverage cans were used in 1982.

Intrametco Processing, a joint operation of Intra American Metals, Inc., of Indianapolis, Ind., and Henry Fligeltaub Co. of Evansville, Ind., began operation of an aluminum recycling plant in Evansville to produce aluminum alloys from scrap. The scrap, melted in an electric induction furnace and then alloyed in a gas-fired furnace, is shipped molten to nearby aluminum mills. The plant made significant improvements to reduce melt loss and was able to utilize many grades of contaminated scrap.

Alcan Ingot and Powders Div. of Alcan Aluminum Corp. ceased production of secondary casting alloys as its Joliet, Ill., plant and will use the 24,000-ton-capacity plant to use can scrap. Wabash Alloys, Inc., of Wabash, Ind., acquired the inventories of the casting plant and will process outstanding orders for secondary alloys.

American Can Co. announced plans to sell its U.S. Reduction Co. subsidiary, one of the largest domestic secondary aluminum producers, within the next 2 years. U.S. Reduction's smelter in East Chicago, Ill., was closed for 3 months owing to a strike with the Oil, Chemical, and Atomic Workers Union.

CONSUMPTION

Contributing to the aluminum consumption decline were the weak markets in the transportation and construction industries caused by declines in the sales of new domestic automobiles and new houses.

The containers and packaging industry continued as the major consumer of aluminum. The aluminum beverage cans industry, shipping 51.7 billion aluminum cans,[4] approximately 89% of total beverage can shipments, continued as the largest single user of aluminum sheet, accounting for 1.12 million tons, or 37% of the net shipments of sheet. The use of aluminum cans for packaging fruits and vegetables increased as a result of the development of new aluminum alloys with acceptable deep-drawing and greater strength.[5] A method that injects liquid nitrogen during packaging is currently being used to package fruit juices, nuts, and wines in aluminum cans.[6]

Although domestic passenger-car sales continued to be weak throughout 1982, the use of aluminum per automobile produced continued to increase. Significant applications in automobiles of the 1980's include aluminum radiators, engine blocks, and bumpers. By 1990, the average 2,250-pound car was expected to utilize about 200 pounds of aluminum.[7] Several makes of domestic automobiles used 180 to 285 pounds of aluminum per vehicle in 1982. In 1983, a domestic sports car is expected to contain 350 to 400 pounds of aluminum.[8]

Table 2.—Consumption of and recovery from purchased new and old aluminum scrap in the United States,[1] by class

(Short tons)

Class	Consumption	Calculated recovery	
		Aluminum	Metallic
1981			
Secondary smelters[r]	976,304	784,134	845,011
Primary producers	730,736	620,836	664,992
Fabricators	167,703	144,748	154,878
Foundries	99,903	84,170	90,541
Chemical producers	37,733	21,004	21,469
Total[r]	2,012,379	1,654,892	1,776,891
Estimated full industry coverage[r]	2,239,000	1,838,000	1,973,000
1982			
Secondary smelters	888,828	712,847	769,555
Primary producers	741,713	621,509	666,280
Fabricators	218,128	186,024	199,175
Foundries	90,315	76,080	81,871
Chemical producers	39,904	17,683	18,300
Total	1,978,888	1,614,143	1,735,181
Estimated full industry coverage	2,095,000	1,707,000	1,836,000

[r]Revised.
[1]Excludes recovery from other than aluminum-base scrap.

Table 3.—Aluminum recovered from purchased scrap processed in the United States, by kind of scrap and form of recovery

(Short tons)

	1981	1982
KIND OF SCRAP		
New scrap:		
Aluminum-base	[1]947,714	[2]855,429
Copper-base	[r]114	[e]103
Zinc-base	[r]300	[e]270
Magnesium-base	210	167
Total	[r]948,338	855,969
Old scrap:		
Aluminum-base	[r]587,858	[3]758,714
Copper-base	[r]58	[e]52
Zinc-base	[r]1,068	[e]961
Magnesium-base	31	322
Total	[r]589,015	760,049
Grand total	[r]1,537,353	1,616,018
FORM OF RECOVERY		
Unalloyed	1,167	387
Aluminum alloys	[r]1,487,195	1,572,174
In brass and bronze	[r]172	[e]155
In zinc-base alloys	[r]1,368	[e]1,231
In magnesium alloys	241	489
Dissipative forms	47,210	41,582
Total	[r]1,537,353	1,616,018

[e]Estimated. [r]Revised.
[1]The amount of aluminum alloys recovered from aluminum-base scrap in 1981, including all constituents, was 1,011,553 tons from new scrap and [r]765,338 tons from old scrap and sweated pig, a total of [r]1,776,891 tons.
[2]The amount of aluminum alloys recovered from aluminum-base scrap in 1982, including all constituents, was 913,189 tons from new scrap and 821,992 tons from old scrap and sweated pig, a total of 1,735,181 tons.
[3]Includes recovery in deoxidizing ingot assuming 85% aluminum content in such ingot.

Table 4.—Stocks, receipts, and consumption of purchased new and old aluminum scrap and sweated pig in the United States in 1982[1]

(Short tons)

Class of consumer and type of scrap	Stocks, Jan. 1	Net receipts[2]	Consumption	Stocks, Dec. 31
Secondary smelters:				
New scrap:				
Solids and clippings	18,900	258,944	260,331	17,513
Borings and turnings	13,912	138,587	139,708	12,791
Foil	W	W	W	W
Dross and skimmings	7,763	84,509	84,400	7,872
Other[3]	294	19,737	19,781	250
Total	40,869	501,777	504,220	38,426
Old scrap:				
Castings, sheet, clippings	12,286	162,134	161,868	12,552
Aluminum-copper radiators	1,577	20,238	20,363	1,452
Aluminum cans	2,185	[4]110,695	[4]110,654	2,226
Other	154	21,693	21,645	202
Total	16,202	314,760	314,530	16,432
Sweated pig	11,445	69,038	70,078	10,405
Total secondary smelters	68,516	885,575	888,828	65,263
Primary producers, foundries, fabricators, chemical plants:				
New scrap:				
Solids and clippings	15,478	450,905	441,969	24,414
Borings and turnings	328	25,955	25,909	374
Foil	W	W	W	W
Dross and skimmings	166	34,272	33,608	830
Other[3]	5,526	31,461	33,422	3,565
Total	21,498	542,593	534,908	29,183
Old scrap:				
Castings, sheet, clippings	1,704	59,223	59,940	987
Aluminum-copper radiators	57	1,262	1,264	55
Aluminum cans	19,597	[4]451,065	[4]453,072	17,590
Other	2,518	22,864	23,355	2,027
Total	23,876	534,414	537,631	20,659
Sweated pig	1,126	17,441	17,521	1,046
Total primary producers, etc	46,500	1,094,448	1,090,060	50,888
All scrap consumed:				
New scrap:				
Solids and clippings	34,378	709,849	702,300	41,927
Borings and turnings	14,240	164,542	165,617	13,165
Foil	2,219	7,748	7,759	2,208
Dross and skimmings	7,929	118,781	118,008	8,702
Other	3,601	43,450	45,444	1,607
Total new scrap	62,367	1,044,370	1,039,128	67,609
Old scrap:				
Castings, sheet, clippings	13,990	221,357	221,808	13,539
Aluminum-copper radiators	1,634	21,500	21,627	1,507
Aluminum cans	21,782	561,760	563,726	19,816
Other	2,672	44,557	45,000	2,229
Total old scrap	40,078	849,174	852,161	37,091
Sweated pig	12,571	86,479	87,599	11,451
Total of all scrap consumed	115,016	1,980,023	1,978,888	116,151

W Withheld to avoid disclosing company proprietary data.
[1]Includes imported scrap. According to reporting companies, 12.62% of total receipts of aluminum-base scrap, or 249,812 short tons, was received on toll arrangements.
[2]Includes inventory adjustment.
[3]Includes data on foil.
[4]Used beverage cans toll-treated for primary producers are included in secondary smelter tabulation.

Table 5.—Production and shipments of secondary aluminum alloys by independent smelters in the United States

(Short tons)

	1981		1982	
	Production	Net shipments	Production	Net shipments
Die-cast alloys:				
13% Si, 360, etc. (0.6% Cu, maximum)	93,676	93,308	94,899	94,277
380 and variations	391,585	392,672	381,456	382,153
Sand and permanent mold:				
95/5 Al-Si, 356, etc. (0.6% Cu, maximum)	37,610	36,930	34,618	34,954
No. 12 and variations	W	W	W	W
No. 319 and variations	50,652	50,314	47,580	47,192
F-132 alloy and variations	15,751	15,278	10,717	11,176
Al-Mg alloys	1,378	1,529	661	819
Al-Zn alloys	8,397	7,846	5,058	5,188
Al-Si alloys (0.6% to 2.0% Cu)	5,758	5,567	4,759	4,842
Al-Cu alloys (1.5% Si, maximum)	3,364	3,344	3,352	3,464
Al-Si-Cu-Ni alloys	4,778	4,627	13,781	13,689
Other	4,089	4,790	2,448	2,590
Wrought alloys: Extrusion billets	108,134	106,814	106,426	106,507
Destructive and other uses: Steel deoxidation:				
Grades 1, 2, 3, and 4	30,831	31,508	28,116	27,926
Miscellaneous:				
Pure (97.0% Al)	1,203	958	399	638
Aluminum-base hardeners	1,493	1,857	972	1,173
Other[1]	10,066	10,010	19,363	19,247
Total	768,765	767,352	754,605	755,835
Less consumption of materials other than scrap:				
Primary aluminum	43,047	--	40,262	--
Primary silicon	39,996	--	39,593	--
Other	2,778	--	2,405	--
Net metallic recovery from aluminum scrap and sweated pig consumed in production of secondary aluminum ingot[2]	682,944	--	672,345	--

W Withheld to avoid disclosing company proprietary data; included with "Other" under "Sand and permanent mold."
[1]Includes other die-cast alloys and other miscellaneous.
[2]No allowance made for melt-loss of primary aluminum and alloying ingredients.

Table 6.—Apparent aluminum supply and consumption in the United States

(Thousand short tons)

	1978	1979	1980	1981	1982
Primary production	4,804	5,023	5,130	4,948	3,609
Change in stocks:[1] Aluminum industry	+106	+184	+25	-765	+203
Imports	1,080	840	713	935	968
Secondary recovery:[2]					
New scrap	1,098	1,163	1,058	r1,137	974
Old scrap	575	614	680	r836	862
Total supply	7,663	7,824	7,606	r7,091	6,616
Less total exports	520	773	1,483	867	824
Apparent aluminum supply available for domestic manufacturing	7,143	7,051	6,123	r6,224	5,792
Apparent consumption[3]	6,045	5,888	5,065	r5,087	4,818

rRevised.
[1]Positive figure indicates a decrease in stocks; negative figure indicates an increase in stocks.
[2]Metallic recovery from purchased, tolled, or imported new and old aluminum scrap expanded for full industry coverage.
[3]Apparent aluminum supply available for domestic manufacturing less recovery from purchased new scrap (a measure of consumption in manufactured end products).

Table 7.—Distribution of end-use shipments of aluminum products in the United States, by industry

Industry	1980 Quantity (thousand short tons)	1980 Percent of total	1981 Quantity (thousand short tons)	1981 Percent of total	1982[p] Quantity (thousand short tons)	1982[p] Percent of total
Building and construction	1,310	18.5	1,265	18.8	1,145	18.8
Transportation	[r]1,116	[r]15.7	1,072	15.9	875	14.3
Containers and packaging	1,667	23.5	1,756	26.1	1,784	29.2
Electrical	[r]698	[r]9.8	666	9.9	566	9.3
Consumer durables	[r]439	6.2	488	7.2	388	6.4
Machinery and equipment	[r]414	5.8	421	6.2	327	5.4
Other markets	[r]299	4.2	318	4.7	270	4.4
Statistical adjustment	[r]+60	.8	+68	1.0	+100	1.6
Total to domestic users	6,003	84.5	6,054	89.8	5,455	89.4
Exports	1,097	15.5	685	10.2	647	10.6
Grand total	7,100	100.0	6,739	100.0	6,102	100.0

[p]Preliminary. [r]Revised.

Source: The Aluminum Association, Inc.

Table 8.—Net shipments of aluminum wrought[1] and cast products in the United States, by producers

(Short tons)

	1980	1981	1982[p]
Wrought products:			
Sheet, plate, foil	3,346,305	3,414,272	3,033,050
Rolled and continuous-cast rod and bar; wire	606,368	523,303	435,657
Extruded rod, bar, pipe, tube, shapes; drawn and welded tubing	1,164,827	1,103,312	993,346
Powder, flake, paste	58,285	53,873	39,986
Forgings (including impacts)	66,635	69,501	52,105
Total	5,242,420	5,164,261	4,554,144
Castings:			
Sand	120,516	122,882	108,230
Permanent mold	192,822	172,351	116,215
Die	443,357	476,431	406,216
Other	12,140	18,964	22,461
Total	768,835	790,628	653,122
Grand total	6,011,255	5,954,889	5,207,266

[p]Preliminary.
[1]Net shipments derived by subtracting the sum of producers' domestic receipts of each mill shape from the domestic industry's gross shipments of that shape.

Source: U.S. Department of Commerce.

Table 9.—Distribution of wrought products in the United States

(Percent)

	1980	1981	1982[p]
Sheet, plate, foil:			
Non-heat-treatable	51.4	54.3	55.4
Heat-treatable	4.5	3.6	3.1
Foil	7.9	8.2	8.1
Rolled and continuous-cast rod and bar; wire:			
Rod, bar, wire	4.3	3.3	2.7
Cable and insulated wire	7.3	6.8	6.9
Extruded products:			
Rod and bar	1.1	1.0	1.0
Pipe and tubing	1.3	1.1	.9
Shapes	18.1	17.5	18.7
Tubing:			
Drawn	.8	.7	.7
Welded	.9	1.1	.5
Powder, flake, paste	1.1	1.0	.9
Forgings (including impacts)	1.3	1.4	1.1
Total	100.0	100.0	100.0

[p]Preliminary.

Source: U.S. Department of Commerce.

STOCKS

Inventories of aluminum ingot, mill products, and scrap at reduction and other processing plants as reported by the Bureau of Industrial Economics, U.S. Department of Commerce, decreased from 3,303,325 tons at the end of 1981 to 3,099,740 tons at the end of 1982.

PRICES

The producers' list price for 99.5% pure aluminum ingot remained at 76 cents per pound throughout 1982. The average spot price, or U.S. market price, as published by Metals Week (McGraw-Hill) for the year was 46.8 cents per pound. The year began with an average spot price of 51.3 cents per pound, but by June, the price declined to 42.9 cents. For the remainder of the year, the average price fluctuated between 44 and 47 cents per pound, ending the year at an average of 46.6 cents per pound. Prices on the London Metal Exchange (LME) began the year at an average of 50.5 cents per pound, fell to 41.7 cents in June, then rose to about 44.7 cents by yearend. The average LME price for the year was slightly under 45 cents per pound.

The price of secondary smelter alloyed aluminum ingot, as quoted in the American Metal Market, ranged from 83 to 96 cents per pound throughout the year. The price of aluminum borings and cast scrap ranged from 13 to 28 cents per pound, depending on the location of the material, at the beginning of 1982, to 8 to 18 cents by yearend. Aluminum-copper clippings ranged from 23 to 32 cents per pound in January and 17 to 27 cents at yearend.

FOREIGN TRADE

U.S. tariff rates in effect during 1982 for wrought and unwrought aluminum products are included in the following table:[9]

Unwrought metal (in coils)	3% ad valorem
Unwrought metal (other than aluminum silicon alloys)	0.6 cent per pound
Wrought aluminum (bars, plates, sheets, strip)	3% ad valorem

Table 10.—U.S. exports of aluminum, by class

Class	1981 Quantity (short tons)	1981 Value (thousands)	1982 Quantity (short tons)	1982 Value (thousands)
Crude and semicrude:				
Ingots, slabs, crude	344,161	$526,646	401,174	$476,186
Scrap	241,161	236,204	214,299	157,666
Plates, sheets, bars, etc	263,672	625,181	193,837	440,373
Castings and forgings	8,930	40,482	7,180	41,156
Semifabricated forms, n.e.c	9,250	49,017	7,979	42,874
Total	867,174	1,477,530	824,469	1,158,255
Manufactures:				
Foil and leaf	36,368	47,324	18,632	34,163
Powders and flakes	3,384	9,259	3,041	9,590
Wire and cable	9,832	23,429	27,625	66,259
Total	49,584	80,012	49,298	110,012
Grand total	916,758	1,557,542	873,767	1,268,267

Table 11.—U.S. exports of aluminum, by class and country

Country	1981						1982					
	Metals and alloys, crude		Plates, sheets, bars, etc.[1]		Scrap		Metals and alloys, crude		Plates, sheets, bars, etc.[1]		Scrap	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Australia	920	$1,784	2,669	$9,250	870	$1,230	164	$373	1,648	$5,690	233	$331
Belgium-Luxembourg	5	23	1,109	5,348	1,634	1,430	18	43	2,072	3,676	3,827	3,094
Brazil	4,562	7,453	1,623	6,155	2,636	2,707	578	1,319	689	3,145	4,013	2,770
Canada	14,874	25,821	125,396	286,470	16,931	14,326	18,360	26,191	92,570	206,366	24,402	18,508
Chile	1,612	3,433	505	1,663	251	402	413	595	219	1,022	192	281
China	4,300	8,113	24	134	--	--	--	--	34	209	--	--
France	4,870	7,309	3,218	15,682	175	179	2,995	4,488	1,373	8,047	438	483
Germany, Federal Republic of	381	1,065	5,199	21,065	5,626	4,777	170	410	2,859	11,307	4,880	3,915
Hong Kong	1,226	2,142	1,386	5,801	63	114	303	849	1,813	6,353	90	145
India	18	33	1,780	3,107	1,799	2,874	--	--	1,468	2,607	99	81
Israel	302	1,103	4,739	16,940	71	82	30	184	2,399	7,393	24	25
Italy	239	1,008	4,784	23,110	1,311	1,124	109	1,346	3,188	15,158	3,060	1,046
Japan	240,219	349,328	17,658	45,116	175,536	170,809	344,608	392,173	3,528	20,080	146,357	106,078
Korea, Republic of	6,121	9,401	1,107	3,783	1,236	1,246	2,224	2,898	1,023	3,797	2,304	1,812
Malaysia	1,080	1,574	94	234	--	--	39	45	176	312	--	--
Mexico	34,034	56,936	50,926	107,096	15,598	19,224	13,186	19,521	36,687	77,861	15,168	12,816
Netherlands	100	528	2,231	8,438	2,349	2,027	1,116	1,086	2,745	10,832	2,002	1,509
Pakistan	102	149	425	728	223	198	1,762	1,975	4,119	4,961	19	21
Philippines	282	429	383	799	209	258	372	447	942	1,869	45	52
Saudi Arabia	791	1,931	2,780	9,944	90	285	48	156	3,213	12,567	4	13
Singapore	1,261	1,882	549	1,966	154	201	1,113	1,444	476	1,819	119	98
South Africa, Republic of	46	144	2,796	6,570	6,100	6,722	2	8	619	1,705	696	771
Spain	2	14	1,674	6,873	2,362	997	26	68	932	3,777	3,493	2,115
Sweden	208	441	3,274	7,870	20	191	208	443	3,848	9,203	--	--
Switzerland	1,233	1,735	949	3,508	15	55	1,162	1,257	385	1,661	--	--
Taiwan	6,578	9,756	1,001	5,507	4,664	3,039	2,471	3,014	1,701	10,938	1,724	975
Thailand	8,943	13,112	454	1,097	11	2	5,170	6,540	301	880	63	76
United Kingdom	1,367	2,833	14,859	36,690	516	648	623	1,369	21,283	41,915	596	301
Venezuela	107	478	15,675	35,165	12	16	593	1,205	7,012	17,053	11	15
Other	8,378	16,688	12,585	38,571	700	1,041	3,311	6,739	9,674	32,200	440	335
Total	344,161	526,646	281,852	714,680	241,162	236,204	401,174	476,186	208,996	524,403	214,299	157,666

[1]Includes castings, forgings, and unclassified semifabricated forms.

Table 12.—U.S. imports for consumption of aluminum, by class

Class	1981 Quantity (short tons)	1981 Value (thousands)	1982 Quantity (short tons)	1982 Value (thousands)
Crude and semicrude:				
Metals and alloys, crude	710,656	$990,869	679,375	$858,017
Circles and disks	5,837	12,954	8,202	16,245
Plates, sheets, etc., n.e.c	118,393	235,642	199,844	384,657
Rods and bars	17,699	57,438	5,658	11,670
Pipes, tubes, etc	583	2,643	639	3,461
Scrap	81,994	79,141	74,338	54,240
Total	935,162	1,378,687	968,056	1,328,290
Manufactures:				
Foil	6,715	34,562	9,664	41,180
Leaf	(1)	131	(1)	102
Flakes and powders	1,694	3,501	2,758	4,436
Wire	1,029	2,721	971	2,236
Total	9,438	40,915	13,393	47,954
Grand total	944,600	1,419,602	981,449	1,376,244

[1] 1981—aluminum leaf not over 30.25 square inches in area, 1,033,500 leaves, and aluminum leaf over 30.25 square inches in area, 175,206,746 square inches; 1982—aluminum leaf not over 30.25 square inches in area, 537,541 leaves, and aluminum leaf over 30.25 square inches in area, 85,990,034 square inches.

Table 13.—U.S. imports for consumption of aluminum, by class and country

Country	1981						1982					
	Metals and alloys, crude		Plates, sheets, bars, etc.[1]		Scrap		Metals and alloys, crude		Plates, sheets, bars, etc.[1]		Scrap	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Argentina	472	$650	663	$1,072	--	--	3,807	$4,602	4,210	$5,540	--	--
Australia	--	--	17,125	29,456	318	$317	2	4	15,372	29,367	--	--
Austria	--	--	1,836	4,012	--	--	--	--	1,440	3,081	--	--
Belgium-Luxembourg	263	330	13,349	24,963	230	215	738	1,033	18,344	30,099	665	$328
Brazil	20	32	1,815	2,903	--	--	58	55	275	432	--	--
Canada	537,450	739,561	24,392	51,463	66,880	65,895	462,300	529,358	26,032	52,361	58,794	46,562
France	7,997	9,595	9,407	21,733	21	8	2,115	2,649	10,994	24,562	44	27
Germany, Federal Republic of	7,101	13,406	2,235	5,648	141	142	5,101	9,409	13,783	27,267	1,882	1,526
Ghana	94,211	144,459	--	--	--	--	188,407	289,210	--	--	--	--
Hong Kong	--	--	1,513	2,979	2	13	--	--	1,696	2,919	332	176
Israel	--	--	677	2,904	454	320	--	--	894	3,473	702	349
Italy	1,642	1,640	6,284	11,770	--	--	572	482	5,202	9,000	(2)	3
Japan	38	403	21,534	43,439	24	17	59	381	88,324	173,895	4	3
Mexico	298	216	181	428	2,850	2,156	134	67	266	290	6,994	2,143
Netherlands	1,896	2,375	4,029	13,691	127	141	218	353	3,159	10,622	57	48
Norway	14,694	19,477	8,793	14,611	--	--	1,299	1,662	7,127	11,057	--	--
Romania	555	581	3,036	4,674	--	--	--	--	837	1,309	--	--
Spain	1,357	1,528	1,125	2,012	--	--	551	740	1,318	2,155	83	89
Suriname	13,076	18,294	--	--	--	--	--	--	--	--	--	--
Sweden	190	252	686	2,190	--	--	663	805	709	2,443	--	--
Switzerland	1,548	2,451	593	1,342	--	--	1,211	1,800	863	1,824	--	--
U.S.S.R	639	613	--	--	3,067	2,996	1,870	1,771	--	--	--	--
United Kingdom	10,616	12,831	2,082	5,387	5,710	5,344	2,463	2,918	4,777	9,610	3,569	2,292
Venezuela	16,250	21,677	12,766	45,922	--	--	6,155	8,228	563	786	--	--
Yugoslavia	--	--	7,723	14,750	--	--	--	--	6,700	11,682	--	--
Other	343	498	668	1,328	2,170	1,577	1,652	2,490	1,458	2,259	1,212	694
Total	710,656	990,869	142,512	308,677	81,994	79,141	679,375	858,017	214,343	416,033	74,338	54,240

[1]Includes circles, disks, rods, bars, pipes, tubes, etc.
[2]Less than 1/2 unit.

WORLD REVIEW

As demand for aluminum continued to weaken, many producers canceled or deferred previously planned capacity expansions or permanently closed down obsolete smelters. As a result, total world primary aluminum capacity increased only 1% in 1982.

Stocks of primary aluminum held by members of the International Primary Aluminum Institute, which represent the bulk of inventories held outside the centrally controlled economies, decreased 6% during 1982.

New primary aluminum smelters were brought into production in Brazil, Indonesia, and Australia. However, world production declined. In addition to the decrease in production in the United States, production decreased markedly in Japan, the United Kingdom, and Venezeula. Other countries that decreased production were Australia, Canada, and most European countries. Production increased in Brazil, Egypt, New Zealand, the U.S.S.R., and Yugoslavia. The United States and Canada, the two largest aluminum-producing countries in 1950 with 67% of world production, produced less than 33% of world production in 1982. The following table shows the changes in shares of world production since 1950:

Country or region	Percent of world production			
	1950	1960	1970	1982
United States	43.6	40.7	37.4	24.7
Canada	24.1	15.4	10.1	8.0
Japan	1.7	3.0	7.6	2.7
U.S.S.R.[e]	12.7	14.9	11.4	14.1
Western Europe	16.5	18.6	20.3	25.4
Eastern Europe[e] [1]	1.1	4.0	4.2	4.8
Australia and New Zealand	--	.3	2.1	4.0
Rest of world	.3	3.1	6.9	16.2

[e]Estimated.
[1]Includes Yugoslavia.

Table 14.—Aluminum: World production,[1] by country

(Thousand short tons)

Country	1978	1979	1980	1981[p]	1982[e]
Argentina	[r]54	[r]131	[r]147	152	[2]155
Australia	290	[r]297	[r]335	418	[2]399
Austria	101	102	104	104	104
Bahrain	135	139	139	155	176
Brazil	205	[r]263	287	283	331
Cameroon	54	48	48	41	41
Canada	1,156	[r]952	1,184	1,230	[2]1,174
China[e]	400	400	400	400	410
Czechoslovakia	41	41	42	41	41
Egypt	111	85	132	148	165
France	431	[r]436	476	480	[2]430
German Democratic Republic[e]	72	66	66	66	66
Germany, Federal Republic of	816	817	806	804	794
Ghana	123	186	207	210	191
Greece	159	155	161	162	162
Hungary	79	79	81	82	[2]82
Iceland	81	80	81	82	85
India	236	233	204	235	225
Iran	28	15	11	6	6
Italy	298	297	[r]299	298	298
Japan[3]	1,166	[r]1,114	1,203	849	[2]387
Korea, North[e]	11	11	11	11	11
Korea, Republic of	22	24	23	19	[2]17
Mexico	48	48	[r]47	48	48
Netherlands	288	284	[r]285	289	288
New Zealand	167	170	171	170	183
Norway	704	[r]732	[r]720	698	[2]702
Poland[4]	110	106	105	73	47
Romania[5]	235	239	266	277	229
South Africa, Republic of	89	95	95	96	96
Spain	234	286	426	437	402
Suriname[6]	61	71	51	35	66
Sweden	90	90	[r]90	91	91
Switzerland	88	91	95	91	91
Taiwan	56	62	70	34	11
Turkey	[r]36	35	38	44	40
U.S.S.R.[e]	1,840	1,930	1,940	1,980	2,070
United Arab Emirates: Dubai	--	--	28	117	138

See footnotes at end of table.

Table 14.—Aluminum: World production,[1] by country —Continued

(Thousand short tons)

Country	1978	1979	1980	1981[p]	1982[e]
United Kingdom	382	396	413	374	265
United States	4,804	5,023	5,130	4,948	[2]3,609
Venezuela	82	251	[r]360	346	269
Yugoslavia	194	185	[r]178	190	231
Total	[r]15,577	[r]16,065	[r]16,955	16,614	14,626

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Output of primary unalloyed ingot unless otherwise specified. Table includes data available through May 18, 1983.
[2]Reported figure.
[3]Includes 4,400 tons of high-purity aluminum for 1978, 1979, and 1980; 6,800 tons for 1981; and 4,800 tons for 1982.
[4]Includes secondary unalloyed ingot.
[5]Includes primary alloyed ingot.
[6]Data represent exports.

Table 15.—Aluminum: World capacity, by continent and country[1]

(Thousand short tons)

Continent and country	1980	1981	1982
North America:			
Canada	1,238	1,299	1,360
Mexico	50	50	50
United States	5,503	5,467	5,487
South America:			
Argentina	154	154	154
Brazil	306	306	434
Suriname	73	73	73
Venezuela	446	446	446
Europe:			
Austria	101	101	101
Czechoslovakia	66	66	66
France	[r]489	[r]489	489
German Democratic Republic	94	94	94
Germany, Federal Republic of	811	804	832
Greece	160	160	160
Hungary	[r]84	[r]84	84
Iceland	95	95	95
Italy	315	315	304
Netherlands	293	293	293
Norway	[r]773	[r]777	872
Poland	[r]61	61	61
Romania	275	275	275
Spain	439	439	439
Sweden	[r]90	[r]90	90
Switzerland	95	95	95
U.S.S.R	[r]2,298	[r]2,387	2,442
United Kingdom	412	421	309
Yugoslavia	[r]248	[r]349	349
Africa:			
Cameroon	68	88	88
Egypt	147	183	183
Ghana	220	220	220
South Africa, Republic of	94	[r]94	145
Asia:			
Bahrain	132	187	187
China	312	356	400
India	380	386	397
Indonesia	--	--	83
Iran	55	55	55
Japan	[r]1,437	[r]1,252	819
Korea, North	22	22	22
Korea, Republic of	20	20	20
Taiwan	92	92	92
Turkey	66	66	66
United Arab Emirates: Dubai	149	149	149
Oceania:			
Australia	380	410	524
New Zealand	[r]172	[r]172	269
Total	[r]18,715	[r]18,942	19,173

[r]Revised.
[1]Detailed information on the individual aluminum reduction plants is available in a 2-part report that can be purchased from Chief, Division of Finance, Bureau of Mines, Bldg. 20, Federal Center, Denver, CO 80225. Part I of "Primary Aluminum Plants, Worldwide" details location, ownership, and production capacity for 1980-87 and sources of energy and aluminum raw materials for foreign and domestic primary aluminum plants, including those in centrally planned economies. Part II summarizes production capacities for 1980-87 by smelter and country.

Australia.—Alcan Australia Ltd. rescheduled construction of a third potline that would increase capacity from 100,000 to 150,000 tons per year at its Kurri Kurri, New South Wales, primary smelter. The project may be resumed when market conditions improve.

Alcoa of Australia Ltd. deferred completion of its $1 billion, 149,000-ton-per-year smelter at Portland, Victoria, until mid-1985. Original plans called for completion in late 1983.

Boyne Smelters Ltd. began production at the first 114,000-ton-per-year potline at its Gladstone, Queensland, primary smelter. Completion of the 227,000-ton-per-year plant was scheduled for 1984. The smelter was specifically built to supply export markets.

The Broken Hill Pty. Co. Ltd. (BHP) abandoned plans for a proposed 260,000-ton-per-year smelter at Lochinvar, New South Wales. BHP and the Japanese partner, Alfarl Pty. Ltd., were unable to find a partner to replace Alumax, which withdrew from the project in 1981.

Construction was underway on the 242,000-ton-per-year smelter at Tomago, New South Wales. The consortium building the smelter, Tomago Aluminium Co. Pty. Ltd., was composed of Pechiney Australia Pty. Ltd. (35%), Gove Alumina Ltd. (35%), Australian Mutual Provident Society (15%), VAW Australia Pty. Ltd. (12%), and Hunter Douglas Ltd. (3%). The first 121,000-ton-per-year potline was scheduled to come on-stream in 1983; the second, in 1984.

Brazil.—Production began at the new 95,000-ton-per-year primary aluminum smelter at Santa Cruz owned by Valesul Alumínio S.A. (VALESUL). The smelter was estimated to cost $390 million. Partners in VALESUL included Cia. Vale do Rio Doce (51%), Shell Brasil Billiton Metais S.A. (44%), and Reynolds Metals (5%).

Alcan's Aluminio do Brazil S.A. increased capacity 33,000 tons per year to 64,000 tons per year at its primary smelter at Aratu.

Construction began on the alumina-aluminum complex owned by Alcoa Alumínio S.A. and Shell Brasil Billiton Metais S.A. at Sao Luis, Maranhão. Completion was scheduled for 1984.

Vereinigte Aluminium-Werke AG reportedly postponed construction of its proposed 242,000-ton-per-year aluminum smelter project at Recife.

Canada.—Alcan Aluminium Ltd. completed construction of a third and last 63,000-ton-per-year potline at its Grande Baie, Quebec, primary aluminum smelter. However, like the second line completed in 1981, startup was delayed until the demand for aluminum increases. Alcan Aluminium postponed indefinitely its plans to construct a 220,000-ton-per-year smelter near Rockwood, Manitoba.

Canadian Reynolds Metals Co. Ltd. began construction on a new 138,000-ton-per-year potline that will increase capacity to 330,000 tons per year at its Baie Comeau, Quebec, primary smelter.

A feasibility study for building a $1 billion, 200,000-ton-per-year aluminum smelter in the Province of Newfoundland was expected to be completed by Arco early next year. Two sites were reportedly being studied for the Arco plant, one site on the island of Newfoundland and the other on the Labrador mainland near Goose Bay.

Péchiney Ugine Kuhlmann Group (PUK) of France reportedly signed an agreement with Hydro Quebec that would provide power for a possible 242,500-ton-per-year smelter at Bécancour, Quebec. Howmet Aluminum Corp., PUK's U.S.-based company, has been managing the feasibility study. If the study proves favorable, the first 121,000-ton-per-year potline could go on-stream in 1986.

China.—Construction was completed on a second 44,000-ton-per-year potline at the 88,000-ton-per-year primary smelter in the southwestern Province of Guizhou. Startup was delayed, however, owing to a shortage of alumina.

Germany, Federal Republic of.—Alcan Aluminiumwerke GmbH considered closing its 49,000-ton-per-year smelter at Ludwigshafen when an agreement on power costs could not be reached with local authorities. A final decision had not been made at yearend.

Ghana.—Volta Aluminium Co. Ltd. shut down 88,000 tons per year of capacity at its 220,000-ton-per-year smelter at Tema. An extended drought that lowered water levels in the Volta Lake reduced hydroelectric power to the smelter.

Indonesia.—The first 83,000-ton-per-year potline of Indonesia Asahan Aluminium Co.'s 248,000-ton-per-year primary smelter in Kuala Tanjung, North Sumatra, came on-stream in February. Full production was scheduled for 1984.

Japan.—The Industrial Structural Council of the Ministry of International Trade and Industry recommended that the primary aluminum industry reduce capacity to

772,000 tons per year, and by yearend, Japanese producers reduced capacity to 819,000 tons per year by shutting down about 433,000 tons per year, as follows:

Nippon Light Metal Co. Ltd. scrapped a 68,000-ton-per-year potline at its 148,000-ton-per-year smelter at Tomakomai.

Sumikei Aluminum Industries Ltd. shut down completely its 109,000-ton-per-year primary smelter at Sakata.

Sumitomo Aluminum Smelting Co. Ltd. completely shut down its 87,000-ton-per-year Isoura primary smelter and reportedly about 40,000 tons per year at its Toyama smelter.

Showa Light Metal Co. Ltd. completely shut down its 32,000-ton-per-year smelter at Kitakata and its 26,000-ton-per-year smelter at Ohmachi. Reportedly, 70,000 tons per year was shut down at Showa's primary smelter at Chiba.

Malaysia.—The Malaysian Government, Conzinc Riotinto of Australia Ltd., Australia, and Sumitomo Aluminum, Japan, held preliminary discussions on constructing a 220,000-ton-per-year aluminum smelter in Sarawak.

Mozambique.—The Government of Mozambique reportedly commissioned a feasibility study, largely financed by the Italian Government, for an integrated aluminum complex to be built in Mozambique. Estimated cost of the project was between $500 and $700 million.

New Zealand.—Construction of a third potline was completed at New Zealand Aluminium Smelter Ltd.'s primary aluminum smelter at Bluff, raising capacity to 269,000 tons per year.

Plans to build a 220,000-ton-per-year aluminum smelter at Aramoana, near Dunedin, were deferred for at least 1 year owing to the world economy. Partners in the proposed smelter project were Fletcher Challenge Ltd. (50%), PUK (25%), and Gove Alumina (25%).

Norway.—Norsk Hydro AS increased capacity by 55,000 tons per year at its primary aluminum smelter at Karmoy.

Årdal og Sunndal Verk AS increased capacity 40,000 tons per year at its Hoyanger primary smelter.

The Norwegian Parliament voted against the modernization of the state-owned Det NorskeNitrid AS primary smelter at Tyssdal. The smelter was closed in 1981.

Paraguay.—Discussions continued between Reynolds Metals and the Government of Paraguay on a proposal to build a 154,000-ton-per-year smelter in Paraguay.

Philippines.—Reynolds Metals proposed to the Philippine Government a modified aluminum smelter project that called for a 39,000-ton-per-year smelter estimated to cost $100 million. The original plans were for a 154,000-ton-per-year smelter.

Taiwan.—Taiwan Aluminium Corp. (Talco) disbanded all of its primary aluminum capacity with the permanent closure of its 55,000-ton-per-year smelter at Kaohsuing. Talco planned to sell and export its aluminum smelting facilities.

United Kingdom.—British Aluminium Co. Ltd. permanently closed its 110,000-ton-per-year primary smelter at Invergordon and reportedly had begun to dismantle the equipment.

Alcan Aluminium (U.K.) Ltd. acquired the assets of British Aluminium for $49 million, and the two companies merged to form British Alcan Aluminium Ltd. British Aluminium assets included two smelters with capacities totaling 52,000 tons per year.

Zaire.—Discussions continued between a consortium of nine companies headed by Swiss Aluminium Ltd. (Alusuisse) for construction of a 231,000-ton-per-year primary smelter in Zaire. The proposed smelter was estimated to cost $1 billion.

TECHNOLOGY

A review of 1982 developments in aluminum electrometallurgy was published.[10] Recent improvements to the Hall-Herault process indicated significant reductions in energy requirements, improved carbon anodes, and the potential use of nonconsumable anodes.[11]

The carbochlorination of plagioclase as a source of aluminum chloride for the winning of aluminum metal was evaluated and compared with kaolin, transition alumina, and bauxite.[12] The Argonne National Laboratory investigated the electrolysis of aluminum sulfide dissolved in fused chlorides[13] and in molten fluorides.[14] Reportedly, this technology, if successful, could be used to reduce aluminum sulfide to aluminum at a low decomposition voltage.

Aluminum Pechiney was assigned a patent that claims a bed of TiB_2 particles covering the carbon block cathode surface permits reduction of the anode-cathode distance of a cell.[15] Reportedly, the distance between electrodes in a 63-kiloampere cell was reduced from 50 to 20 millimeters, and the voltage drop across the cell was reduced from 4.2 to 3.2 volts. Electrical energy consumption was reported to be about 4.5 kilowatt hours per pound of aluminum.

The Bureau of Mines evaluated used smelter potlining as a substitute for fluorspar in basic oxygen steelmaking.[16] The potlining in both lump and pelletized form provided adequately fluid slags. Furnace performance and the quality of steel were unaffected by substituting the used potlining. The Bureau of Mines investigated a hydrochloric acid-fluoride leaching process to recover aluminum from Wyoming anorthosite.[17] Using an 85% stoichiometric hydrochloric acid and a fluorine-to-aluminum mole ratio of 0.27, over 90% of the aluminum was extracted by three-stage countercurrent leaching.

A carbonaceous seam mix that can be applied to aluminum cell bottoms at room temperatures, rather than above 100° C, was developed by Alcoa Laboratories.[18] The mix, basically consisting of calcined anthracite and coke-oven pitch, is mixed with methyl naphthalene coal tar distillate to form a low-temperature viscous binder for the carbon block cathodes that form the bottom of the aluminum cell. In addition to reducing a health hazard caused by the evolution of pitch fumes at high temperatures, the mix has been used successfully for other metallurgical processes.

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[1]Physical scientist, Division of Nonferrous Metals.

[2]Statistical assistant, Division of Nonferrous Metals.

[3]National Association of Recycling Industries, Inc. Second Annual Aluminum Can Recycling Survey. 1982.

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Antimony

By Patricia A. Plunkert[1]

The production and consumption of primary antimony decreased significantly in 1982 compared with that of 1981 as a result of a general softening of demand in the antimony market. Imports in 1982 were down from those of 1981. Domestic and world mine production also decreased in 1982. The General Services Administration (GSA) initiated sales of excess antimony metal from the National Defense Stockpile.

Domestic Data Coverage.—Domestic primary production data for antimony are developed by the Bureau of Mines from two voluntary surveys of U.S. operations. Typical of these surveys is the Primary Antimony survey. Of the 11 operations to which this survey request was sent, all responded, representing 100% of the smelter production shown in table 1 and the primary antimony production shown in table 3.

Table 1.—Salient antimony statistics

(Short tons unless otherwise specified)

	1978	1979	1980	1981	1982
United States:					
Production:					
Primary:					
Mine	798	722	343	646	503
Smelter[1]	14,110	15,062	16,062	r17,844	12,282
Secondary	26,456	24,155	19,893	19,856	16,596
Exports of metal and alloys	556	485	453	324	830
Imports for consumption (antimony content)	17,516	22,141	17,996	17,970	13,387
Reported consumption, primary antimony[1]	13,152	11,753	11,239	11,592	9,414
Stocks: Primary antimony, all classes (antimony content), Dec. 31	8,201	7,144	8,411	9,158	5,973
Price: Average, cents per pound[2]	114.5	140.7	150.8	135.5	107.2
World: Production	r68,241	r69,519	69,672	p63,356	e59,304

eEstimated. pPreliminary. rRevised.

[1]Includes primary antimony content of antimonial lead produced at primary lead refineries.

[2]New York dealer price for 99.5% to 99.6% metal, c.i.f. U.S. ports.

Legislation and Government Programs.—GSA reported that at yearend the Government stocks of antimony totaled 40,707 short tons of stockpile-grade material. The Government stockpile goal remained at 36,000 tons.

The Omnibus Budget Reconciliation Act of 1981 (Public Law 97-35) authorized the disposal of a total of 3,000 tons of antimony metal from the National Defense Stockpile at the rate of 1,000 tons per year. On April 15, 1982, GSA issued its initial invitation to bid on this material. Total sales of antimony metal from the stockpile during 1982 amounted to 21 tons.

DOMESTIC PRODUCTION

MINE PRODUCTION

Two companies accounted for all of the domestic mine production of antimony in 1982, and the total output decreased compared with that of 1981. In June, the Sunshine Mining Co. announced that it was temporarily suspending production at its Sunshine Mine in the Coeur d' Alene district of Idaho owing to depressed silver prices. In response to rising silver prices, the mine was reopened in November. However, full production was not expected to be reached until February 1983. As a result of this shutdown, the Sunshine Mine produced 294 tons of antimony in 1982 compared with 432 tons in 1981. The antimony was produced as a byproduct of the treatment of tetrahedrite, a complex silver-copper-antimony sulfide, one of the principal ore minerals in the Kellogg, Idaho, area. The United States Antimony Corp. (USAC) produced antimony from stibnite mined at the Babitt, Bardot, and Black Jack Mines at Thompson Falls, Mont. In 1982, USAC produced 209 tons of antimony compared with 214 tons in 1981.

Antimony was also produced as a byproduct in the smelting of some primary lead ores.

Table 2.—Antimony mine production and shipments in the United States

(Short tons of recoverable antimony)

Year	Produced	Shipped
1978	798	863
1979	722	701
1980	343	382
1981	646	590
1982	503	365

SMELTER PRODUCTION

Primary.—Production of primary antimony products in 1982 declined from the output recorded in 1981 owing to a decrease in demand. With the exception of residues, all categories of production were less than in 1981. A total of 11 plants produced primary antimony products during 1982. During the year, Mineral Processes JV in Moscow, Tenn., was reorganized and renamed Antimony Processors, Inc. The other producers of antimony products were Anzon America Inc., Laredo, Tex.; ASARCO Incorporated, Omaha, Nebr., and El Paso, Tex.; Chemet Co., Moscow, Tenn.; Harshaw Chemical Co., Gloucester City, N.J.; McGean Chemical Co., Inc., Cleveland, Ohio; M & T Chemicals Inc., Baltimore, Md.; PPG Industries, Inc., La Porte, Tex.; Sunshine Mining, Kellogg, Idaho; and USAC, Thompson Falls, Mont.

Secondary.—Old scrap, predominantly battery plates, was the source of most of the secondary output. New scrap, mostly in the form of drosses and residues from various sources, supplied the remainder. The antimony content of scrap is usually recovered and consumed as antimonial lead.

Table 3.—Primary antimony produced in the United States

(Short tons of antimony content)

Year	Class of material produced: Metal	Oxide	Residues	Byproduct antimonial lead	Total
1978	1,108	12,117	184	701	14,110
1979	2,642	12,141	--	279	15,062
1980	507	15,461	64	30	16,062
1981	790	16,425	r83	546	r17,844
1982	539	11,564	179	W	12,282

rRevised. W Withheld to avoid disclosing company proprietary data.

Table 4.—Byproduct antimonial lead produced at primary lead refineries in the United States

Year	Gross weight (short tons)	Antimony content: From domestic ores[1] (short tons)	From foreign ores[2] (short tons)	From scrap (short tons)	Total: Quantity (short tons)	Total: Percent of gross weight
1978	5,518	539	162	82	783	14.2
1979	3,750	208	71	20	299	8.0
1980	971	18	12	--	30	3.1
1981	3,922	361	185	9	555	14.2
1982	W	W	W	W	W	W

W Withheld to avoid disclosing company proprietary data.
[1]Includes primary residues and a small quantity of antimony ore.
[2]Includes foreign base bullion and small quantities of foreign antimony ore.

Table 5.—Secondary antimony produced in the United States, by kind of scrap and form of recovery

(Short tons of antimony content unless otherwise specified)

	1981	1982
KIND OF SCRAP		
New scrap:		
Lead-base	2,103	1,661
Tin-base	2	2
Total	2,105	1,663
Old scrap:		
Lead-base	17,744	14,928
Tin-base	7	5
Total	17,751	14,933
Grand total	19,856	16,596
FORM OF RECOVERY		
In antimonial lead	[1]16,371	14,603
In other lead alloys	3,476	1,987
In tin-base alloys	9	6
Total	19,856	16,596
Value (millions)	$79.4	$66.4

[1]Includes 9 tons of antimony recovered in antimonial lead from secondary sources at primary plants in 1981.

CONSUMPTION AND USES

Domestic consumption of primary antimony decreased significantly in 1982 compared with that of 1981. In recent years, improved technology has lowered the average antimony content of the antimonial lead alloy used in the manufacture of starting-lighting-ignition (SLI) batteries. In 1982, the Battery Council International reported a 2% decrease in the total shipments of replacement and original equipment automotive SLI batteries in the United States compared with those of 1981. Antimony alloyed with lead was also used in industrial chemical pumps and pipes, tank linings, roofing sheets, and cable sheaths. In these alloys, antimony increases strength and inhibits chemical corrosion.

Nonmetallic antimony was used in plastics both as a stabilizer and as a flame retardant. The use of antimony oxide as a flame retardant decreased in 1982 owing primarily to a slowdown in the automotive and construction industries. Antimony trioxide in an organic solvent was used to make fabrics, plastics, and other combustibles flame retardant. Flames accompanying initial combustion are restricted or extinguished by chemicals released by heat from the treated materials. Antimony was also used as a decolorizing and refining agent in some types of glass such as special optical glass.

Table 6.—Reported industrial consumption of primary antimony in the United States

(Short tons of antimony content)

Year	Class of material consumed						Total
	Ore and concentrate	Metal	Oxide	Sulfide	Residues	Byproduct antimonial lead	
1978	131	2,709	9,399	28	184	701	13,152
1979	15	1,899	9,528	32	--	279	11,753
1980	--	1,648	9,469	28	64	30	11,239
1981	--	1,546	9,385	32	83	546	11,592
1982	--	1,282	7,924	29	179	W	9,414

W Withheld to avoid disclosing company proprietary data.

Table 7.—Reported industrial consumption of primary antimony in the United States, by product

(Short tons of antimony content)

Product	1978	1979	1980	1981	1982
Metal products:					
Ammunition	133	253	362	409	294
Antimonial lead	2,832	1,300	748	1,257	793
Bearing metal and bearings	279	235	223	206	143
Cable covering	21	16	31	24	25
Castings	15	14	10	11	9
Collapsible tubes and foil	17	24	18	9	1
Sheet and pipe	39	36	29	36	26
Solder	206	199	134	105	124
Type metal	81	37	21	19	11
Other	113	99	74	69	67
Total	3,736	2,213	1,650	2,145	1,493
Nonmetal products:					
Ammunition primers	13	23	20	25	20
Fireworks	5	6	4	4	6
Ceramics and glass	1,259	1,127	1,303	782	1,358
Pigments	410	399	499	341	330
Plastics	1,456	1,580	1,636	1,551	1,050
Rubber products	254	182	325	232	221
Other	165	140	107	111	103
Total	3,562	3,457	3,894	3,046	3,088
Flame-retardant:					
Plastics	4,063	4,262	3,874	4,509	3,312
Pigments	33	35	56	40	25
Rubber	196	146	189	174	104
Adhesives	298	302	461	585	179
Textiles	990	1,143	942	962	1,110
Paper	274	195	173	131	103
Total	5,854	6,083	5,695	6,401	4,833
Grand total	13,152	11,753	11,239	11,592	9,414

Table 8.—Industry stocks of primary antimony in the United States, December 31

(Short tons of antimony content)

Stocks	1978	1979	1980	1981	1982
Ore and concentrate	1,610	1,757	2,743	2,529	532
Metal	1,119	1,184	680	916	556
Oxide	4,906	3,398	3,855	4,707	4,711
Sulfide	19	17	13	25	24
Residues and slags	457	730	1,116	864	150
Antimonial lead[1]	90	58	4	117	W
Total	8,201	7,144	8,411	9,158	5,973

W Withheld to avoid disclosing company proprietary data.
[1]Inventories from primary sources at primary lead refineries only.

PRICES

The New York dealer price for imported antimony metal began the year at $1.20 to $1.24 per pound and decreased steadily through March. A slight upturn in price occurred during the month of April. However, during June, the price began a decrease that continued throughout the remainder of the year, and the yearend price was $0.93 to $0.98 per pound. At the beginning of the year, the industry price quotation for antimony trioxide was $1.40 to $1.80 per pound. During the year, Asarco announced several price reductions owing to the fall in demand and the availability of lower priced imported materials. Other domestic producers adjusted their prices to remain competitive so that by yearend the published price for antimony trioxide ranged from $1.20 to $1.80 per pound.

In April 1982, Metal Bulletin began publishing European price quotations for various grades of antimony ore and concentrates. Prices declined steadily throughout the year so that by yearend the quotations were as follows: sulfide ore concentrates, 50% to 55% antimony content, nominal; clean sulfide concentrates, 60% antimony content, $14 to $15 per metric ton unit (equivalent to $12.75 to $13.60 per short ton unit); and lump sulfide ore, 60% antimony content, $14.75 to $16.00 per metric ton unit (equivalent to $13.40 to $14.50 per short ton unit).

Table 9.—Antimony price ranges in 1982, by type

Type	Price per pound
Domestic metal[1]	$2.00
Foreign metal[2]	$0.93- 1.24
Antimony trioxide[3]	1.20- 1.80

[1]Based on antimony in alloy.
[2]Duty-paid delivery, New York.
[3]Producer price.

FOREIGN TRADE

Exports.—In 1982, exports of antimony metal, alloys, and scrap were more than twice those of 1981. Mexico, Belgium-Luxembourg, the Netherlands, and Venezuela, in descending order of receipts, received approximately 75% of the total exports; the balance was shipped in small parcels to 27 countries. Exports of antimony oxide decreased to 334 tons (gross weight) in 1982. Approximately 30% of the total oxide was shipped to Mexico, and the balance was divided among 20 other countries.

Imports.—Total imports of antimony (antimony content) in 1982 decreased significantly from those of 1981 because of the continued slowdown in the antimony market. Imports of antimony ore and concentrates were about one-half the level of those of 1981. Imports of antimony metal, antimony oxide, and antimony sulfide also showed significant decreases from 1981 levels.

In 1982, approximately 60% of the antimony metal imports came from China, whereas Bolivia continued to provide most of the imported ore and concentrates. The Republic of South Africa remained the largest single source for imports of antimony oxide, followed by Bolivia, China, and France.

Table 10.—U.S. import duties for antimony

Item	TSUS No.	Most favored nation (MFN) January 1, 1982	Most favored nation (MFN) January 1, 1983	Non-MFN January 1, 1982
Ore	601.03	Free	Free	Free.
Needle or liquated	603.10	0.1 cent per pound	0.1 cent per pound	0.25 cent per pound.
Metal, unwrought	632.02	.6 cent per pound	.5 cent per pound	2 cents per pound.
Antimony oxide	417.50	.2 cent per pound	.1 cent per pound	2 cents per pound.

Table 11.—U.S. imports for consumption of antimony, by class and country

Class and country	1981		1982	
	Gross weight (short tons)	Value (thousands)	Gross weight (short tons)	Value (thousands)
Antimony metal:				
Belgium-Luxembourg	175	$408	93	$184
Bolivia	2,086	5,114	504	961
Brazil	--	--	28	255
Canada	3	176	1	205
Chile	61	107	56	109
China	176	460	1,157	2,116
Dominican Republic	4	8	--	--
Germany, Federal Republic of	(1)	2	(1)	2
Japan	(1)	2	(1)	4
Mexico	55	102	39	17
Netherlands	19	51	--	--
Taiwan	33	86	--	--
United Kingdom	19	53	(1)	(1)
Yugoslavia	--	--	22	40
Total	2,631	6,569	1,900	3,893
Antimony oxide:				
Belgium-Luxembourg	470	1,222	230	561
Bolivia	2,311	4,884	2,272	3,807
Brazil	110	256	2	5
Canada	--	--	21	15
Chile	220	422	--	--
China	2,085	5,233	2,058	5,190
France	1,864	4,856	1,582	4,520
Germany, Federal Republic of	22	53	87	456
Hong Kong	33	86	--	--
Italy	88	220	--	--
Japan	--	--	(1)	2
Netherlands	40	111	22	58
South Africa, Republic of	4,602	1,613	3,200	745
United Kingdom	325	966	959	2,686
Total	12,170	19,922	10,433	18,045
Antimony sulfide:[2]				
Austria	12	35	--	--
Belgium-Luxembourg	6	17	30	85
China	72	138	48	68
France	14	36	10	27
Germany, Federal Republic of	(1)	2	(1)	1
Japan	--	--	(1)	2
United Kingdom	2	21	(1)	5
Total	106	249	88	188

[1]Less than 1/2 unit.
[2]Includes needle or liquated.

Table 12.—U.S. imports for consumption of antimony ore and concentrate, by country

Country	1981			1982		
	Gross weight (short tons)	Antimony content (short tons)	Value (thousands)	Gross weight (short tons)	Antimony content (short tons)	Value (thousands)
Bolivia	4,089	2,656	$4,916	2,498	1,683	$2,724
Canada	186	86	162	680	427	622
Chile	458	302	593	--	--	--
China	55	36	56	--	--	--
Germany, Federal Republic of	124	88	186	--	--	--
Guatemala	809	517	931	--	--	--
Hong Kong	217	119	183	--	--	--
Mexico	3,951	883	1,318	2,162	485	597
Peru	33	21	38	--	--	--
South Africa, Republic of	587	297	454	110	71	125
Thailand	275	150	226	--	--	--
United Kingdom	--	--	--	41	31	99
Zimbabwe	29	13	32	116	72	122
Total	10,813	5,168	9,095	5,607	2,769	4,289

Table 13.—U.S. imports for consumption of antimony

Year	Antimony ore and concentrate			Antimony sulfide[1]			Antimony metal[2]		Antimony oxide		
	Gross weight (short tons)	Antimony content (short tons)	Value (thousands)	Gross weight (short tons)	Antimony content (short tons)	Value (thousands)	Gross weight (short tons)	Value (thousands)	Gross weight (short tons)	Antimony content (short tons)	Value (thousands)
1980	11,044	5,235	$11,646	34	23	$216	2,590	$7,277	12,224	10,148	$15,771
1981	10,813	5,168	9,095	106	70	249	2,631	6,569	12,170	10,101	19,922
1982	5,607	2,769	4,289	88	59	188	1,900	3,893	10,433	8,659	18,045

[1]Includes needle or liquated.
[2]Does not include alloy containing 83% or more antimony.

Table 14.—Antimony: World mine production (content of ore unless otherwise indicated), by country[1]

(Short tons)

Country	1978	1979	1980	1981[p]	1982[e]
Australia[2]	1,674	[r]1,603	1,315	993	937
Austria	561	629	730	665	660
Bolivia	14,702	14,351	17,047	16,866	[3]15,408
Brazil	[r]302	[r]80	51	297	300
Burma	650	750	485	[e]110	--
Canada[e 4]	3,310	3,256	2,600	[r]1,560	--
China[e]	11,000	11,000	11,000	11,000	11,000
Czechoslovakia	[r e]560	[r]584	639	551	550
Guatemala	254	728	613	563	550
Honduras	86	51	25	[e]22	11
Italy	1,026	1,047	786	767	770
Malaysia (Sarawak)	290	338	147	211	130
Mexico[5]	2,708	3,166	2,399	1,984	1,984
Morocco	2,437	2,175	606	1,257	2,200
Pakistan	23	7	11	11	44
Peru (recoverable)	821	[r]602	379	753	770
South Africa, Republic of[6]	10,024	12,815	14,413	10,748	[7]9,397
Spain	487	552	689	712	680
Thailand	3,167	3,235	3,214	1,322	790
Turkey	[r]1,378	[r]309	863	924	880
U.S.S.R.[e]	[r]8,900	[r]9,100	9,300	9,500	9,900
United States[8]	798	722	343	646	503
Yugoslavia	2,950	2,245	1,852	1,604	1,540
Zimbabwe	133	174	165	290	300
Total	[r]68,241	[r]69,519	69,672	63,356	59,304

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through May 18, 1983.
[2]Antimony content of antimony ore and concentrates, lead concentrates, and lead and zinc middlings.
[3]Reported figure.
[4]Partly estimated on the basis of reported value of total production.
[5]Antimony content of ores for export plus antimony content of antimonial lead and other smelter products produced.
[6]As reported by the Government of the Republic of South Africa; differs slightly from data reported by the Nation's only significant producer, Consolidated Murchison Ltd. Official figures apparently represent content of hand-cobbed ores and antimony concentrates, apparently excluding antimony content of arsenical concentrates reported as follows by Consolidated Murchison Ltd. in short tons: 1978—1,173; 1979, 1980, and 1981—nil.
[7]Reported figure from Consolidated Murchison Ltd. 1982 annual report.
[8]Production from antimony mines; excludes amount produced as a byproduct of domestic lead ores.

WORLD REVIEW

The second international meeting on antimony sponsored by the Bolivian Committee of Antimony Producers was held in October at La Paz, Bolivia. The participants signed a letter of intentions recommending the creation of an international antimony organization with membership open to producers, traders, end users, and research institutions involved with antimony.

Bolivia.—Empresa Nacional de Fundiciones (ENAF), the state-owned smelting and refining company, cut antimony production at its Vinto smelter by 70% during 1982.[2] ENAF was also considering changing its production of antimony oxide at the smelter from a pure form (99.9% trioxide) to a crude oxide containing 70% to 75% antimony for sale to foreign smelters.[3]

Canada.—Consolidated Durham Mines & Resources Ltd., operator of the Lake George antimony mine in New Brunswick, announced that it was allowing the mine to flood until market conditions improved sufficiently for the mine to be reopened and a deeper ore body to be developed. The mine had been closed since 1981.

Czechoslovakia.—Antimony metal production in Czechoslovakia could double to about 2,200 tons per year with the commissioning of a new cyclone reactor at Vajskova in central Slovakia that will process byproduct concentrates from mercury production. The concentrates, not of a high enough grade to process previously, were reported to contain copper, antimony, bismuth, mercury, and arsenic.[4]

South Africa, Republic of.—In June, Consolidated Murchison Ltd. announced a reduction in antimony ore and concentrate production in response to lower prices and lower demand. This new reduction was in addition to the decrease in production rates announced in 1981.

[1]Physical scientist, Division of Nonferrous Metals.
[2]Latin American Mining Letter. V. 1, No. 19, Oct. 1, 1982, p. 5.
[3]Metal Bulletin Monthly. Antimony Seeks Solutions. No. 146, February 1983, pp. 69-71.
[4]World Mining. V. 35, No. 10, October 1982, p. 170.

Asbestos

By R. A. Clifton[1]

U.S. apparent consumption of asbestos continued to decline in 1982 because of the depressed construction and automotive industries and because of its unfavorable public ecological image. U.S. apparent consumption declined 29% compared with that of 1981 and 72% compared with the all-time high of 1973. Shipments from domestic mines, all chrysotile, decreased 16% and imports decreased 28% compared with those of 1981.

Domestic Data Coverage.—Domestic production data for asbestos are developed by the Bureau of Mines by means of a voluntary industry survey. Of the three canvassed operations to which a survey collection request was made, all responded and 100% of the total production data shown in table 1 were represented.

Table 1.—Salient asbestos statistics

	1978	1979	1980	1981	1982
United States:					
Production (sales) metric tons	93,097	93,354	80,079	75,618	63,515
Value thousands	$27,987	$28,925	$30,599	$30,685	$24,917
Exports and reexports (unmanufactured) metric tons	r41,783	43,291	48,671	64,419	58,771
Value thousands	r$13,396	$17,381	$21,067	$21,508	$19,713
Exports and reexports of asbestos products (value) do	r$127,052	$137,690	$141,653	$145,130	$127,867
Imports for consumption (unmanufactured) metric tons	570,020	513,084	327,296	337,618	241,737
Value thousands	$154,351	$135,210	$91,809	$103,893	$64,925
Released from stockpile (unmanufactured) metric tons	--	1	--	--	--
Consumption do	618,700	560,500	358,700	348,800	246,500
World: Production do	r4,693,217	r4,906,389	4,808,310	p4,479,783	e4,310,685

eEstimated. pPreliminary. rRevised.

Legislation and Government Programs.—The Occupational Safety and Health Administration (OSHA) published in the Federal Register (FR) of March 19 its proposed rule on workplace hazard communication and labeling. Employers in manufacturing facilities would be required by the proposal to communicate hazardous workplace chemical information to employees by use of labels and placards, material safety data sheets, lists of hazardous chemicals, and education and training.

In the May 27th FR, the Environmental Protection Agency (EPA) published its asbestos-in-school-buildings rule. Under the rule, inspections and identification of friable asbestos-containing material are required of all public and private elementary and secondary schools. Inspection results must be maintained and communicated to a school's parent-teacher association. Employees must be notified of the location of friable asbestos materials and be provided with instructions on exposure reduction.

In the July 30th FR, EPA issued a final asbestos reporting rule effective August 30, 1982. The rule, designed to "obtain current information about major aspects of asbestos manufacturing, processing, and importation to support the Agency's asbestos risk investigation," required a report containing detailed information from the primary processors of asbestos by November 30. The primary processors were identified as "those who mine, mill, or import bulk asbestos, or process it to form an asbestos mixture or products." October 30 was the reporting date for the secondary processors of asbestos, those who make products from asbestos mixtures, and the importers of asbestos or other asbestos-containing products.

In the September 2d FR, EPA published a final rule under the Toxic Substances Control Act (TSCA) with an effective date of October 4 requiring submission of unpublished health and safety studies on specifically listed chemicals. On the rationale that it "is being considered for control" under TSCA, asbestos was included.

Environmental Impact.—On August 26, 1982, the Manville Corp., formerly Johns-Manville, Inc., filed a bankruptcy petition under Chapter 11 of the Federal Bankruptcy Code. Despite this, Manville, and the news media, indicated that supply would continue to meet U.S. demand. Manville is the largest producer of asbestos among the market economy countries, from its Canadian mines, and the largest manufacturer of asbestos-containing products in the United States. The purpose of the bankruptcy filing was to relieve the burden of 16,500 outstanding lawsuits against Manville in the asbestos-related-disease area. Manville was also hopeful of legislative relief.

The continuing Reserve Mining Co. case came before more than three dozen State and Federal judges in six courts up to and including the Supreme Court. This widely publicized case, *United States of America* versus *Reserve Mining Co.*, finally ended in May in St. Paul, Minn. It was one of the country's foremost environmental disputes and required more than 12 years and 25,000 pages of testimony to conclude. Reserve Mining, under court orders, had previously spent more than $370 million establishing a land disposal system and paid about $1 million in fines and penalties. Under the consent decree, the company must pay $1.8 million toward water filtration plants in four communities and $1.1 million to Minnesota.

The World Symposium on Asbestos in Montreal, Canada, in May addressed the question, "Can society live with asbestos or must it learn to do without?" The consensus answer was that asbestos need not be banned.

The American Society for Testing and Materials (ASTM) published a voluntary consensus standard for occupational exposure to asbestos. The standard was titled "Standard Practice for Health and Safety Requirements Relating to Occupational Exposure to Asbestos" and numbered E 849-82. The main difference between this standard and OSHA's current one is that it endorses an aspect ratio, the ratio of a fiber's length to its width of 5 to 1.

ASTM also sponsored, in October, a conference and workshops on "The Need for Specific Definitions for Health Related Minerals." The conference papers, including a new recommended asbestos definition, were scheduled to be published in 1983.

Table 2.—Stockpile goals and Government inventories for asbestos as of December 31

(Metric tons)

	Stockpile goals	Total inventories 1980	1981	1982
Amosite	15,422	38,587	38,587	38,587
Chrysotile	2,722	9,034	9,034	9,034
Crocidolite	--	2,163	754	754
Total	18,144	49,784	48,375	48,375

DOMESTIC PRODUCTION

Mines in the United States shipped about 16% less asbestos in 1982 than in 1981, and the value decreased 19%. Only two States produced asbestos; California was the leader, followed by Vermont. The one Arizona mine ceased operation at the beginning of the year.

Calaveras Asbestos Corp. was California's and the Nation's leading producer, from its Copperopolis Mine. The other California producer, the Santa Rita Mine on the Joaquin Ridge near Coalinga, in San Benito County, was owned and operated by Union Carbide Corp.

Table 3.—Asbestos producers in the United States in 1982

State and company	County	Mine	Type of asbestos
California:			
Calaveras Asbestos Corp	Calaveras	Copperopolis	Chrysotile.
Union Carbide Corp	San Benito	Santa Rita	Do.
Vermont: Vermont Asbestos Group	Orleans	Lowell	Do.

The Vermont Asbestos Group's Lowell Mine in Orleans County, Vt., was second in the country in production.

The Jaquays Mining Corp. mine in Gila County, Ariz., was closed in 1982. No production occurred in Arizona in 1982 but some shipments were made.

Employment in U.S. asbestos mines and mills decreased by approximately 10% to an average of about 400 persons during 1982.

An Alaskan newspaper described chrysotile deposits in the Eagle Quadrant.[2] Doyon, Ltd., a Native corporation, owns the mineral rights. The managing entity, Alaska Asbestos Co., is an equal partnership between International Paper Co. and Tanana Asbestos Co., a subsidiary of Doyon. After more than 100 cores had been drilled, the Slate Creek deposit was said to have a "drill indicated" reserve of 50 million metric tons of asbestos-bearing ore. Their Champion Creek deposit 13 miles away, after 16 drill holes, promised to be even larger. Initial evaluation indicated sufficient ore to support a mine producing 2.0 million tons per year of ore and a mill producing annually 150,000 tons of fiber. Such an establishment was projected to cost $120 to $150 million. Based on this, Alaska has the potential of becoming the country's leading asbestos State, could more than double total U.S. production capacity, and could have one of the world's largest mines.

CONSUMPTION AND USES

Total U.S. asbestos consumption decreased 29% in 1982 from that of 1981. Chrysotile was 93% of that consumed; crocidolite, 6%. Small amounts of amosite were reported used.

Included in this report are revised end-use data, table 4, for the years 1977 through 1981, the result of newly acquired data. An observable trend over the last few years has been the continued high usage of asbestos for friction products during a declining market. Although this use showed only a small rise in 1982 over that of 1981, its market share rose from 15% to 21%.

Less than 1% of the chrysotile used was spinning grades (1, 2, or 3); of the remainder, the grade 7's were the most used, 77%, followed by the 4's and 6's, 8% each, and the 5's, 7%.

Table 4.—U.S. asbestos consumption by end use, grade, and type

(Thousand metric tons)

	Chrysotile							Crocidolite	Amosite	Total asbestos
	Grades 1 and 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Total			
1977:[r]										
Asbestos-cement pipe	--	--	68.1	32.8	2.4	--	103.3	11.2	0.5	115.0
Asbestos-cement sheet	--	--	5.1	8.9	7.1	5.8	26.9	--	.1	27.0
Flooring products	2.6	--	--	65.6	.1	81.7	150.0	--	--	150.0
Roofing products	--	--	.3	4.0	16.5	49.2	70.0	--	--	70.0
Packing and gaskets	.3	3.1	3.9	13.9	1.5	5.0	27.7	--	--	27.7
Insulation:										
Thermal	--	1.7	.5	.4	8.4	5.5	16.5	--	--	16.5
Electrical	--	.2	--	2.2	1.0	.3	3.7	--	--	3.7
Friction products	.1	1.1	1.5	18.9	6.9	28.5	57.0	--	--	57.0
Coatings and compounds	--	--	.2	.4	1.1	34.1	35.8	--	--	35.8
Plastics	--	.1	--	1.1	--	6.3	7.5	.5	--	8.0
Textiles	1.1	8.4	.2	--	--	--	9.7	--	--	9.7
Paper	--	--	.5	.3	4.8	1.4	7.0	.3	--	7.3
Other	.3	1.2	28.1	37.6	28.0	48.6	143.8	--	--	143.8
Total	4.4	15.8	108.4	186.1	77.8	266.4	658.9	12.0	.6	671.5

See footnote at end of table.

Table 4.—U.S. asbestos consumption by end use, grade, and type —Continued

(Thousand metric tons)

	Chrysotile							Crocidolite	Amosite	Total asbestos
	Grades 1 and 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Total			
1978:[r]										
Asbestos-cement pipe	--	--	58.7	28.3	2.0	--	89.0	15.8	1.0	105.8
Asbestos-cement sheet	--	--	4.6	8.1	6.5	5.3	24.5	--	.2	24.7
Flooring products	2.4	--	--	60.3	.1	75.2	138.0	--	--	138.0
Roofing products	--	--	.2	3.7	15.2	45.2	64.3	--	--	64.3
Packing and gaskets	.3	2.8	3.6	12.7	1.4	4.6	25.4	--	--	25.4
Insulation:										
Thermal	--	1.6	.5	.4	7.9	5.1	15.5	--	--	15.5
Electrical	--	.2	--	2.2	1.0	.3	3.7	--	--	3.7
Friction products	.1	1.0	1.4	17.5	6.4	26.2	52.6	--	--	52.6
Coatings and compounds	--	--	.2	.4	1.0	31.2	32.8	--	--	32.8
Plastics	--	.1	--	1.0	--	5.6	6.7	.7	--	7.4
Textiles	1.0	7.5	.2	--	--	--	8.7	--	--	8.7
Paper	--	--	.4	.3	4.4	1.3	6.4	.4	--	6.8
Other	.4	1.2	29.3	34.5	25.0	42.6	133.0	--	--	133.0
Total	4.2	14.4	99.1	169.4	70.9	242.6	600.6	16.9	1.2	618.7
1979:[r]										
Asbestos-cement pipe	--	--	54.5	26.3	1.9	--	82.7	12.7	.4	95.8
Asbestos-cement sheet	--	--	4.2	7.4	5.9	4.8	22.3	--	.1	22.4
Flooring products	2.1	--	--	54.6	.1	68.2	125.0	--	--	125.0
Roofing products	--	--	.2	3.3	13.8	41.0	58.3	--	--	58.3
Packing and gaskets	.3	2.6	3.2	11.5	1.2	4.2	23.0	--	--	23.0
Insulation:										
Thermal	--	1.4	.4	.3	7.2	4.7	14.0	--	--	14.0
Electrical	--	.2	--	2.0	.9	.3	3.4	--	--	3.4
Friction products	.1	.9	1.2	15.8	5.8	23.8	47.6	--	--	47.6
Coatings and compounds	--	--	.2	.3	.9	28.3	29.7	--	--	29.7
Plastics	--	.1	--	.9	--	5.1	6.1	.6	--	6.7
Textiles	.9	6.7	.2	--	--	--	7.8	--	--	7.8
Paper	--	--	.4	.3	4.0	1.2	5.9	.3	--	6.2
Other	.4	1.2	25.7	31.4	22.8	39.1	120.6	--	--	120.6
Total	3.8	13.1	90.2	154.1	64.5	220.7	546.4	13.6	.5	560.5
1980:[r]										
Asbestos-cement pipe	--	--	21.5	7.9	1.3	.9	31.6	10.0	.3	41.9
Asbestos-cement sheet	--	--	--	.3	12.5	10.1	22.9	--	.1	23.0
Flooring products	--	.1	--	27.9	.1	41.9	70.0	--	--	70.0
Roofing products	--	.1	.3	.1	3.5	20.0	24.0	--	--	24.0
Packing and gaskets	--	.8	2.3	6.3	.1	2.8	12.3	--	--	12.3
Insulation:										
Thermal	--	--	.1	--	.7	5.2	6.0	--	--	6.0
Electrical	--	.2	--	.1	--	2.6	2.9	--	--	2.9
Friction products	--	.5	2.5	16.9	5.6	26.5	52.0	--	--	52.0
Coatings and compounds	--	--	.1	--	.1	10.7	10.9	--	--	10.9
Plastics	.2	--	--	.3	--	.7	1.2	.3	--	1.5
Textiles	.2	1.7	--	--	--	--	1.9	--	--	1.9
Paper	--	--	--	.2	.1	--	.3	.2	--	.5
Other	--	.5	61.8	34.3	1.0	14.2	111.8	--	--	111.8
Total	.4	3.9	88.6	94.3	25.0	135.6	347.8	10.5	.4	358.7
1981:[r]										
Asbestos-cement pipe	--	--	20.3	7.4	.3	--	28.0	14.0	--	42.0
Asbestos-cement sheet	--	.1	.3	2.8	2.8	13.6	19.6	--	.1	19.7
Flooring products	--	--	--	.4	--	66.6	67.0	--	--	67.0
Roofing products	--	.1	.2	.6	3.7	11.4	16.0	--	--	16.0
Packing and gaskets	--	1.0	1.6	5.2	.1	11.4	19.3	--	--	19.3
Insulation:										
Thermal	--	--	.2	--	--	5.8	6.0	--	--	6.0
Electrical	--	.3	--	--	--	.3	.6	--	--	.6
Friction products	--	--	1.2	15.1	6.2	28.5	51.0	--	--	51.0
Coatings and compounds	--	--	.1	.3	1.1	11.6	13.1	--	--	13.1
Plastics	.1	.1	--	.3	--	.6	1.1	--	--	1.1
Textiles	--	1.7	--	--	--	--	1.7	--	--	1.7
Paper	--	.1	--	.4	.9	.3	1.7	--	--	1.7
Other	--	.4	51.1	22.4	5.4	29.7	109.0	--	.6	109.6
Total	.1	3.8	75.0	54.9	20.5	179.8	334.1	14.0	.7	348.8

See footnote at end of table.

Table 4.—U.S. asbestos consumption by end use, grade, and type —Continued

(Thousand metric tons)

	Chrysotile							Cro-cido-lite	Amo-site	Total asbes-tos
	Grades 1 and 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Total			
1982:										
Asbestos-cement pipe	--	--	15.6	5.0	1.0	--	21.6	16.0	--	37.6
Asbestos-cement sheet	--	--	.2	1.0	7.2	2.4	10.8	--	--	10.8
Flooring products	--	--	--	--	--	49.0	49.0	--	--	49.0
Roofing products	--	--	--	--	3.0	4.0	7.0	--	--	7.0
Packing and gaskets	--	--	.4	.5	.8	11.9	13.6	--	--	13.6
Insulation:										
Thermal	--	--	--	--	--	--	--	--	.2	.2
Electrical	--	--	--	--	--	.7	.7	--	--	.7
Friction products	--	--	1.0	7.9	6.7	37.3	52.9	--	--	52.9
Coatings and compounds	--	--	--	--	--	25.0	25.0	--	--	25.0
Plastics	--	--	--	.2	--	.2	.4	--	--	.4
Textiles	--	1.1	--	--	--	--	1.1	--	--	1.1
Paper	--	--	--	.1	--	1.5	1.6	--	--	1.6
Other	--	1.2	1.2	.3	.1	43.3	46.1	--	.5	46.6
Total	--	2.3	18.4	15.0	18.8	175.3	229.8	16.0	.7	246.5

[r]Revised.

PRICES

Depressed markets and high producer inventories of the last few years have caused final negotiated asbestos prices to be lower than listed prices. A realistic set of unit values can be calculated using import data as shown in table 5. These averaged data represented most of the domestic market. The unit value of exported asbestos, $335 per ton in 1982, did not change significantly.

Table 5.—Customs unit values of imported asbestos

(Dollars per metric ton)

	1978	1979	1980	1981	1982
Canada:					
Chrysotile:					
Crude	381	201	158	--	380
Spinning	902	868	843	927	917
Cement	250	238	251	272	234
Other	267	292	296	373	334
South Africa, Republic of:					
Amosite	569	499	1,611	728	771
Crocidolite	624	711	686	676	646

FOREIGN TRADE

There was a 12% decrease in the total value of asbestos fibers and asbestos products exported from the United States in 1982 from that of 1981; of this, the fiber portion remained at 13%. Canada remained the largest user of U.S. asbestos and products accounting for 31% of the value of exports of these products in 1982, followed by Saudi Arabia and Mexico, 10% each.

Canada provided 95% of the asbestos fiber imported into the United States in 1982, and the Republic of South Africa provided 5%. Several countries provided minor amounts. Chrysotile again dominated the imported types with 97% of the total. The value of imported fiber in 1982 was only 62% of that of 1981.

In 1982, the United States recovered 227% of the cost of imported asbestos by exporting and reexporting fibers and products.

Table 6.—Countries importing U.S. asbestos fibers and products, by country

(Thousand dollars)

Country	1981 Unmanufactured fibers	1981 Manufactured products	1981 Total	1982 Unmanufactured fibers	1982 Manufactured products	1982 Total
Australia	117	4,480	4,597	145	5,034	5,179
Canada	1,029	55,754	56,783	1,144	43,714	44,858
Colombia	55	1,867	1,922	153	2,124	2,277
Germany, Federal Republic of	713	3,098	3,811	980	2,417	3,397
Japan	4,246	4,171	8,417	3,933	6,475	10,408
Mexico	5,267	18,344	23,611	4,902	9,837	14,739
Netherlands	14	1,680	1,694	4	980	984
Saudi Arabia	118	11,717	11,835	17	15,291	15,308
United Kingdom	206	3,627	3,833	178	2,761	2,939
Venezuela	222	4,951	5,173	259	5,747	6,006
Other	9,362	34,842	44,204	7,828	32,324	40,152
Total	21,349	144,531	165,880	19,543	126,704	146,247

Table 7.—U.S. exports and reexports of asbestos and asbestos products

Products	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
EXPORTS						
Unmanufactured:						
Crudes, fibers, and stucco ... metric tons	36,426	$17,044	50,131	$17,328	42,342	$14,752
Sand and refuse ... do	11,793	3,693	13,995	4,021	16,183	4,791
Total ... do	48,219	20,737	64,126	21,349	58,525	19,543
Products:						
Asbestos fibers ... do	2,695	8,610	3,840	9,544	2,538	8,119
Shingles and clapboard ... do	4,535	2,560	21,771	3,686	4,011	3,235
Other articles of asbestos ... do	16,646	14,236	17,504	14,292	17,639	13,444
Gaskets ... do	438	3,542	451	4,144	358	3,020
Packing and seals ... do	2,118	15,661	1,598	18,179	1,311	15,309
Insulation ... do	NA	6,151	NA	8,185	NA	6,799
Other articles, n.s.p.f ... do	NA	25,442	NA	23,660	NA	17,047
Brake linings and disk brake pads ... do	NA	55,471	NA	50,058	NA	42,852
Clutch facings and linings ... number	NA	9,626	NA	12,783	NA	16,879
Total	XX	141,299	XX	144,531	XX	126,704
REEXPORTS						
Unmanufactured:						
Crudes and fibers ... metric tons	383	307	240	150	246	170
Sand and refuse ... do	69	23	53	9	XX	XX
Total ... do	452	330	293	159	246	170
Products:						
Asbestos fibers ... do	--	--	6	34	66	203
Shingles and clapboard ... do	477	78	34	20	--	--
Gaskets ... do	--	--	1	7	--	1
Packing and seals ... do	1	5	1	2	5	22
Insulation ... do	NA	1	NA	17	--	--
Other articles, n.s.p.f ... do	NA	14	NA	120	NA	9
Brake linings and disk brake pads ... do	NA	219	NA	149	NA	539
Clutch facings and linings ... number	NA	24	NA	234	NA	309
Other articles of asbestos ... metric tons	3	13	1	16	27	80
Total	XX	354	XX	599	XX	1,163

NA Not available. XX Not applicable.

Table 8.—U.S. imports for consumption of asbestos fibers by type, origin, and value

Type	Canada		Republic of South Africa		Other		Total	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
1980	315,540	$83,276	10,261	$7,202	1,495	$1,331	327,296	$91,809
1981:								
Chrysotile:								
Crude	--	--	957	554	--	--	957	554
Spinning fibers	4,450	4,124	471	175	90	91	5,011	4,390
All other	313,917	86,704	7,802	4,762	1,875	2,000	323,594	93,466
Crocidolite (blue)	--	--	7,376	4,988	--	--	7,376	4,988
Amosite	--	--	506	367	174	128	680	495
Total	318,367	90,828	17,112	10,846	2,139	2,219	337,618	103,893
1982:								
Chrysotile:								
Crude	36	14	--	--	8	1	44	15
Spinning fibers	1,328	1,218	904	453	202	283	2,434	1,954
All other	227,715	55,482	2,193	1,341	1,058	728	230,966	57,551
Crocidolite (blue)	--	--	7,904	5,105	--	--	7,904	5,105
Amosite	--	--	389	300	--	--	389	300
Total	229,079	56,714	11,390	7,199	1,268	1,012	241,737	64,925

WORLD REVIEW

An early 1982 review of the world asbestos industry in a trade magazine described it as "going through a period of rapid evolution."[3] Sales and mergers of asbestos mines and plants were almost as common as temporary mine closures due to excessive inventory.

Canada.—The Government announced in July that it would provide Can$400,000 toward establishment of a Canadian Asbestos Information Center. The principal function of the center was to be to distribute information on the health and technical aspects of asbestos use.

In an article in a September 1982 financial paper, asbestos industry representatives blamed the lowered demand for asbestos on the recession and not on environmental considerations.[4] At that time, a drop in 1982 production of 20% to 25% from that of 1981 was expected. Production in 1981 had been only 59% of that of the 1973 peak year and industry was producing at only 50% of its capacity.

The government of Ontario, Canada, made its permissible occupational exposure limits identical to those of the United Kingdom, effective August 20, 1982.

The Federal Government of Canada and the government of Newfoundland, working in concert, prevented, at least temporarily, the closing of the Advocate Asbestos Mine at Baie Verte, Newfoundland. The Newfoundland government expropriated the mine and sold it to Transpacific Asbestos, Inc. As part of the deal, the Federal Government announced that it would extend $14 million in credit guarantees to Transpacific over a 3-year period.

Cassiar Resources Ltd. closed its asbestos mine in British Columbia for 7 weeks to repair its tramway that had been damaged in an accident.

Greece.—Technical difficulties and other problems prevented the new 100,000-ton-per-year Zidani Mine and Kozani mill asbestos complex from reaching more than one-third of capacity. At least 80% of the product was aimed at export markets in the Mediterranean and the Middle and Far East for fabrication of asbestos-cement pipes and sheets.[5]

Sudan.—Three Sudanese asbestos deposits were described in a mining journal article.[6] A small deposit of chrysotile was found at Qala en Nahal that contained fibers in lengths up to 7 centimeters. Several thousand tons of 5% ore had been estimated. The Ingesanna deposit of chrysotile had an estimated 9 million tons of 3.4% or better ore. Another magazine article indicated that 30 million tons of low-grade ore occurs at this deposit.[7] Johns Manille Canada, Inc., was said to be reluctant to start commercial mining there. The Red Sea Hills deposit is reportedly anthophyllite and is of little interest.

U.S.S.R.—A trade magazine reported that a new high-quality deposit of asbestos was found in Siberia.[8] The deposit, near Taksimo on the Baykal-Amur railway in the Buryat Associated Soviet Socialist Republic, was described as very rich. Another source, the Molodezhnoye underground deposit, was evaluated as among the world's best.

United Kingdom.—The United Kingdom Health and Safety Commission decided to enact the recommendations of the Advisory Committee on Asbestos, effective January 1, 1983. The permissible occupational exposure limits without personal protective equipment was as follows: for chrysotile, 1 fiber per milliliter of air; for amosite, 0.5 fiber per milliliter of air; and for crocidolite, 0.2 fiber per milliliter of air.

Zimbabwe.—Early in the year, a bill was passed enabling the Government to set up its Minerals Marketing Corp. (MMC).[9] One of the two mining company representatives on the MMC board was the managing director of African Associated Mines, the only asbestos producer in the country.

A considerable transportation cost saving was reported for the Shabaine Mines and mill.[10] A ropeway designed to carry 125 tons per hour of ore the 2.5 kilometers between mine and mill was commissioned in July.

Table 9.—Asbestos: World production, by country[1]

(Metric tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Afghanistan	[e]13,000	[e]4,000	--	--	--
Argentina	1,069	1,371	1,261	1,400	1,300
Australia	62,744	79,721	92,418	44,647	45,000
Brazil	122,815	138,457	169,173	138,420	140,000
Bulgaria	700	600	700	400	400
Canada (shipments)	1,421,808	1,492,719	1,323,053	1,122,000	822,000
China[e]	250,000	250,000	250,000	250,000	250,000
Cyprus	34,342	35,472	34,535	24,440	24,000
Egypt	349	238	316	325	310
Greece	--	--	--	--	100,000
India	24,623	32,094	31,253	24,515	25,000
Italy	135,402	143,931	157,794	137,086	135,000
Japan	5,746	3,502	3,897	[e]3,500	3,500
Korea, Republic of	13,616	14,804	9,854	14,084	15,000
Mozambique	--	789	[e]800	[e]800	[e]800
South Africa, Republic of	257,325	249,187	277,734	235,943	[3]211,860
Swaziland[4]	36,957	34,294	32,833	35,264	35,000
Taiwan	2,031	2,957	683	2,317	2,500
Turkey	13,372	[r]38,967	8,872	2,833	3,000
U.S.S.R.[e]	1,945,000	2,020,000	2,070,000	2,105,000	2,180,000
United States (sold or used by producers)	93,097	93,354	80,079	75,618	63,515
Yugoslavia	10,360	10,041	12,106	13,591	12,500
Zimbabwe	248,861	259,891	250,949	247,600	240,000
Total	[r]4,693,217	[r]4,906,389	4,808,310	4,479,783	4,310,685

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through Apr. 21, 1983.
[2]In addition to the countries listed, Czechoslovakia, North Korea, and Romania also produced asbestos, but output is not officially reported, and available general information is inadequate for the formulation of reliable estimates of output levels.
[3]Reported figure.
[4]Exports.

TECHNOLOGY

The Quebec Provincial government's Société Nationale de l'Amiante (SNA) was rapidly becoming a center for research on asbestos fiber and on asbestos mines residue as a mineral resource. A Canadian Government magazine detailed how the toxicity of asbestos fibers can be reduced by phosphorylation with little reduction in physical properties and little increase in cost.[11] This development work was done at the SNA laboratory under its director of research technology. A U.S. professional journal described research done under a SNA contract to develop two refractory raw materials from asbestos tailings.[12] A magnetic separation process was used to separate an iron-rich fraction from the tailings. The iron-rich fraction is a potential heat storage material. The less magnetic fraction, an olivine, contained less iron than any olivine now used for periclase production. Another magazine described a cooperative development project between SNA and Noranda Mines Ltd.[13] A pilot plant was built at a Noranda smelter in which a flue gas containing 3% to 6% sulfur dioxide was to be sprayed with a slurry of magnesium-rich asbestos tailings. Byproducts of this flue gas desulfurization process were expected to be marketable magnesium sulfate crystals.

Transpacific, put their 1.5-ton-per-day prototype asbestos wet mill in operation in Australia in January.[14] Initial indications were that it could more than double fiber recovery from many ores using the dry process. The company estimates a new mill cost at about one-half that of a conventional dry mill.

Substitutes.—In an article in a trade magazine, asbestos was compared with other fibrous materials used in packing and gaskets.[15] The article showed that material costs for products with characteristics comparable to asbestos were several times higher than that for asbestos.

Several claims were made for asbestos substitutes in cement products. Among them were a rock wool developed by a Bureau of Mines contractor,[16] two acrylic fibers from Hoechst AG of the Federal Republic of Germany, and a polyvinyl alcohol fiber from Japan's Unitika Kasei.[17]

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[7]Mining Journal. V. 298, No. 7660, June 11, 1982, p. 433.
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[10]———. V. 299, No. 7665, July 16, 1982, p. 48.
[11]Cossette, M. De l'Amiante Moins Toxique Grace a la Phosphorylation (Phosphorylation Creates a Less Toxic Asbestos). Geos., v. 12, No. 1, winter 1983, pp. 15-21.
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[17]Environmental Chemical News. Hoechst, Turner & Newall To Market Asbestos Substitutes. V. 39, No. 1062, Dec. 13, 1982, p. 16.

Barite

By Sarkis G. Ampian[1]

Domestic production of barite decreased 35% to 1.85 million short tons in 1982 valued at $70 million. Nevada, the leading producer, decreased output 37% to 1.6 million tons. Production from Missouri, the second leading producer, decreased substantially, down 42% from that of 1981. Imports for consumption of crude barite continued to increase, reaching 2.32 million tons, 20% above the record 1981 level. The principal use for barite, as a weighting agent in oil- and gas-well-drilling fluids (muds), accounted for 98% of U.S. consumption in 1982.

Demand for barite in the latter half of 1982 declined sharply from the record highs of recent years and the first half of 1982 owing to an oil glut and economic downturn that resulted in lower oil- and gas-well-drilling activity accompanied by use of less barite per foot of well. In 1982, primary barite producers lowered output to pre-1978 levels; however, imports for consumption of foreign crude barite continued to increase and, for the first time, exceeded domestic production. Also, barite grinding capacity, escalated in earlier years to meet the higher demand, was in a position to meet present and/or projected demand.

Domestic Data Coverage.—Domestic production data for barite are developed by the Bureau of Mines from one voluntary survey of U.S. operations. Of the 99 operations to which a survey request was sent, 93 responded, representing an estimated 82% of the total crushed and ground production sold or used shown in table 1. Production of the remaining six nonrespondents was estimated using reported prior year production levels adjusted by trends in employment and other guidelines.

Table 1.—Salient barite and barium-chemical statistics

(Thousand short tons and thousand dollars)

	1978	1979	1980	1981	1982
United States:					
Barite, primary:					
Sold or used by producers	2,170	2,112	2,245	2,849	1,845
Value	$45,130	$53,581	$65,957	$102,439	$69,522
Exports	50	109	97	62	49
Value	$2,724	$10,861	$13,794	$9,947	$6,510
Imports for consumption (crude)	1,291	1,489	1,850	1,932	2,320
Consumption (apparent)[1]	3,411	3,492	3,998	4,719	4,116
Crushed and ground (sold or used by processors)[2]	2,897	3,223	3,649	4,716	4,088
Value	$132,312	$179,009	$365,632	$406,255	$322,700
Barium chemicals (sold or used by processors)	55	50	40	34	25
Value	$24,018	$26,063	$22,441	$20,670	$18,720
World: Production	[r]7,590	[r]7,999	8,188	[p]9,057	[e]7,887

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Sold or used plus imports minus exports.
[2]Includes imports.

DOMESTIC PRODUCTION

The term "primary barite" denotes the first marketable product and includes crude run-of-mine barite, flotation concentrates, and material concentrated by other beneficiation processes such as washing, jigging, or magnetic separation. Run-of-mine barite sold or used by producers represented 36% of total production in 1982 compared with 32% in 1981; flotation concentrate remained at 4% of the total 1982 production; and the balance was other beneficiated material.

In 1982, reported primary barite production decreased 35%. Nevada and Missouri continued to be the leading States and, together, accounted for 91% of barite output. Other producing States, in descending order, were Arkansas, Georgia, Montana, Tennessee, Illinois, and Washington. Illinois produces barite as a coproduct of fluorspar mining and milling; in all other States, barite was the primary product.

The leading domestic barite producers in 1982 were (in alphabetical order) Baroid Div., NL Industries, Inc., with mines in Arkansas, Missouri, and Nevada; Dresser Minerals Div., Dresser Industries, Inc., with mines in Missouri and Nevada; IMCO Services Div., Halliburton Co., with mines in Missouri and Nevada; and Milchem, Inc., with mines in Nevada. Other important producers in Nevada were (in alphabetical order) All Minerals Corp., A. W. Arnold and Associates, Inc., Chromalloy American Corp., Eisenmann Chemical Co. (a subsidiary of Newpark Resources, Inc.), FMC Corp., Old Soldier Mining Co., and T. Norris, Inc. In Missouri, Agers Bros., Inc., DeSoto Mining Co., and General Barite Co., and, in Washington, David Beck Co., produced important quantities of barite in 1982.

The domestic barite industry continued its rapid expansion, begun in the latter half of the 1970's, until midyear 1982. Then an oil glut and economic downturn resulted in lower oil- and gas-well-drilling activity. This left many barite producers with excess inventories and commitments to purchase foreign ore and was followed by cutbacks in domestic mine production and grinding plant activity. Meanwhile, foreign ore prices decreased because of the oversupply and also because of lower ocean freight rates, in part owing to cheaper bunker fuel. This, coupled with high domestic rail rates from domestic mines and more expensive domestic ore, combined to make foreign barite more attractive than domestic ore. Many mining and grinding operations at yearend were either suspended or on minimal product schedules. Most of the following additions to mining, milling, and/or grinding capacity were begun before the 1982 downturn. Many ongoing and planned projects were being critically reevaluated.

In 1982, C-E Minerals, a division of Combustion Engineering Inc., completed development of both its Flagstaff Mountain mining property in Stevens County, Wash., and a 50,000-ton-per-year flotation plant at Deep Lake.

In Alaska, NANA Development Corp. was investigating the feasibility of a barite mining and milling complex to produce drilling-mud-grade barite from deposits held by Cominco American, Inc., and the Kennecott Corp. The mill feed metal values were slated to be stockpiled for the claim owner.

In Arkansas, Milchem continued plant tests at its Fancy Hill flotation complex completed during the year.

In Oklahoma, Best Barite, Inc., a division of Blast Abrasives, Inc., completed construction of its third grinding plant at Cyril, southwest of Oklahoma City and near the oil-well-drilling activities in the Anadarko Basin. Expansions and/or modifications of existing Oklahoma grinding plants were completed by All Minerals and Eisenmann Chemical at Clinton, A. W. Arnold at Bessi, and Old Soldier at Elk City. Oklahoma, which had no grinding plants in 1978, had six plants in operation during the year.

In Texas, construction of a new grinding plant was completed by Coastal and Western Minerals, Inc., in Knippa, to produce filler- and extender-grade barites for the paint and coating industries. All Minerals acquired a grinding plant with a 50-inch Raymond mill at Channelview and built another grinding plant at Pecos with a similar sized mill. Enlargement and/or changes to the existing Texas grinding plants were made by Chromalloy at Houston and PIP Minerals at Kingsville.

In Nevada, IMCO completed an $11 million excavation of its Clipper open pit mine near Crescent Valley. The 540-foot-deep pit is lined with 20- to 30-foot benches that serve as both a roadway and a barrier for falling rock. Chromalloy added two Bendelari jigs to its Dry Creek plant to process ore from the Snoose Mine, and A. W. Arnold opened its new North Rim Rock Mine near its Rim Rock jig plant. Old Soldier also added two Bendelari jigs to its Stormy Creek plant and Eisenmann Chemical installed a new grinding plant and crushing circuit at Carlin. All Minerals added three Wemco jigs to its East Northumberland mill.

In Louisiana, shakedown tests were underway at Baroid's new grinding plant in Lake Charles. The new plant consists of two 66-inch Raymond mills and ancillary equipment for packing, palletizing, and bulk loading of trucks, railroad cars, and barges. Expansions and/or modifications were also made by IMCO and Chromalloy at their Houma plants.

Table 2.—Primary barite sold or used by producers in the United States, by type and State

State	Number of operations	Run of mine		Flotation concentrates		Beneficiated material		Total	
		Quantity (thousand short tons)	Value (thousands)	Quantity (thousand short tons)	Value (thousands)	Quantity (thousand short tons)	Value (thousands)	Quantity (thousand short tons)	Value (thousands)
1981:									
Arizona	1	--	--	--	--	W	W	W	W
Arkansas	1	--	--	W	W	--	--	W	W
Georgia	2	--	--	W	W	W	W	W	W
Illinois	2	--	--	W	W	--	--	W	W
Missouri	10	--	--	--	--	185	$9,725	185	$9,725
Montana	1	W	W	--	--	--	--	W	W
Nevada	20	[r]872	[r]$22,495	--	--	[r]1,610	[r]57,221	2,482	79,716
Tennessee	1	W	W	--	--	--	--	W	W
Total	38	[r]920	[r]26,523	[r]112	[r]$6,834	1,817	69,081	2,849	102,439
1982:									
Arkansas	2	--	--	W	W	W	W	W	W
Georgia	2	--	--	W	W	W	W	W	W
Illinois	1	--	--	W	W	--	--	W	W
Missouri	8	--	--	--	--	107	5,703	107	5,703
Montana	1	W	W	--	--	--	--	W	W
Nevada	17	633	13,727	--	--	942	39,000	1,575	52,727
Tennessee	1	W	W	--	--	--	--	W	W
Washington	1	W	W	--	--	--	--	W	W
Total	33	668	16,481	82	6,420	1,095	46,621	1,845	69,522

[r]Revised. W Withheld to avoid disclosing company proprietary data; included in "Total."

CONSUMPTION AND USES

Consumption of crushed and ground barite declined 13% from the alltime high of 1981 because of a significant decrease in barite consumption in well drilling. Use as a weighting agent in oil- and gas-well-drilling fluids continued to be the dominant end use, accounting for 98% of total sales volume in 1982. The oil- and gas-well-drilling industry appeared to have had another record year by completing nearly 86,000 wells and drilling nearly 400 million feet of hole.[2] Total footage drilled exceeded 10 million feet in seven States: Texas, 135.9 million feet; Oklahoma, 63.5 million feet; Louisiana, 32.6 million feet; Kansas, 28.9 million feet; Ohio, 15.5 million feet; Wyoming, 15.1 million feet; and New Mexico, 12.5 million feet. Generally, the deeper a hole is drilled, the more barite is used per foot of drilling. However, hole depth did not increase significantly in 1982. Among the seven leading States, Wyoming had the highest average well depth, over 7,300 feet, and Kansas, the lowest, about 3,200 feet per well. The U.S. average remained at about 4,600 feet. The major reason that barite consumption decreased appears to be that the average consumption of barite per foot of drilling decreased to 20.4 pounds per foot in 1982 compared with 25.1 pounds per foot in 1981. Another barometer of drilling activity is the Hughes Tool rig count, which shows that the average number of drilling rigs operating in 1982 declined from the alltime high of 3,969 in 1981 to 3,105.[3]

Table 3.—Crushed and ground barite sold or used by processors in the United States, by State

State	1981			1982		
	Number of plants	Quantity (thousand short tons)	Value (thousands)	Number of plants	Quantity (thousands short tons)	Value (thousands)
Louisiana	13	1,673	$169,188	13	1,585	$123,056
Missouri	4	220	20,711	4	98	6,964
Nevada	6	609	28,888	7	588	29,686
Oklahoma	4	261	28,132	6	321	34,803
Texas	12	1,392	112,823	13	1,080	91,824
Utah	6	247	19,740	5	164	12,502
Other[1]	13	314	26,773	12	252	23,866
Total	58	4,716	406,255	60	4,088	[2]322,700

[1]Includes Arkansas, California, Georgia, Illinois, Kansas, and Montana.
[2]Data do not add to total shown because of independent rounding.

Table 4.—Crushed and ground barite sold or used by processors in the United States, by use[1]

(Thousand short tons and thousand dollars)

Use[2]	1981		1982	
	Quantity	Value	Quantity	Value
Barium chemicals	45	3,945	31	3,152
Filler or extender[3]	86	12,807	58	8,825
Well drilling	4,585	389,505	3,999	310,721
Total[4]	4,716	406,255	4,088	322,700

[1]Includes imported barite.
[2]Uses reported by processors of ground and crushed barite, except for barium chemicals.
[3]Includes glass, paint, rubber, other filler, and other uses.
[4]Data may not add to totals shown because of independent rounding.

Table 5.—Barium chemicals produced and sold or used by processors in the United States[1]

Barium chemical	1981				1982			
	Plants[2]	Production (short tons)	Sold or used by processors: Quantity (short tons)	Sold or used by processors: Value (thousands)	Plants[2]	Production (short tons)	Sold or used by processors: Quantity (short tons)	Sold or used by processors: Value (thousands)
Barium carbonate	4	25,000	22,000	$9,400	3	18,770	16,330	$7,560
Barium chloride	2	W	W	W	2	W	W	W
Black ash	1	W	W	W	1	W	W	W
Blanc fixe	1	W	W	W	1	W	W	W
Other	3	11,000	12,000	11,270	3	9,370	8,970	11,160
Total	5	36,000	34,000	20,670	4	28,140	25,300	18,720

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Only data reported by barium-chemical plants that consume barite are included. Partially estimated.
[2]A plant producing more than one product is counted only once.

Table 6.—U.S. hydrocarbon well-drilling and barite consumption

Year	Barite used for well drilling (thousand short tons)	Wells drilled (thousands)[1]				Successful wells (percent)	Average depth per well (feet)	Average barite per well (short tons)
		Oil	Gas	Dry holes	Total			
1962	934	21.73	5.35	17.08	44.16	61.3	4,408	21.15
1963	907	20.14	4.57	16.76	41.47	59.6	4,405	21.87
1964	931	19.91	4.69	17.69	42.29	58.2	4,431	22.01
1965	987	18.07	4.48	16.23	38.78	58.1	4,510	25.45
1966	1,022	16.78	4.38	15.23	36.39	58.1	4,478	28.08
1967	965	15.33	3.66	13.23	32.22	58.9	4,385	29.95
1968	1,006	14.33	3.46	12.81	30.60	58.1	4,738	32.88
1969	1,235	14.37	4.08	13.74	32.19	57.3	4,881	38.37
1970	1,119	13.02	3.84	11.26	28.12	60.0	4,952	39.79
1971	1,044	11.86	3.83	10.16	25.85	60.7	4,806	40.39
1972	1,183	11.31	4.93	11.06	27.30	59.5	4,932	43.33
1973	1,326	9.90	6.39	10.31	26.60	61.2	5,129	49.85
1974	1,440	12.78	7.24	11.67	31.69	63.2	4,750	45.44
1975	1,638	16.41	7.58	13.25	37.24	64.4	4,685	43.98
1976	1,986	17.06	9.09	13.62	39.77	65.7	4,571	49.94
1977	2,372	18.91	11.38	14.69	44.98	67.3	4,687	52.73
1978	2,632	17.76	12.93	16.25	46.94	65.4	4,829	56.07
1979	2,967	19.38	14.68	15.75	49.81	68.4	4,791	59.57
1980	3,385	26.99	15.74	18.09	60.82	70.3	4,675	55.66
1981	4,526	37.67	17.89	22.97	78.53	70.8	4,602	57.63
1982	4,048	40.30	18.95	26.55	85.80	69.1	4,616	47.18

[1]Includes exploratory and development wells; excludes service wells, stratigraphic tests, and core tests.

Source: American Petroleum Institute.

PRICES

Price quotations for some grades of barite increased slightly in 1982 according to the published literature. The prices listed in table 7 are from trade publications; they serve as a general guide but do not reflect actual transactions.

The reported average value per ton of primary barite produced in the United States in 1982 increased 5% to $37.68, f.o.b. plant. The average reported value per ton of ground barite from Texas and Louisiana was about $92; the average value from California, Nevada, and Utah was approximately $57 per ton. The average customs value of ground barite exported to Canada was about $190 per ton; the customs value of material exported to Mexico and Latin America was nearly $127 per ton.

Table 7.—Barite price quotations

Item	Price per short ton[1]	
	1981	1982
Barite:[2]		
Chemical, filler, glass grades, f.o.b. shipping point, carlots:		
Handpicked, 95% $BaSO_4$, not over 1% Fe	$72.00	$90.00
Magnetic or flotation, 96% to 98% $BaSO_4$, not over 0.5% Fe	105.00	105.00
Water ground, 95% $BaSO_4$, 325 mesh, 50-pound bags	$80.00-155.00	$80.00-155.00
Drilling-mud grade:		
Dry ground, 83% to 93% $BaSO_4$, 3% to 12% Fe, specific gravity 4.20 to 4.30, f.o.b. shipping point, carlots	95.00-115.00	87.00-120.00
Crude, imported, specific gravity 4.20 to 4.30, f.o.b. shipping point	32.00- 61.00	65.00- 75.00
Barium chemicals:[3]		
Barium carbonate:		
Precipitated, bulk, carlots, freight equalized (per pound)	.26	.24
Electronics grade, bags	335.00	335.00
Barium chloride:		
Technical crystals, bags, carlots, works	300.00	450.00
Anhydrous, bags, carlots, same basis	400.00	565.00
Barium hydrate: Mono, 55-pound bags, carlots, delivered (100 pounds)	55.00	55.00
Barium sulfate:		
Blanc fixe, technical grade, bags, carlots	430.00	430.00
USP, X-ray diagnosis grade, powder, 25-kilogram bags, 10,000-kilogram lots (per pound)	.51	.54
Barium sulfide (black ash), drums, carlots, works	115.00-150.00	115.00-150.00

[1]Unless otherwise specified.
[2]Engineering and Mining Journal. V. 182, No. 12, December 1981, p. 23, and v. 183, No. 12, December 1982, p. 19.
[3]Chemical Marketing Reporter. V. 220, No. 26, Dec. 28, 1981, p. 29, and v. 222, No. 26, Dec. 27, 1982, p. 25.

FOREIGN TRADE

During 1982, over 49,000 tons of "natural barium sulfate" was exported from the United States. Export and import data provided by the U.S. Bureau of the Census do not indicate what type or form of barite was traded; however, based on the value of individual shipments, it was estimated that 99% of barite exports was ground drilling-mud-grade and 1% was chemical, filler, or glass grade. No crude barite was exported during the year. Mexico continued as the leading importer of U.S. barite, accounting for 75% of total exports. Exports to Canada decreased significantly. Exports to Guatemala began in 1982 in significant quantity.

Imports of crude barite increased to a record high of 2.32 million tons in 1982. The average unit value of this material declined by approximately 9% to $50.38 per ton, indicating that prices of foreign ores were declining in response to oversupply and lower ocean shipping rates. Domestic producers and consumers faced with high rail rates from domestic mines to gulf coast area grinding plants took advantage of the more attractively priced foreign ores to meet their demands. Average values per ton for material shipped from the principal source countries were China, $57.06; Morocco, $54.32; Chile, $50.66; Peru, $49.90; India, $39.64; Thailand, $43.26; and Mexico, $34.81. The more costly higher quality barite, generally material with a specific gravity greater than 4.3, had usually been blended with lower grade ore during grinding to meet the American Petroleum Institute (API) specifications of 4.2 for drilling-mud-grade barite. Imports from India, Morocco, and Thailand increased significantly.

The United States imported over 23,000 tons of ground barite in 1982. Imports of ground barite from India resumed in large quantities. India supplied 95% of ground barite imports during the year, and Canada, the Netherlands, and the Federal Republic of Germany supplied the remaining 5%. Ground barite imports generally had been limited to premium-quality pharmaceutical grade, unavailable domestically and averaging in value from $300 to $500 per ton. The average value of the new Indian imports, about $140 per ton, would suggest that these materials were probably destined for the domestic filler and extender markets that have been supplied domestically.

For the most part, crude barite entered through customs districts located along the gulf coast. This reflected the concentration of grinding plants along the gulf coast and their nearness to the most important drilling-mud markets. The import distribution by customs district in 1982 (1981) was New Orleans, La., 55% (56%); Houston, Tex., 34% (14%); Laredo, Tex. (Port of Brownsville, Tex.), 9% (9%); Port Arthur, Tex. (Port Lake Charles, La.), 1% (2%); El Paso, Tex., 1% (1%); and Galveston, Tex., none (18%).

The United States imported nearly 24,000 tons of barium chemicals valued at $13.2 million in 1982. China, France, the Federal Republic of Germany, Italy, Japan, and Taiwan were the major suppliers of imported barium chemicals in 1982.

Table 8.—U.S. exports of natural barium sulfate, by country

Country	1981 Quantity (short tons)	1981 Value (thousands)	1982 Quantity (short tons)	1982 Value (thousands)
Angola	600	$87	--	--
Argentina	327	140	45	$19
Australia	2	1	--	--
Barbados	732	80	519	163
Brazil	110	19	--	--
Canada	11,002	2,499	3,166	603
Chile	1,400	168	4	11
Colombia	5	58	3	2
Dominican Republic	3,528	431	--	--
Guatemala	--	--	7,676	935
Jamaica	500	83	335	44
Japan	61	84	42	74
Mexico	39,333	5,624	36,293	4,544
Paraguay	1,000	150	--	--
Philippines	10	2	6	6
Sierra Leone	510	93	--	--
Venezuela	3,062	423	75	48
Other	11	4	368	60
Total[1]	62,187	9,947	48,533	6,510

[1]Data may not add to totals shown because of independent rounding.

Source: U.S. Department of Commerce.

Table 9.—U.S. imports for consumption of barite, by country

Country	1981 Quantity (short tons)	1981 Value[1] (thousands)	1982 Quantity (short tons)	1982 Value[1] (thousands)
Crude barite:				
Chile	313,926	$13,848	331,876	$16,812
China	735,905	46,360	780,497	44,534
Greece	17,638	1,479	--	--
India	54,902	4,001	169,126	6,705
Ireland	78,287	3,060	81,157	2,456
Italy	--	--	36,921	1,763
Mexico	133,550	5,576	143,619	5,000
Morocco	230,328	14,605	350,801	19,054
Peru	317,236	15,188	241,634	12,058
Thailand	23,479	1,361	152,005	6,575
Total[2]	1,932,227	107,236	2,320,241	116,886
Ground barite:				
Belgium-Luxembourg	53	16	12	5
Canada	451	248	534	243
China	10,844	771	--	--
Colombia	39	8	--	--
Germany, Federal Republic of	372	129	177	53
India	--	--	22,487	3,197
Mexico	1,561	107	--	--
Netherlands	208	71	360	108
Spain	40	12	81	26
Total[3]	13,569	1,363	23,651	3,632

[1]C.i.f. value.
[2]Includes 26,976 tons valued at $1,758,000 in 1981 and 32,605 tons valued at $1,929,198 in 1982 from Taiwan, not believed to have originated in Taiwan.
[3]Data may not add to totals shown because of independent rounding.

Source: U.S. Department of Commerce.

Table 10.—U.S. imports for consumption of barium chemicals

Year	Lithopone		Blanc fixe (precipitated barium sulfate)		Barium chloride		Barium hydroxide	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1978	142	$58	9,424	$4,160	5,287	$1,173	3,138	$1,539
1979	1,535	662	9,352	4,152	6,839	1,398	3,912	2,009
1980	1,310	599	7,752	4,460	4,216	980	2,917	1,694
1981	NA	NA	8,402	5,369	3,601	1,170	3,663	2,451
1982	NA	NA	8,135	5,580	2,930	878	3,570	2,758

Year	Barium nitrate		Barium carbonate, precipitated		Other barium compounds	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1978	468	$123	10,712	$2,465	2,987	$1,186
1979	517	117	11,596	2,770	1,540	783
1980	1,143	243	6,876	2,050	883	597
1981	270	87	5,709	2,323	664	538
1982	682	263	7,787	3,055	753	629

NA Not available.

Source: U.S. Department of Commerce.

Table 11.—U.S. imports for consumption of crude, unground, and crushed or ground witherite[1]

Year	Crude, unground		Crushed or ground	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1978	--	--	1,809	$387
1979	5	$1	436	105
1980	22,145	713	62	23
1981	7	2	92	85
1982	292	82	41	44

[1]Barium carbonate.

Source: U.S. Department of Commerce.

WORLD REVIEW

Estimated world production of barite decreased 13% to 7.9 million tons in 1982. The United States produced 23% of the world total and imported 30% of the world output.

The Bureau of Mines awarded a $179,500 contract to Brown and Root Development, Inc., for determining foreign mineral deposit data on barite and antimony.[4] The data were expected to become part of the Bureau of Mines computerized Minerals Availability System (MAS), which would eventually contain engineering and cost information on numerous U.S. and foreign deposits. Under the contract, information was to be provided on selected mines, active and inactive, as well as on specific deposits that had not been mined. The data would include the name, ownership, and location of each deposit; ore tonnage and grade figures; a description of the ore body and the extraction system used or applicable; work force and energy requirements; and a detailed cost analysis or estimate.

Algeria.—The lead-zinc mine and mill complex at Bou Caid was converted to develop a nearby marginal barite deposit.

Cameroon.—Peirson and Whitman International, a North Carolina-based company, was constructing a barite grinding plant with a 50-inch Raymond mill for Milchem, Minerals Div., in Douala.[5]

Canada.—A grinding plant was being built at Ross River, Yukon Territory, for startup in early 1983, to process barite from the Tea Claims in the MacMillian Pass area.[6] The plant was to include a 50-inch Raymond mill.

Chile.—Milchem completed construction of a jig plant at Punta Colorado, north of La Serana.[7] The plant was expected to produce about 30,000 tons of barite annually.[8]

China.—KCA Minerals Ltd., a member of the English KCA International Group, completed its new barite grinding mill at Wuzhou in Guangxi Zhuang Province.[9] The plant was built by KCA under terms of a joint venture with the China National Metals and Minerals Import/Export Corp. (Minmet). The mill was expected to have a processing capacity in excess of 200,000 tons per year. In another barite event, a new deposit of barite was reportedly discovered.[10] The only particulars released noted that the deposit contained nearly 6 million tons of ore.

Gabon.—The Government, Essence et Lubrificants de France (ELF)-Gabon, Nyanga Mining Co., and France's Bureau de Recherches Géologiques et Minières (BRGM) were working jointly to develop a barite deposit at Dourekiki, in Nyanga Province, reportedly containing about 1 million tons of barite reserves. A feasibility study with a plant capable of producing around 35,000 tons annually had been completed earlier by the Koussou syndicate formed by the Gabon Government, Compagnie Minière de l'Ogooue S.A. (COMILOG), and BRGM.

India.—The Government ended all quantitative restrictions on exports of lump or powdered barite.[11] However, floor price restrictions still remained on exports of API-grade lump barite shipped to west Asia, $42 per metric ton, and other areas, $40 per metric ton. The Cuddapah district in Andhra Pradesh, with over 70 million tons of barite reserves, accounted for 98% of Indian barite production. The remaining output came from Rajasthan, Maharashtra, Himachal Pradesh, and Bihar.[12]

Malaysia.—KCA in another barite venture (see also Mexico and China in this section), started developing a mine and grinding mill complex near Kuala Tregganu.[13]

Mexico.—Minera Capela, a member of the Pen Oles Group, installed a 50-ton-per-hour flash dryer at its barite operation.[14] The new dryer is capable of reducing the water content of the feed from 16% to less than 3%. The state-owned oil company, Pemex, awarded a 1-year contract to KCA to supply 125,000 tons of ground drilling-grade barite.[15] The barite was to be delivered to Pemex through the Port of Coatzacoalcos, 150 miles south of Veracruz on the Gulf of Mexico.

Pakistan.—The Geological Survey of Pakistan discovered a deposit containing upwards of 5 million tons of barite near Khuzdar in Baluchistan.[16]

Peru.—Perubar S.A. completed construction of a jig plant at the Graciela Mine, northeast of Lima.[17]

Spain.—Unibario, S.A., completed its new jigging plant at La Carolina in the Jaen Province of Andalucia.[18] The plant was the first stage of a project to produce drilling-mud-grade barite from local low-grade sedimentary limestones. Planned annual production was about 50,000 tons of high-grade concentrates from the 400,000 tons of jigging plant feed alone. A second-stage construction of an adjacent flotation plant to recover an additional 20,000 tons per year was planned. Total investment, including mine development and the jig and flotation plants, was estimated to be about $1.4 million. Unibario also planned to add white filler-grade barite to its product line.

Turkey.—Baroid and Saim Budin joint venture completed construction of its barite grinding plant near Silifke. Bastas Barite increased the grinding capacity of its Antalya plant to 100,000 tons per year.[19]

United Kingdom.—A new company, Strontian Minerals Ltd., has been formed to resume barite mining in 1983 near the village of Strontian on Loch Sunart in Argyllshire.[20] The mining operation was to recover upwards of 40,000 tons of barite plus 5,000 tons annually of lead-zinc concentrate by flotation techniques. The barite occurs in a vein deposit in the Moinian schist and granite host rocks. The company planned to first supply drilling-mud-grade barite for the North Sea market, but the deposit appears to contain sufficient amounts of white barite that could be selectively mined and treated for the more profitable chemical-grade and filler and extender markets.

The assets of Athole G. Allen Ltd. were purchased by English China Clays, Ltd., the world's leading kaolin producer. The grinding plant and barite mine are located in the northeast, near the North Sea oilfields.[21]

Venezuela.—Another Williams mill was added to Baroid de Venezuela's Pamatacualito plant.[22]

Yugoslavia.—Work continued on the new barite mine to be opened on Mount Bobija near Ljubovija in Serbia.[23] The operation was scheduled to produce annually about 150,000 tons of feed resulting in over 55,000 tons of barite concentrate, largely targeted for export. Reserves had been estimated to be 2 million tons. Another new barite-lead-zinc mine, with an annual production capacity of over 400,000 tons of ore, was opened near Vares, north of Sarajevo in Bosnia and Hercegovina.[24]

Table 12.—Barite: World production, by country[1]

(Thousand short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Afghanistan[3]	14	3	--	--	--
Algeria	r82	r113	108	r e109	110
Argentina	50	61	55	54	[4]58
Australia	15	r104	43	45	44
Austria	([5])	([5])	([5])	--	--
Belgium	--	--	e33	e44	44
Bolivia[6]	3	2	10	2	[4]1
Brazil	118	119	115	128	132
Burma[7]	39	44	44	r e11	[4]22
Canada	r110	r e83	r e105	r e88	33
Chile	r201	250	249	286	265
China[e]	440	550	750	r880	990
Colombia	4	4	4	4	4
Czechoslovakia	72	75	67	e67	67
Egypt	1	r2	5	2	3
France	248	187	261	210	220
German Democratic Republic[e]	39	r39	r39	r39	39
Germany, Federal Republic of	186	178	193	193	193
Greece[8]	49	53	53	52	52
Guatemala	1	4	5	6	3
India	428	r541	478	390	[4]359
Iran	220	198	165	r83	88
Ireland	385	362	287	e287	287
Italy	261	237	224	195	196
Japan	78	61	62	62	[4]65
Kenya	([5])	([5])	7	e7	7
Korea, North[e]	120	120	120	r110	--
Korea, Republic of	1	1	([5])	--	--
Malaysia	6	2	--	21	25
Mexico	255	167	297	350	[4]357
Morocco	195	316	353	513	461
Pakistan	21	38	15	26	26
Peru	436	490	457	451	400
Philippines	6	7	6	2	10
Poland	100	106	106	94	88
Portugal	1	1	1	1	1
Romania	r90	r90	88	r e87	86
South Africa, Republic of	3	3	3	3	[4]4
Spain	79	82	66	58	55
Thailand	303	417	336	338	[4]351
Tunisia	18	r16	30	27	39
Turkey	r110	110	30	205	165
U.S.S.R.[e]	525	550	r560	r560	570
United Kingdom	60	50	60	69	72
United States[9]	2,170	2,112	2,245	2,849	1,845
Yugoslavia	47	51	53	49	50
Zimbabwe	([5])	([5])	([5])	--	--
Total	r7,590	r7,999	8,188	9,057	7,887

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through June 15, 1983.
[2]In addition to the countries listed, Bulgaria also produces barite, but available information was inadequate to make reliable estimates of output levels.
[3]Year beginning Mar. 21 of that stated.
[4]Reported figure.
[5]Less than 1/2 unit.
[6]Series represents exports only; Bolivia also produced barite for domestic consumption, but available data are not adequate for formulation of estimates or levels of production to meet internal needs.
[7]Year beginning Apr. 1 of that stated.
[8]Barite concentrates.
[9]Sold or used by producers.

TECHNOLOGY

The Bureau of Mines published the results of two barite-related research investigations conducted at its Research Center in Tuscaloosa, Ala. Successful methods were developed to recover barite from ultrafine mill wastes[25] and high-grade barite from waste pond materials.[26] The former investigation showed that by optimizing flotation variables it was possible to produce a barite concentrate meeting drilling-mud specifications from Nevada waste materials that were finer than 20 micrometers. Concentrates were produced that contained nearly 95% barium sulfate ($BaSO_4$), with recovery of 91%. In addition to the flotation tests, a selective barite flocculation process was developed to treat the fines, which produced a barite concentrate containing 97% $BaSO_4$ with barite recovery of over 82%. In the other investigation, barite waste pond samples, from Georgia, Nevada, Missouri, and Illinois, were found to vary widely in character, particle size, and barite content. The developed flotation flowsheet was modified for some of the materials to reject barren coarse and slime fractions. One material had to be scrubbed prior to flotation to remove residual flotation reagents. The $BaSO_4$ content of the concentrates ranged from 95% to 97% and barite recovery was 81% to 96%.

In another Bureau of Mines study at its Research Center in Salt Lake City, an improved barite medium was developed for use in metals separation.[27] The barite substitutes for more expensive ferrosilicon in a heavy-media separation scheme. In practice, the mixed metals, usually shredded automobile parts entering the trough carrying a flowing barite-water mixture, separate according to density, with aluminum first, then stainless steel and thin-wall zinc die-castings floating off, while heavier metals sink. Barite has an advantage of being readily washed from the recovered metal by water, while the ferrosilicon must be removed magnetically.

An in-depth review of the recent developments in the world barite industries was published.[28] The review covered output, production flowsheets, specifications, trade, reserves, and geology. The article stressed the fact that oil-well-drilling activities consume over 90% of the world's barite supply in drilling-mud formulations. The review also discussed current worldwide drilling activities, with particular reference to the U.S. gulf coast and North Sea areas. Another comprehensive paper, featuring barite, was published in a treatise on the industrial minerals of Ireland.[29] The paper detailed the barite geology, mineralogy, mining, and production methods in Ireland along with estimates of reserves for the two U.S. companies currently producing barite in the country.

The technology and uses of barium and strontium compounds were detailed in another work.[30] The article describes techniques for manufacturing these chemicals from their ores and market trends for barium and strontium chemicals in the production of glass and television tubes; the chemical industry; production of ceramics and electroceramics, ferrites, and titanates; in purification of feedstock in chloralkaline and zinc electrolysis; as well as in the paper and paint industries. A special feature of the paper includes an in-depth technical discussion for each of the major consuming industries cited earlier.

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[1]Physical scientist, Division of Industrial Minerals.

[2]American Petroleum Institute. Quarterly Review of Drilling Statistics for the United States. 4th Quarter, 1982, and Annual Summary, 1982. V. 16, No. 4, February 1983, 39 pp.; available from American Petroleum Institute, Publications and Distributions, 2101 L St. N.W., Washington, DC 20037.

Hughes Tool Co. 1982 Annual Report. P. 18. The company maintained that the U.S. footage reported by the API included a significant amount of footage actually drilled in 1981. The company estimated that 1982 footage was overestimated by 40 to 50 million feet and that the 1981 footage was understated by a similar amount.

[3]Second work cited in footnote 2.

[4]Energy and Minerals Resources. BuMines Awards Contracts Totaling Over $2 Million for Foreign Mineral Deposit Data. V. 10, No. 44, Nov. 5, 1982, p. 405.

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[23]Mining Magazine (London). World Highlights: Europe—New Yugoslav Barites Mine. V. 147, No. 1, July 1982, p. 17.

[24]Mining Journal (London). Industry in Action: Production—New Yugoslavian Mines. V. 299, No. 7687, Dec. 17, 1982, p. 435.

[25]Lamont, W. E., and G. V. Sullivan. Recovery of Ultrafine Barite From Mill Wastes. BuMines RI 8668, 1982, 12 pp.

[26]———. Recovery of High-Grade Barite From Waste Pond Materials. BuMines RI 8673, 1982, 13 pp.

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[28]Waston, I. Barytes: U.S. Drilling Downturn Weighs Heavily on the Market. Ind. Miner. (London), No. 183, December 1982, pp. 21-57.

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[30]Massone, J. Technology and Uses of Barium and Strontium Compounds. Ind. Miner. (London), No. 177, June 1982, pp. 65-69.

Bauxite and Alumina

By Luke H. Baumgardner[1] and Ruth A. Hough[2]

During 1982, the global economic recession adversely affected the world aluminum metal market and constrained world bauxite and alumina production. World bauxite and alumina output declined significantly from 1981 production levels.

Leading suppliers of U.S. imports of crude and dried bauxite in 1982 were Guinea and Jamaica. Calcined bauxite imports were supplied largely by China, Guyana, and Suriname. About 84% of 1982 alumina imports came from Australia, and most of the balance from Canada, Jamaica, and Suriname.

The development of new bauxite mines was under consideration and study in Cameroon, Hungary (Fenyofo), Italy, Madagascar, and the Philippines (Samar). New bauxite-alumina projects were being examined in Brazil, Ghana, Indonesia, and Saudi Arabia.

Domestic Data Coverage.—Domestic production data for bauxite and alumina are developed by the Bureau of Mines from four separate voluntary surveys of U.S. operations. Typical of these surveys is the quarterly and annual Production of Bauxite Survey. Of the 19 operations to which a survey form was sent, 100% responded, representing 100% of domestic 1982 bauxite production as shown in tables 1, 2, and 18.

Table 1.—Salient bauxite statistics

(Thousand metric tons and thousand dollars)

	1978	1979	1980	1981	1982
United States:					
Production: Crude ore (dry equivalent)	1,669	1,821	1,559	1,510	732
Value	$23,185	$24,875	$22,353	$26,489	$12,334
Exports (as shipped)	13	15	21	20	49
Imports for consumption[1]	13,847	13,780	14,087	12,802	10,122
Consumption (dry equivalent)	14,738	15,697	15,962	13,525	9,217
World: Production	[r]80,975	[r]85,411	89,119	[p]85,474	[e]74,441

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Excludes calcined bauxite. Includes bauxite imported to the U.S. Virgin Islands.

Legislation and Government Programs.—Stockpile goals for different forms and grades of bauxite remained unchanged in 1982. The goals for metal-grade bauxite were 21.3 million tons[3] of Jamaica-type ore and 6.2 million tons of Suriname-type ore. Goals for calcined bauxite were 1.4 million tons of refractory-grade bauxite and 762,000 tons of abrasive-grade bauxite. The General Services Administration (GSA) purchased 26,000 tons of calcined refractory-grade bauxite from China. The imported material was stored at the Government stockpile in Granite City, Ill. This addition raised the yearend 1982 inventory of refractory-grade bauxite in the stockpile to 203,000 tons. GSA also purchased 1.6 million tons of metal-grade bauxite from the Jamaican Government. Delivery was completed September 1982 to a Government stockpile site at Gregory, Tex., raising the yearend inventory of Jamaica-type bauxite to 10.6 million tons. The inventory of 5.4 million tons of metal-grade, Suriname-type bauxite remained unchanged in 1982. Import duties on bauxite and alumina were suspended by Public Law 92-151 in 1971.

DOMESTIC PRODUCTION

Domestic bauxite production in 1982 was at the lowest level since 1940 and less than 50% of 1981 production. Chief factors in reduction of output were the closing of the Reynolds Metals Co. mine in Arkansas in March 1982 and the continuation of the depressed demand for refractory bauxite from mines in Alabama and Georgia. About 80% of the domestic bauxite consumed during the year was used to produce alumina compared with 94% of imported bauxite consumed for this use. Three companies, the Aluminum Co. of America (Alcoa), American Cyanamid Co., and Reynolds Metals Co., mined bauxite from open pit mines in Saline County, Ark. Porocel Corp., the fourth bauxite processing company in the State, produced activated bauxite from purchased ore at a plant in Pulaski County.

Bauxite produced in Alabama and Georgia was for the refractory and chemical markets. A. P. Green Refractories Co., Didier Taylor Refractories Corp., and Harbison-Walker Refractories Co. mined bauxite in Alabama, and the Mullite Co. of America operated bauxite mines in Georgia.

The nine domestic Bayer process plants in 1982 produced 4.13 million tons of alumina, a decline of 31% from 1981 production. All forms of alumina, including calcined, activated, and tabular aluminas, and commercial alumina trihydrate, are included in the total, expressed as calcined equivalent weight.

Primary aluminum plants in 1982 received an estimated 3.57 million tons of calcined alumina from domestic refineries. The balance of calcined alumina shipments were delivered to the abrasive, ceramic, chemical, and refractory industries.

Table 2.—Mine production of bauxite and shipments from mines and processing plants to consumers in the United States

(Thousand metric tons and thousand dollars)

State	Mine production			Shipments from mines and processing plants to consumers[2]		
	Crude	Dry equivalent	Value[1]	As shipped	Dry equivalent	Value[1]
1980:						
Alabama and Georgia	336	260	3,101	477	474	15,240
Arkansas	1,533	1,299	19,252	1,577	1,371	24,405
Total[3]	1,869	1,559	22,353	2,054	1,844	39,645
1981:						
Alabama and Georgia	342	268	4,303	389	442	17,670
Arkansas	1,505	1,242	22,185	1,429	1,221	26,358
Total[3]	1,847	1,510	26,489	1,819	1,663	44,028
1982:						
Alabama and Georgia	W	W	W	197	203	10,180
Arkansas	W	W	W	1,214	1,038	25,142
Total	896	732	12,334	1,411	1,241	35,322

W Withheld to avoid disclosing company proprietary data.
[1]Computed from values assigned by producers and from estimates of the Bureau of Mines.
[2]May exclude some bauxite mixed in clay products.
[3]Data may not add to totals shown because of independent rounding.

Table 3.—Recovery of dried, calcined, and activated bauxite in the United States

(Thousand metric tons)

Year	Crude ore treated	Total processed bauxite recovered[1]	
		As recovered	Dry equivalent
1981	419	187	328
1982	234	120	178

[1]Dried, calcined, and activated bauxite. May exclude some bauxite mixed in clay products.

Table 4.—Percent of domestic bauxite shipments, by silica content

SiO_2 (percent)	1978	1979	1980	1981	1982
Less than 8	2	1	--	--	--
From 8 to 15	55	55	62	65	63
More than 15	43	44	38	35	37

Table 5.—Production and shipments of alumina in the United States

(Thousand metric tons)

Year	Calcined alumina	Other alumina[1]	Total[2]	
			As produced or shipped[3]	Calcined equivalent
Production:[e]				
1978	5,550	580	6,130	5,960
1979	5,950	700	6,650	6,450
1980	6,310	720	7,030	6,810
1981	5,490	700	6,190	5,960
1982	3,810	465	4,280	4,130
Shipments:[e]				
1978	5,620	580	6,200	6,020
1979	5,970	710	6,680	6,480
1980	6,160	720	6,880	6,660
1981	5,610	715	6,320	6,085
1982	3,730	420	4,150	4,020

[e]Estimated.
[1]Trihydrate, activated, tabular, and other aluminas. Excludes calcium and sodium aluminates.
[2]Data may not add to totals shown because of independent rounding.
[3]Includes only the end product if one type of alumina was produced and used to make another type of alumina.

Table 6.—Capacities of domestic alumina plants,[1] December 31

(Thousand metric tons per year)

Company and plant	1981	1982
Aluminum Co. of America:		
Bauxite, Ark	340	340
Mobile, Ala	800	800
Point Comfort, Tex	1,325	1,400
Total	2,465	2,540
Martin Marietta Aluminum, Inc.: St. Croix, V.I	635	635
Kaiser Aluminum & Chemical Corp.:		
Baton Rouge, La	955	955
Gramercy, La	770	770
Total	1,725	1,725
Ormet Corp.: Burnside, La	545	545
Reynolds Metals Co.:		
Hurricane Creek, Ark	650	650
Corpus Christi, Tex	1,400	1,400
Total	2,050	2,050
Grand total	7,420	7,495

[1]Capacity may vary depending upon the bauxite used.

CONSUMPTION AND USES

Consistent with the pattern over the past 5 years, about 93% of the bauxite consumed was refined to various forms of alumina. An average of 2.07 tons (dry basis) of bauxite was required to produce 1 ton of calcined alumina. Of the nine domestic alumina plants (including the refinery at St. Croix, U.S. Virgin Islands) only one plant, in central Arkansas, used domestic bauxite exclusively. A second plant in Arkansas processed blended domestic and imported ores, while the seven other gulf coast and Caribbean plants consumed only imported bauxite.

Abrasive-grade bauxite quantities reported in table 7 include ore consumed in Canada to produce intermediate abrasive materials that are subsequently used in U.S. plants to manufacture abrasive end products. About 71,000 tons of bauxite was consumed for special uses such as cement, water treatment, and as a filter medium in the oil and gas industry.

Approximately 6,296,000 tons of calcined alumina was consumed in 1982 by the 30 operating domestic primary aluminum plants. Aluminum fluoride and synthetic cryolite made from alumina were also consumed by the primary aluminum industry, but data were not available for this and other alumina uses.

Table 7.—Bauxite consumed in the United States, by industry

(Thousand metric tons, dry equivalent)

Industry	Domestic	Foreign	Total[1]
1981:			
Alumina	1,233	11,277	12,510
Abrasive[2]	--	249	249
Chemical	[3]79	[3]227	232
Refractory	162	298	460
Other	W	W	75
Total[1 2]	1,474	12,052	13,525
1982:			
Alumina	559	7,984	8,543
Abrasive[2]	--	149	149
Chemical	[3]47	[3]192	169
Refractory	100	186	286
Other	W	W	71
Total[1 2]	706	8,511	9,217

W Withheld to avoid disclosing company proprietary data; included with "Chemical."
[1]Data may not add to totals shown because of independent rounding.
[2]Includes consumption by Canadian abrasive industry.
[3]Includes "Other."

Table 8.—Crude and processed bauxite consumed in the United States

(Thousand metric tons, dry equivalent)

Type	Domestic origin	Foreign origin	Total
1981:			
Crude and dried	1,242	11,516	12,758
Calcined and activated	233	534	767
Total	1,475	12,050	13,525
1982:			
Crude and dried	564	8,180	8,744
Calcined and activated	142	330	[1]473
Total	706	[1]8,511	9,217

[1]Data do not add to total shown because of independent rounding.

Table 9.—Production and shipments of selected aluminum salts in the United States, in 1981

Item	Number of producing plants	Production (thousand metric tons)	Total shipments including interplant transfers: Quantity (thousand metric tons)	Total shipments including interplant transfers: Value (thousands)
Aluminum sulfate:				
Commercial and municipal (17% Al_2O_3)	63	1,174	1,077	$138,484
Iron-free (17% Al_2O_3)	16	82	71	9,769
Aluminum chloride:				
Liquid and crystal (32° Bé)[1]	3	W	W	W
Anhydrous (100% $AlCl_3$)	5	W	W	W
Aluminum fluoride, technical	5	129	126	97,935
Aluminum hydroxide, trihydrate (100% $Al_2O_3 \cdot 3H_2O$)	7	579	563	137,328
Other inorganic aluminum compounds[2]	XX	XX	XX	[1]37,152

W Withheld to avoid disclosing company proprietary data. XX Not applicable.
[1]"Aluminum chloride: liquid and crystal" have been combined with "Other inorganic aluminum compounds."
[2]Includes sodium aluminate, light aluminum hydroxide, cryolite, and alums.

Source: Data are based upon U.S. Bureau of the Census report Form MA-28A, Annual Report on Shipments and Production of Inorganic Chemicals.

Table 10.—Stocks of bauxite in the United States,[1] December 31

(Thousand metric tons, dry equivalent)

Sector	1981	1982
Producers and processors	r897	583
Consumers	r7,395	7,010
Government	14,661	16,326
Total	r22,953	23,919

rRevised.
[1]Domestic and foreign bauxite; crude, dried, calcined, activated; all grades.

Table 11.—Stocks of alumina in the United States,[1] December 31

(Thousand metric tons, calcined equivalent)

Sector	1981	1982
Producers[e]	155	244
Primary aluminum plants	1,267	1,144
Total[e]	1,422	1,388

eEstimated.
[1]Excludes consumers' stocks other than those at primary aluminum plants.

PRICES

Bauxite is not traded publicly on open world markets, and except for spot sales and specialty grades, prices are not quoted in trade journals. The bulk of the world's bauxite is traded under long-term contracts or through intracompany transfers.

An average value of $15.53 per ton was estimated by the Bureau of Mines for domestic crude bauxite shipments, f.o.b. mine or plant, in 1982. The estimated average value of domestic calcined bauxite shipments was $107 per ton.

The Engineering and Mining Journal published monthly prices for super-calcined, refractory-grade bauxite imported from Guyana. Quoted prices, per metric ton, in carload lots, delivered f.o.b. Baltimore, Md., Mobile, Ala., or Burnside, La., were as follows:

Jan. 1982	Feb.-June 1982	July-Sept. 1982	Oct.-Dec. 1982
$198.72	$214.53	$211.10	$178.72

An average value of $260 per ton was estimated for domestic shipments of calcined alumina in 1982. Reports of the U.S. Bureau of the Census were used to derive an average value of $244 per ton of imported alumina, including a small amount of hydrate, at port of shipment (f.a.s.) and $268 per ton at U.S. ports (c.i.f.).

Table 12.—Average value of U.S. imports of crude and dried bauxite[1]

(Per metric ton)

Country	1981 Port of shipment (f.a.s.)	1981 Delivered to U.S. ports (c.i.f.)	1982 Port of shipment (f.a.s.)	1982 Delivered to U.S. ports (c.i.f.)
To U.S. mainland:				
Brazil	$26.70	$36.36	$29.47	$40.46
Dominican Republic	33.79	42.01	37.05	45.60
Guinea	26.38	36.27	27.50	38.05
Guyana	33.89	48.53	37.52	52.75
Haiti	25.15	31.49	32.54	38.34
Jamaica	27.07	30.63	35.43	39.91
Sierra Leone	19.68	29.54	--	--
Suriname	41.48	53.42	46.89	59.72
Weighted average	28.30	35.37	32.62	40.42

[1]Computed from quantity and value data reported to U.S. Customs Service and compiled by the Bureau of the Census, U.S. Department of Commerce. Not adjusted for moisture content of bauxite or differences in methods used by importers to determine value of individual shipments.

Table 13.—Market quotations on alumina and aluminum compounds

(Per metric ton, in bags, carlots, freight equalized)

Compound	Dec. 31, 1982	Jan. 3, 1983
Alumina, calcined	$228.18	$228.18
Alumina, hydrated, heavy	203.93	203.93
Alumina, activated, granular, works	352.74	352.74
Aluminum sulfate, commercial, ground (17% Al_2O_3)	259.04	259.04
Aluminum sulfate, iron-free, dry (17% Al_2O_3)	270.06	$270.06- 382.50

Source: Chemical Marketing Reporter.

FOREIGN TRADE

Bauxite exports in 1982 included 29,700 tons of calcined bauxite and 19,000 tons of dried bauxite, or a total of 65,000 tons expressed as dry equivalent. Canada and Mexico received 87% of the exported bauxite. Additional exports included 6,100 tons of aluminum sulfate, 26,000 tons of aluminum oxide abrasives, and 36,000 tons of other aluminum compounds, such as aluminum fluoride and synthetic cryolite.

Canada processed calcined abrasive-grade bauxite from Australia, Guinea, and Suriname into fused crude aluminum oxide that was shipped to U.S. plants for use in abrasive and refractory products.

Table 14.—U.S. exports of alumina,[1] by country

(Thousand metric tons and thousand dollars)

Country	1980		1981		1982	
	Quantity	Value	Quantity	Value	Quantity	Value
Argentina	16	4,514	1	501	1	460
Australia	4	1,920	2	1,234	(2)	342
Belgium-Luxembourg	1	729	1	1,570	1	2,129
Brazil	18	5,829	2	1,363	1	1,128
Canada	264	71,488	201	63,940	103	37,106
France	4	4,214	3	3,010	3	2,583
Germany, Federal Republic of	6	7,581	3	6,514	3	6,403
Ghana	151	24,958	76	13,862	160	29,222
Japan	3	9,489	3	10,454	3	7,769
Mexico	125	29,655	127	35,657	85	23,976
Netherlands	2	1,768	1	1,392	1	1,878
Norway	226	36,241	141	21,364	145	38,086
Poland	23	2,570	(2)	26	(2)	102
Spain	(2)	714	20	4,349	(2)	152
Sweden	72	16,749	15	4,358	27	6,174
U.S.S.R.	18	2,124	36	8,570	(2)	14
United Kingdom	6	4,502	6	6,284	6	6,962
Venezuela	189	36,057	94	25,695	23	7,308
Other	10	10,840	7	8,497	5	7,490
Total	1,138	271,942	[3]737	218,640	567	179,284

[1]Includes exports of aluminum hydroxide: 1980—38,000 tons; 1981—19,300 tons (revised); and 1982—11,300 tons. Also includes alumina exported from the U.S. Virgin Islands to foreign countries: 1980—271,000 tons; 1981 and 1982—data not reported separately.
[2]Less than 1/2 unit.
[3]Data do not add to total shown because of independent rounding.

Table 15.—U.S. imports for consumption of bauxite, crude and dried,[1] by country

(Thousand metric tons)

Country	1980	1981	1982
Brazil	777	1,265	512
Dominican Republic[2]	565	449	163
Guinea	4,112	3,546	4,198
Guyana	585	463	239
Haiti	452	529	500
Jamaica[2]	6,146	5,352	4,080
Sierra Leone	75	108	--
Suriname	1,369	1,079	409
Other	6	11	21
Total	14,087	12,802	10,122

[1]Includes bauxite imported to the U.S. Virgin Islands from foreign countries: 1980—1,241,000 tons; 1981 and 1982—data not reported separately.
[2]Dry equivalent of shipments to the United States.

Note: Total U.S. imports of crude and dried bauxite (including the U.S. Virgin Islands) as reported by the U.S. Bureau of the Census were as follows: 1980—15,136,854 tons; 1981—13,856,826 tons; and 1982—11,049,685 tons.

Table 16.—U.S. imports for consumption of bauxite (calcined), by country

(Thousand metric tons and thousand dollars)

Country	1981				1982			
	Refractory grade		Other grade		Refractory grade		Other grade	
	Quantity	Value[1]	Quantity	Value[1]	Quantity	Value[1]	Quantity	Value[1]
Australia	--	--	15	1,561	--	--	10	967
China[2]	122	14,681	12	1,410	55	6,264	18	2,064
Guyana	101	19,146	35	4,406	52	9,225	17	1,443
Suriname	28	4,575	6	467	22	1,658	14	1,126
Other	(3)	22	(3)	23	2	306	(3)	22
Total	251	38,424	68	7,867	131	17,453	59	5,622

[1]Value at foreign port of shipment as reported to U.S. Customs Service.
[2]The 1981 data for imports from China have been revised and adjusted to conform to information supplied by industry and the U.S. Bureau of the Census.
[3]Less than 1/2 unit.

Table 17.—U.S. imports for consumption of alumina,[1] by country

(Thousand metric tons and thousand dollars)

Country	1980		1981		1982	
	Quantity	Value[2]	Quantity	Value[2]	Quantity	Value[2]
Australia	3,408	578,031	2,955	574,688	2,679	598,157
Brazil	(3)	159	(3)	142	11	3,511
Canada	37	9,380	34	10,222	131	51,334
France	5	14,452	4	13,479	5	13,183
Germany, Federal Republic of	8	8,934	8	9,469	12	14,341
Guyana	17	1,472	4	613	--	
Jamaica	634	113,392	523	124,180	196	49,651
Japan	1	875	1	1,639	1	1,243
Suriname	246	55,440	448	102,486	117	27,387
Other	1	r766	1	r1,014	33	11,637
Total[4]	4,358	782,902	3,978	837,932	3,183	770,444

rRevised.

[1]Includes aluminum hydroxide; excludes shipments from the U.S. Virgin Islands to the United States: 1980—208,506 tons ($39,199,528); 1981 and 1982—not available.

[2]Value at foreign port of shipment as reported to U.S. Customs Service.

[3]Less than 1/2 unit.

[4]Data may not add to totals shown because of independent rounding.

WORLD REVIEW

Countries such as Guyana, Jamaica, and Suriname, whose economies were heavily reliant on bauxite and alumina exports, were seriously affected by the 1982 slump in demand for these commodities.

Australia.—Lower demand for bauxite and alumina in European, Japanese, and United States markets resulted in a substantial decrease in Australian production in 1982. At Comalco Ltd.'s bauxite mine at Weipa, Queensland, production and shipments of ore also were reduced by a dispute between two maritime unions that halted ore carrier operation for 8 weeks. Queensland Alumina Ltd. (QAL), at Gladstone, was operating at about 77% of its 2.03-million-ton annual capacity at yearend 1982. In November 1982, Kaiser Aluminum & Chemical Corp. sold its 45% interest in Comalco to CRA Ltd. and six Australian institutions, but retained a 28% share of QAL and a 20% share in the Gladstone refinery.

In Western Australia, the new 500,000-ton-per-year alumina plant at Wagerup was completed by Alcoa of Australia Ltd. in mid-1982. However, the refinery remained closed through the end of the year owing to depressed world alumina demand. Alcoa has not announced an opening date. Construction work continued on the Worsley Alumina Pty. Ltd. bauxite-alumina complex owned jointly by Reynolds Australia Alumina Ltd. (40%), Shell Co. of Australia (30%), Dampier Mining Co. Ltd. (20%), and Kobe Alumina Associates (Australia) Pty. Ltd. (10%). The Worsley plant, with an annual capacity of 1 million tons, was scheduled to open in the third quarter of 1983.

Brazil.—Bauxite production from the Trombetas Mine operated by Mineração Rio do Norte S.A. (MRN) was reduced in 1982 from the 1981 record of 3.2 million tons. A 500,000-ton bauxite sale by MRN to the U.S.S.R. was reportedly delivered in 1982 as was the first shipment of bauxite to Venezuela's nearly completed Interamericana de Alumina C.A. (Interalumina) refinery at Puerto Ordaz. The recovery of bauxite demand was still uncertain, and by yearend 1982, MRN shareholders had not announced their decision on the scheduled expansion to 6.4 million tons per year. At São Luis in Maranhão State, construction of the Consorcio-Alumar alumina plant and primary aluminum smelter was 35% complete by December 1982. The complex, which will have an annual capacity of 500,000 tons of alumina and 100,000 tons of aluminum, is scheduled to go into operation in 1985. The project is jointly owned by Alumínio S.A. and Billiton BV. Near Belém, Pará State, on the Amazon River, construction of the Alumínio Brasileiro S.A.-Alumina do Norte do Brasil S.A. aluminum-alumina complex was temporarily suspended while the shareholders held a series of meetings to decide whether to proceed or to postpone work on the 320,000-ton-per-year smelter and 800,000-ton-per-year refinery. Participants in the venture include 27 Japanese companies with a 44% interest and Cia. Vale do Rio Doce (CVRD) with a 51% interest.

Dominican Republic.—Alcoa shut down bauxite mining operations on the east end of the island of Hispaniola in mid-1982. The closure of the bauxite mine was reported as temporary, and limited mining operations were continuing to produce limestone for export to other Alcoa plants.

Ghana.—During 1982, bauxite reserves at Kibi were reevaluated and a feasibility study for an alumina plant was in progress. Brown & Root Inc. as prime contractor, and Gränges International Mining AB and Swiss Aluminium Ltd. (Alusuisse) participated in the contracted study. The Government of Ghana was reported to have signed an agreement to proceed with the construction of an 800,000-ton-per-year alumina plant near the Kibi bauxite deposits.

Guinea.—Bauxite production in 1982 was nearly the same as in 1981, although alumina output was about 10% lower. In exchange for additional bauxite, the U.S.S.R. was reported to have offered Guinea assistance in expanding the capacity of the Government-owned bauxite mine at Kindia through the supply of mining equipment. The Soviet-built Kindia mining operation has been supplying the U.S.S.R. annually with about 2 million tons of bauxite in recent years. A new market for Guinea bauxite is expected to open in 1983 when the Aughinish alumina plant in Ireland starts operating. The plant is owned 40% by Aluminium Co. of Canada Ltd. (Alcan), 35% by Billiton Aluminium Ireland Ltd., and 25% by Anaconda Ireland Co. and was scheduled to use bauxite from the Sangaredi Mine in the Boké district. The Sangaredi Mine is operated by Compagnie des Bauxites de Guinée, a consortium in which Alcan holds a 14% interest.

Guyana.—The market for calcined refractory-grade bauxite, a major Guyanese export, was very limited in 1982. Green Construction Co., Iowa, continued under Government contract to remove overburden and mine bauxite at East Montgomery. The alumina plant at Linden was shut down for extensive maintenance work and modifications and was not expected to be in operation until 1984. Guyana was reported to have signed a contract to supply bauxite to Venezuela's new Interalumina refinery for a 2- to 3-year term.

Haiti.—Reynolds Haitian Mines permanently closed its bauxite mine at Miragoane at yearend 1982. This was the only mining operation in Haiti. The parent company, Reynolds Metals Co., reported that the marginal grade ore was no longer economically competitive with bauxite from other sources.

Jamaica.—Despite the sale of 1.6 million tons of bauxite to the U.S. Government stockpile, Jamaica's bauxite and alumina production was about 30% lower than the 1981 level. The year began with January labor strikes against all five of the bauxite and alumina operations as the National Workers Union sought new 3-year contracts with the companies. By the time the last agreement was settled on March 18, all mines and plants had resumed operations. Kaiser Jamaica Bauxite Co. and Reynolds Jamaica Mines Ltd. jointly supplied the 1.6 million tons of bauxite that was delivered to a U.S. national stockpile at Gregory, Tex., by September 1982. The Jamaican Government vigorously sought countertrade agreements and was moderately successful in trading bauxite and alumina to U.S. companies in exchange for trucks, buses, and heavy equipment. Aluminum Partners of Jamaica (Alpart), owned by Reynolds, Kaiser, and Anaconda, placed an order with Cable Belt Ltd., United Kingdom, for a 15-kilometer conveyor belt that could handle 6.5 million tons of bauxite per year. The new conveyor was planned to supply the plant with higher grade bauxite than was previously available.

Venezuela.— Interalumina was organized by the Venezuelan Government in 1977 to construct and operate a 1-million-ton-per-year alumina plant at Puerto Ordaz on the Orinoco River. By yearend 1982, the $1.2 billion plant was nearing completion and was scheduled to start up in the first quarter of 1983 with an initial annual alumina capacity of 500,000 tons. Interalumina planned to purchase the annual 1.2 million tons of bauxite supply from Brazil, Guyana, Sierra Leone, and Suriname until 1985. At that time, the Los Pijiguaos bauxite mine was scheduled to be shipping ore 650 kilometers down the Orinoco River to the Interalumina refinery. When local bauxite becomes available, Venezuela could become one of the few countries of the world to have a vertically integrated aluminum industry from ore to primary metal.

Table 18.—Bauxite: World production, by country[1]

(Thousand metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Australia	24,293	27,583	27,178	25,541	23,621
Brazil	1,160	2,388	5,538	5,770	[2]4,186
China	1,500	1,500	1,500	1,500	1,500
Dominican Republic[3]	568	524	510	405	[2]152
France	1,978	[r]1,969	1,921	1,827	[2]1,671
Germany, Federal Republic of	(4)	(4)	(4)	--	--
Ghana	328	214	225	181	[2]173
Greece	2,663	2,812	3,286	3,216	[2]2,853
Guinea[5]	[r]11,627	[r]11,326	11,862	11,112	[2]10,908
Guyana[3]	2,425	2,312	1,844	1,681	[2]953
Haiti[6]	580	584	312	427	[2] [6]377
Hungary	2,899	2,976	2,950	2,914	[2]2,627
India	1,663	[r]1,952	1,785	1,923	[2]1,854
Indonesia	1,008	1,052	1,249	1,203	[2]704
Italy	24	26	23	19	[2]24
Jamaica[7]	11,739	11,618	12,054	11,682	[2]8,380
Malaysia	615	387	920	701	[2]589
Pakistan	2	2	2	2	2
Romania	708	708	[e]710	[e]712	680
Sierra Leone	716	672	766	[e]610	[2]606
Spain	[r]3	[r]8	4	9	10
Suriname	5,188	5,010	4,646	4,100	[2]3,059
Turkey	449	[e]350	533	575	[2]508
U.S.S.R.[e 8]	4,600	4,600	[r]4,600	4,600	4,600
United States[3]	1,669	1,821	1,559	1,510	[2]732
Yugoslavia	2,565	3,012	3,138	3,249	[2]3,668
Zimbabwe	5	5	4	5	4
Total	[r]80,975	[r]85,411	89,119	85,474	74,441

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through June 29, 1983.
[2]Reported figure.
[3]Dry bauxite equivalent of crude ore.
[4]Less than 1/2 unit.
[5]Dry bauxite equivalent of ore processed by drying plant.
[6]Shipments.
[7]Bauxite processed for conversion to alumina in Jamaica plus kiln-dried ore prepared for export.
[8]In addition to the bauxite reported in the body of the table, the U.S.S.R. produces nepheline syenite concentrates and alunite ore as sources of aluminum. Estimated nepheline syenite production was as follows, in thousand metric tons: 1978—2,500; 1979—2,500; 1980—2,500; 1981—2,500; and 1982—2,500, and estimated alunite ore production was as follows in thousand metric tons: 1978—600; 1979—600; 1980—600; 1981—600; and 1982—600. Nepheline syenite concentrate grades 25% to 30% alumina, and alunite ore grades 16% to 18% alumina; these commodities may be converted to their bauxite equivalent by using factors of 1 ton of nepheline syenite concentrate equals 0.55 ton of bauxite and 1 ton of alunite equals 0.34 ton of bauxite.

Table 19.—Alumina: World production,[1] by country[2]

(Thousand metric tons)

Country[3]	1978	1979	1980	1981[p]	1982[e]
Australia	6,776	7,415	7,246	7,079	[4]6,631
Brazil	352	449	493	519	500
Canada	1,054	953	1,202	1,208	[4]1,127
China[e]	750	750	750	750	800
Czechoslovakia[e]	100	100	100	100	100
France	1,056	1,069	1,173	1,095	[4]960
German Democratic Republic	38	41	43	43	43
Germany, Federal Republic of	[r]1,556	[r]1,539	1,608	1,419	[4]1,565
Greece	477	495	494	490	[4]420
Guinea	610	660	708	608	[4]549
Guyana[5]	250	200	231	170	[4]73
Hungary	782	788	805	792	[4]745
India	480	493	[e]500	[e]500	500
Italy	819	854	900	794	800
Jamaica	2,117	2,094	2,456	2,556	1,700
Japan	1,502	[r]1,545	1,936	1,344	[4]959
Poland	--			(6)	
Romania[e]	449	502	534	540	520
Spain	--		58	695	[4]673
Suriname	1,310	1,325	1,316	1,200	[4]1,172

See footnotes at end of table.

Table 19.—Alumina: World production,[1] by country[2] —Continued

(Thousand metric tons)

Country[3]	1978	1979	1980	1981[p]	1982[e]
Taiwan[e]	51	58	65	61	20
Turkey	74	70	138	119	[4]84
U.S.S.R.[e]	2,600	2,600	2,700	[r]2,800	3,000
United Kingdom	94	88	102	90	80
United States[e]	5,960	6,450	6,810	5,960	[4]4,130
Yugoslavia	496	836	1,058	1,037	[4]1,072
Total	[r]29,753	[r]31,374	33,426	31,969	28,223

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Figures presented generally represent calcined alumina; exceptions are noted individually.
[2]Table includes data available through June 29, 1983.
[3]In addition to the countries listed, Austria produces alumina (fused aluminum oxide), but output is entirely for abrasives production. Output totaled 28,223 metric tons in 1973; production data subsequent to 1973 are not available.
[4]Reported figure.
[5]Calcined alumina plus calcined alumina equivalent of alumina hydrate.
[6]Revised to zero.

Table 20.—World annual alumina capacity, by country

(Thousand metric tons, yearend)

Country	1980	1981	1982
Australia	7,340	7,340	7,840
Brazil	540	540	540
Canada	1,225	1,225	1,225
China	650	650	650
Czechoslovakia	100	100	100
France	1,320	1,320	1,320
German Democratic Republic	65	65	65
Germany, Federal Republic of	1,745	1,745	1,745
Greece	500	500	500
Guinea	660	700	700
Guyana	354	355	355
Hungary	895	895	895
India	675	675	675
Italy	920	920	920
Jamaica	2,824	2,825	2,825
Japan	2,614	2,615	2,615
Poland	--	(1)	--
Romania	540	540	540
Spain	80	800	800
Suriname	1,350	1,350	1,350
Taiwan	140	140	160
Turkey	200	200	200
U.S.S.R.[e]	3,400	4,500	4,500
United Kingdom	138	140	140
United States	7,208	7,420	7,495
Yugoslavia	1,635	1,635	1,635
Total	37,118	[r]39,195	39,790

[e]Estimated. [r]Revised.
[1]Revised to zero.

TECHNOLOGY

The Bureau of Mines research on aluminous resources in 1982 was divided between domestic nonbauxitic sources of (1) cell-grade alumina for primary aluminum production and (2) alternate raw materials for high-alumina refractories. Much of the work was a continuation of projects started in 1981 or earlier.

In the cell-grade alumina studies, specific problems that had been identified in leaching clay with hydrochloric acid were examined, and the results of past work were reviewed and published.[4] Literature on coal waste composition, availability, and alumina extraction technologies was collected, evaluated, and summarized. Samples of various types of coal ash and coal shale were obtained, and initial analytical work was started. Research continued on the development of a process to extract alumina and soda ash from the dawsonite ($NaAl(OH)_2CO_3$) and nahcolite ($NaHCO_3$) contained in retorted oil shale. Within Colorado's Piceance Creek Basin, oil shales were estimated to contain some 6.7 billion tons of alumina and 14.8 billion tons of Na_2O.[5]

Because the United States produces no refractory-grade bauxite of a quality comparable to that imported from China, Guyana, and Suriname, development of alternate high-alumina materials is of critical importance. In 1982, the Bureau evaluated gibbsite concentrates from Alabama and North Carolina saprolites as possible sources of refractory materials. The Alabama samples were collected by the the Alabama Geological Survey under a grant from the Bureau. Preliminary tests on concentrates from a bulk sample of corundum ore from Montana indicated encouragingly high pyrometric cone equivalent values. Research was continuing on alkaline desilication of calcined kaolin clay to produce a 75% alumina, 17% silica, low-iron, low-alkali refractory product.[6]

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[1]Physical scientist, Division of Nonferrous Metals.

[2]Statistical assistant, Division of Nonferrous Metals.

[3]All quantities in this chapter are given in metric tons unless otherwise specified.

[4]Schaller, J. L., D. B. Hunter, and D. L. Sawyer, Jr. Alumina Miniplant Operations—Production of Misted Raw Kaolin Feed. BuMines RI 8712, 1982, 20 pp.

Eisele, J. A., F. R. Smith, and D. J. Bauer. Iron Extraction From Simulated Aluminum Nitrate Leach Liquor. BuMines RI 8634, 1982, 9 pp.

[5]Gabler, R. C., Jr., and R. L. Stoll. Removal of Leachable Metals and Recovery of Alumina From Utility Coal Ash. BuMines RI 8721, 1983, 20 pp.

Apa, R. P., E. S. Grimmett, F. R. Keller, and J. N. McFee. Alumina Extraction From Anthracite Culm With Energy Recovery. BuMines OFR 121-83, 1982, 80 pp.

[6]Beg, M. A. Evaluation of Ceramic and Refractory Grade Raw Materials in Alabama: Gibbsite in Saprolites of East-Central Alabama. BuMines OFR 118-82, 1982, 80 pp.

Beryllium

By Benjamin Petkof[1]

The U.S. beryllium industry continued to convert domestic and imported beryllium ore concentrates to beryllia, metal, and alloys. Imports of beryl continued to increase. Exports of beryllium materials increased from those of 1981. Beryllium concentrate consumption dropped sharply from that of 1981. World beryl production declined slightly.

Domestic Data Coverage.—Domestic production data for beryllium were developed by the Bureau of Mines from two separate, voluntary surveys of U.S. operations. Typical of these surveys was the Beryllium Mineral Concentrate and Beryllium Ore survey. All 17 operations to which a survey request was sent responded, representing 100% of the total production. Production data were withheld in table 1 to avoid disclosing company proprietary data.

Table 1.—Salient beryllium mineral statistics

(Short tons unless otherwise specified)

	1978	1979	1980	1981	1982
United States:					
Beryllium mineral concentrates:					
Shipped from mines[1]	W	W	W	W	W
Imports for consumption	1,031	1,037	1,703	2,138	2,652
Consumption[1]	5,916	9,518	8,508	8,141	5,387
Price, approximate, per short ton unit BeO, imported cobbed beryl at port of exportation	$40	$47	$69	$94	$121
Yearend stocks[1]	1,346	835	1,350	2,223	5,112
World production of beryl	2,888	[r]2,642	2,823	[p]3,257	[e]3,158

[e]Estimated. [p]Preliminary. [r]Revised. W Withheld to avoid disclosing company proprietary data.
[1]Includes bertrandite ore, which was calculated as equivalent to beryl containing 11% BeO.

Legislation and Government Programs.—Beryllium occupational and health standards promulgated in 1975 by the Occupational Safety and Health Administration were still pending in 1982.

DOMESTIC PRODUCTION

Brush Wellman, Inc., remained the only major commercial producer of beryllium concentrates. Brush mined low-grade bertrandite ore at Spor Mountain, Utah, for processing into beryllium hydroxide. A small quantity of beryl was also mined domestically.

Brush converted beryllium concentrates to beryllium hydroxide at its processing plant north of Delta, Utah. During the year, Brush continued with plans to modify the Delta plant to utilize lower grade beryllium concentrates. Brush also announced plans for a major expansion and modernization of its beryllium-copper wire, tube, and rod manufacturing capability at its Elmore, Ohio, plant.

The Cabot Berylco Div. of the Cabot Corp. continued to produce beryllium copper and other beryllium alloys at its plant in Reading, Pa., from imported and domestic ores that were converted to beryllium hydroxide. Cabot's High Technology Materials Div. in Kokomo, Ind., started up a new rolling mill to process beryllium-copper alloy and other metals and alloys. Eventually Cabot plans to transfer all beryllium alloy rolling operations to the Kokomo plant. The Reading plant was to continue to produce beryllium alloy billet.

Domestic production of beryllium metal in 1982 was more than that of 1981, but output of all categories of beryllium alloys and beryllium oxide ceramics was less than that of 1981.

CONSUMPTION AND USES

The U.S. beryllium industry consumed beryllium ore equivalent to 5,387 short tons of beryl containing 11% beryllium oxide (BeO) in 1982. Ore consumption was about two-thirds that of 1981, reflecting the completion or termination of defense, aerospace, and other programs in 1982.

Copper-based beryllium alloys were the most widely used beryllium-containing products. The addition of about 2% beryllium to copper provides a commercial copper alloy with physical properties that allow the alloy's use for a wide range of applications in cast and wrought forms. Much of the alloy consumption was as thin strip or small-diameter rod. The alloy was used to fabricate items such as connectors, springs, sockets, switches, bushings, bearings, noncorrosive and nonmagnetic housings, and temperature- and pressure-sensing devices for the aircraft, automotive, electronic, and well-drilling industries.

Beryllium oxide ceramics found increasing use in electronics and electrical industries because of its high thermal conductivity, good mechanical hardness and strength, electrical insulation capability, and low dielectric constant. It was used in the manufacture of lasers, microwave tubes, semiconductors, electronic substrates, microprocessors, aerospace and communications equipment, home appliances, and other equipment.

Beryllium metal with its high stiffness-to-weight ratio, light weight, excellent thermal conduction properties, and nuclear reflection and absorption properties was used in inertial guidance systems, military and commercial satellite and space vehicle structures, instrumentation, space optics, and special nuclear applications.

STOCKS

Yearend stocks were more than double those of the previous year and were at the highest level since 1977, reflecting increased beryllium mineral production, imports, and lower consumption.

PRICES AND SPECIFICATIONS

From the beginning of 1982 until midyear, Metals Week quoted the price range for beryl ore at $100 to $130 per short ton unit. After midyear, the price range was quoted at $110 to $135 per short ton unit through the rest of the year.

At yearend, the American Metal Market quoted the following prices for beryllium materials: vacuum cast ingot, $194 per pound; metal powder (in 5,000-pound lots), $166 per pound; beryllium-copper master alloy, $130 per pound of contained beryllium; beryllium-copper casting alloy, $4.39 to $5.30 per pound; beryllium-copper in rod, bar, and wire, $7.20 per pound; beryllium-copper in strip, $7.10 per pound; beryllium-aluminum alloy, (100,000-pound lots), $201 per pound; and beryllium oxide powder, $40 per pound. All beryllium metal quotations were for 97% purity metal.

FOREIGN TRADE

Almost three-fourths of U.S. exports of beryllium materials were destined for Switzerland with significant quantities also shipped to France, Japan, the Republic of Korea, Spain, and Sweden.

Beryl was the only beryllium mineral ore imported into the United States. The average value of imported ore increased from $936.39 per ton in 1981 to $1,212.29 per ton in 1982. China, Brazil, and the Republic of

South Africa supplied about four-fifths of total imports. In addition, 292 pounds of wrought, unwrought, and waste and scrap beryllium metal valued at $10,734 was imported from Canada and the United Kingdom.

Table 2.—U.S. exports of beryllium alloys, wrought or unwrought, and waste and scrap,[1] by country

Country	1981 Quantity (pounds)	1981 Value (thousands)	1982 Quantity (pounds)	1982 Value (thousands)
Argentina	931	$119	--	--
Australia	2,238	11	1	$1
Brazil	117	4	--	--
Canada	7,057	293	304	130
China	--	--	476	8
France	4,387	605	4,229	1,293
Germany, Federal Republic of	2,338	144	542	140
Hong Kong	--	--	345	16
India	276	30	--	--
Ireland	528	3	--	--
Israel	194	4	--	--
Italy	3,000	92	57	6
Japan	4,470	882	9,649	751
Korea, Republic of	84	1	2,951	40
Mexico	247	3	50	1
Netherlands	60	44	28	53
Spain	--	--	8,962	16
Sweden	--	--	7,478	88
Switzerland	48,227	589	98,556	1,126
Taiwan	57	6	3	1
United Kingdom	3,914	262	347	22
Other	r64	r2	35	4
Total	78,189	3,094	134,013	3,696

rRevised.
[1]Consisting of beryllium lumps, single crystals, powder; beryllium-base alloy powder; and beryllium rods, sheets, and wire.

Table 3.—U.S. imports for consumption of beryl, by customs district and country

Customs district and country	1981 Quantity (short tons)	1981 Value (thousands)	1982 Quantity (short tons)	1982 Value (thousands)
Baltimore district: South Africa, Republic of	--	--	22	$31
Houston district:				
Brazil	--	--	165	218
Zimbabwe	--	--	18	28
Total	--	--	183	246
Los Angeles district:				
Argentina	49	$51	31	32
Australia	--	--	2	3
Brazil	580	573	235	308
China	616	569	860	935
Hong Kong	5	6	127	159
Japan	--	--	60	74
Mozambique	22	11	--	--
Portugal	20	16	--	--
South Africa, Republic of	18	16	--	--
Switzerland	--	--	99	132
Taiwan	--	--	31	34
Total	1,310	1,242	1,445	1,677
New Orleans district:				
Belgium-Luxembourg	([1])	1	--	--
Brazil	--	--	33	51
Total	([1])	1	33	51

See footnote at end of table.

Table 3.—U.S. imports for consumption of beryl, by customs district and country —Continued

Customs district and country	1981 Quantity (short tons)	1981 Value (thousands)	1982 Quantity (short tons)	1982 Value (thousands)
New York City district:				
Brazil	11	$13	27	$35
China	--	--	66	64
South Africa, Republic of	6	9	--	--
Total	17	22	93	99
Philadelphia district:				
Argentina	30	27	--	--
Belgium-Luxembourg	22	10	44	38
Brazil	248	288	485	650
China	337	256	49	42
Hong Kong	33	35	--	--
Portugal	--	--	22	33
Rwanda	22	10	22	19
South Africa, Republic of	79	90	205	267
Switzerland	--	--	19	24
United Kingdom	40	19	10	9
Zimbabwe	--	--	20	29
Total	811	735	876	1,111
Seattle district: Canada	(1)	2	--	--
Grand total	2,138	2,002	2,652	3,215

[1]Less than 1/2 unit.

WORLD REVIEW

World beryl production in 1982 was less than that of 1981. Brazil and the U.S.S.R. were the major producers (table 4). China was also a large active beryl producer, but production data were unavailable.

[1]Physical scientist, Division of Nonferrous Metals.

Table 4.—Beryl: World production, by country[1]

(Short tons)

Country	1978	1979	1980	1981[p]	1982[e]
Argentina	24	13	34	33	29
Brazil	815	[r]498	606	894	882
Kenya	--	(2)	(2)	--	--
Madagascar	12	11	11	10	11
Mozambique	NA	31	22	20	17
Nepal[3]	(2)	(2)	(2)	(2)	(2)
Portugal	(2)	6	21	20	21
Rwanda	64	51	119	100	110
South Africa, Republic of	4	1	(2)	134	66
U.S.S.R.[e]	1,930	2,000	2,000	2,000	2,000
United States[4]	W	W	W	W	W
Zimbabwe[e]	39	31	10	46	22
Total	2,888	[r]2,642	2,823	3,257	3,158

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]In addition to the countries listed, China produced beryl, and Bolivia and Namibia may also have produced beryl, but available information is inadequate to formulate reliable estimates of output levels. Table includes data available through Apr. 6, 1983.
[2]Less than 1/2 unit.
[3]Fiscal year ending in July of year stated.
[4]Primarily bertrandite ore.

Bismuth

By James F. Carlin, Jr.[1]

Domestic consumption, imports, and exports all declined in 1982. Australia remained the leading producer, followed by Peru and Mexico.

Domestic Data Coverage.—Domestic production data for bismuth metal are developed by the Bureau of Mines from a voluntary survey of the only U.S. bismuth refinery.

Legislation and Government Programs.—Government stocks remained at 2,081,298 pounds. The stockpile goal remained at 2,200,000 pounds.

Federal income tax laws provided a depletion allowance of 22% for domestic production and 14% for U.S. companies producing from foreign sources.

Table 1.—Salient bismuth statistics

(Thousand pounds unless otherwise specified)

	1978	1979	1980	1981	1982
United States:					
Consumption	2,512	2,727	2,289	2,393	1,876
Exports[1]	96	428	129	79	53
Imports, general	2,658	2,167	2,217	2,436	2,026
Producer price, average per pound (ton lots)	$3.38	$3.01	(2)	(2)	(2)
Consumer stocks, Dec. 31	782	630	674	509	542
World: Production[3]	r9,379	r7,547	7,326	p7,457	e7,161

eEstimated. pPreliminary. rRevised.
[1]Includes bismuth, bismuth alloys, and waste and scrap.
[2]Domestic producers' list price has been suspended since Oct. 1, 1980.
[3]Excludes the United States.

DOMESTIC PRODUCTION

Bismuth was produced from the treatment of lead ores and bullion of both foreign and domestic origin. A single primary refinery operated by ASARCO Incorporated at Omaha, Nebr., accounted for all primary production. Refinery production statistics are withheld to avoid disclosing company proprietary data. Small quantities of secondary bismuth were produced from bismuth scrap materials by several firms.

CONSUMPTION AND USES

Domestic consumption declined in 1982, and virtually every usage category shared in the decrease. The sharpest decline occurred in metallurgical additives where the demand for malleable iron castings was severely impacted by lowered demand from the major capital goods markets.

Various steel companies continued to experiment with and sell commercially new bismuth-bearing steel grades for the free-machining bar steel market.

Table 2.—Bismuth metal consumed in the United States, by use

(Thousand pounds)

Use	1981	1982
Fusible alloys	657	572
Metallurgical additives	307	125
Other alloys	26	21
Pharmaceuticals[1]	1,388	1,145
Experimental	(2)	(2)
Other	15	13
Total	2,393	1,876

[1]Includes industrial and laboratory chemicals and cosmetics.
[2]Less than 1/2 unit.

STOCKS

During the year, consumer stocks increased but remained well below the levels of most recent years.

PRICES

Asarco continued suspension of its producer list price throughout the year. The published price of a major foreign producer remained at $2.30 per pound throughout the year. Dealer quotations started the year at $1.85 to $1.95 per pound and generally were lowered throughout the year to finish at $1.35 to $1.40 per pound.

FOREIGN TRADE

Exports of bismuth declined sharply, reaching a 6-year low.

Starting January 1, 1982, the U.S. import duties for bismuth were unwrought metal (TSUS 632.10), free for most favored nations (MFN) and 7.5% ad valorem for non-MFN; alloys (TSUS 632.66), 7.7% ad valorem for MFN and 45% ad valorem for non-MFN; and compounds (TSUS 418.00 and 432.80), 11.4% ad valorem for MFN and 35% ad valorem for non-MFN.

Table 3.—U.S. exports of bismuth, bismuth alloys, and waste and scrap, by country

Country	1981		1982	
	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)
Argentina	2,500	$10	--	--
Australia	--	--	108	$1
Bahrain	--	--	278	1
Belgium-Luxembourg	7,444	43	--	--
Bermuda	--	--	382	1
Brazil	10,586	46	905	15
Canada	16,269	171	11,794	88
Colombia	--	--	506	1
Denmark	430	1	--	--
France	11,996	55	28	6
Germany, Federal Republic of	459	2	1,387	21
Greece	--	--	1,000	3
Hong Kong	1,006	6	25	5
India	1,789	14	3,451	25
Ireland	6,451	37	--	--
Israel	1,508	6	4	1
Italy	579	12	1,983	26
Japan	4,180	23	5,142	46

Table 3.—U.S. exports of bismuth, bismuth alloys, and waste and scrap, by country —Continued

Country	1981		1982	
	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)
Korea, Republic of	287	$1	10	$2
Malaysia	--	--	244	1
Mexico	1,308	4	--	--
Peru	--	--	204	2
Portugal	--	--	767	1
Singapore	1,224	6	1,128	6
South Africa, Republic of	4,905	187	811	5
Spain	369	5	2,840	10
Sweden	--	--	267	5
Switzerland	18	7	400	3
Taiwan	705	16	--	--
Thailand	3,086	28	382	7
Trinidad	--	--	528	6
United Kingdom	853	7	16,841	59
Venezuela	429	13	1,099	21
Other	[r]322	[r]8	244	3
Total	78,703	708	52,758	371

[r]Revised.

Table 4.—U.S. general imports[1] of metallic bismuth, by country

Country	1981		1982	
	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)
Belgium-Luxembourg	156,868	$328	908	$3
Canada	41,740	94	50,290	82
Germany, Federal Republic of	77,162	172	118,571	253
Japan	124,093	262	41,361	73
Korea, Republic of	37,556	72	13,412	15
Mexico	724,052	1,309	699,547	913
Peru	859,325	1,605	864,100	1,319
United Kingdom	415,453	1,041	238,056	548
Total	2,436,249	4,883	2,026,245	3,206

[1]General imports and imports for consumption were the same in 1981 and 1982.

WORLD REVIEW

World production of bismuth continued the generally declining pattern of recent years. This was primarily due to planned reductions in response to the continued decline in bismuth demand.

Japan.—Bismuth was produced by seven companies, mostly as a byproduct of lead smelting. About one-third of Japan's production originated from native ores, and the remainder from imported materials. The leading producers of bismuth metal were Mitsui Mining & Smelting Co. Ltd. and Dowa Mining Co. Ltd. Other producers included Furukawa Mining Co. Ltd., Mitsubishi Metals Corp., Nippon Mining Co. Ltd., Sumitomo Metal Smelting Co. Ltd., and Toho Zinc Co. Ltd. About one-half of Japan's bismuth production was used domestically, and the remainder was exported. The major export destination was to the U.S.S.R., followed by the United States and the Federal Republic of Germany.

Korea, Republic of.—Korea Tungsten Mining Co., Ltd. (KTM), was the only mine and smelter source of bismuth. KTM's bismuth was produced as a byproduct of tungsten mining from the Sangtong Mine in Kangwong Province. The bismuth refinery was located in Daegu and had an annual capacity of about 180,000 pounds of bismuth. About 90% of KTM's refined bismuth was exported mainly to Europe and the United States, and the remainder was consumed domestically.

[1]Physical scientist, Division of Nonferrous Metals.

Table 5.—Bismuth: World mine production, by country[1]

(Thousand pounds)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Australia (in concentrates)	2,324	[e]2,200	[e]2,000	[e]1,870	1,650
Bolivia (in concentrates)	677	22	24	25	9
Canada[3]	320	[r]306	377	271	260
China (in ore)[e]	530	570	570	570	570
France (metal)	(4)	(4)	(4)	(4)	(4)
Germany, Federal Republic of (in ore)[e]	20	22	22	22	22
Japan (metal)[5]	1,375	1,010	745	1,054	1,060
Korea, Republic of (metal)[3]	269	192	271	220	200
Mexico[6]	2,156	1,662	1,698	1,446	1,370
Peru[6]	1,347	1,162	1,096	1,409	1,540
Romania (in ore)[e]	180	180	180	180	180
Sweden (in ore)	(7)	(7)	(7)	(7)	--
Uganda (in ore)[e]	2	11	NA	NA	NA
U.S.S.R. (metal)[e 5]	150	160	160	165	170
United States (in ore)	W	W	W	W	W
Yugoslavia (metal)[5]	29	50	183	225	130
Total	[r]9,379	[r]7,547	7,326	7,457	7,161

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; excluded from total.

[1]Table includes data available through Mar. 21, 1983.

[2]In addition to the countries listed, Brazil, Bulgaria, the German Democratic Republic, and Namibia are believed to have produced bismuth, but available information is inadequate for formulation of reliable estimates of output levels.

[3]Refined metal and bullion plus recoverable bismuth content of exported concentrate.

[4]France terminated metallic bismuth production in 1977; the solitary French mine that has produced bismuth in prior years continued to operate through 1980 and may have operated in 1981, but whether bismuth was recovered at all and, if so, where and in what form is unknown.

[5]Although output reported is at the smelter stage of production rather than at the mine stage, and thus could include metal contained in ores mined in other countries, it is believed that any such production derived from ores from other countries is not duplicative to any significant extent of mine production reported elsewhere in this table.

[6]Bismuth content of refined metal, bullion, and alloys produced indigenously plus recoverable bismuth content of ores and concentrates exported for processing.

[7]Revised to zero.

Boron

By Phyllis A. Lyday[1]

U.S. production and sales of boron minerals and chemicals decreased to a 7-year low. The world recession caused weak demand for borates in insulation products and glass-fiber-reinforced plastics. Glass-fiber insulation (glass wool) continued to be the largest use for borates, followed by textile-grade fibers, cellulosic insulation, and special borosilicate glasses.

California was the only domestic source of boron minerals, which were mostly in the form of sodium borate, but also as calcium borate and sodium-calcium borates. Notwithstanding the fact that most domestic and world borate markets were weak, the United States continued to provide most of its own supply while maintaining a strong position as a source of sodium borate products and boric acid to foreign markets.

Supplementary U.S. imports of Turkish calcium and sodium-calcium borate ores and boric acid, primarily for textile-grade and insulation-grade glass fibers, continued.

Domestic Data Coverage.—Domestic data for boron were developed by the Bureau of Mines by means of three separate, voluntary surveys of U.S. operations. Of the three operations to which production survey requests were sent, all responded, representing 100% of the total production data shown in table 1. A Bureau canvass of the three U.S. producers also collected data on do-

Table 1.—Salient statistics of boron minerals and compounds

(Thousand short tons and thousand dollars)

	1978	1979	1980	1981	1982
United States:					
Sold or used by producers:					
Quantity:					
Gross weight[1]	1,554	1,590	1,545	1,481	1,234
Boron oxide (B_2O_3) content	778	799	783	740	607
Value	$279,927	$310,211	$366,760	$435,387	$384,597
Exports:					
Sodium borates (refined):[2]					
Quantity	304	332	325	228	227
Value[e]	$80,000	$94,000	$65,000	$58,000	$59,000
Boric acid:[3]					
Quantity	46	42	47	46	35
Value	$22,217	$22,938	$23,735	$24,602	$19,082
Imports for consumption:					
Colemanite:[4]					
Quantity	104	89	69	98	39
Value	$9,320	$10,946	$6,218	$15,202	$6,386
Boric acid:					
Quantity	16	8	10	1	4
Value	$8,921	$4,267	$6,393	$763	$1,903
Consumption: Boron oxide (B_2O_3) content[5]	413	410	384	373	266
World: Production	2,936	2,778	2,876	[p]2,820	[e]2,530

[e]Estimated. [p]Preliminary.

[1]Minerals and compounds sold or used by producers, including both actual mine production and a marketable ore equivalent of brine products.

[2]Comparable quantities of crude sodium borates are exported also; however, export data are not available.

[3]Includes orthoboric and anhydrous boric acid.

[4]Reported value includes approximately 33,100 tons of ulexite in 1978, 11,000 tons in 1979, 5,500 tons in 1980, 44,000 tons in 1981, and 35,000 tons in 1982.

[5]See table 2.

mestic consumption of boron minerals and compounds. Tables 2 and 3 present the results of this survey. In addition, both producers of refined borates supplied data for table 5.

Legislation and Government Programs.—American Borate Co. and U.S. Borax & Chemical Corp. were two of four companies that petitioned the U.S. Department of the Interior to amend the regulations governing mining activities on patented and valid unpatented mining claims within units of the National Park System. Under the new rules suggested by the companies, claim holders in designated mineral resource areas would be allowed to conduct surface operations outside the boundaries of their claims. The National Park System Protection and Resources Management Act, which would establish buffer zones to prevent development detrimental to the National Parks, was still being debated at yearend.

In 1981, U.S. Borax petitioned the Antitrust Div. of the U.S. Department of Justice to modify provisions of a 1945 Antitrust Consent Decree. In the petition, U.S. Borax sought to buy the Little Placer deposit from Kerr-McGee Chemical Corp. The Little Placer, a continuation of the Kramer deposit in Boron, Calif., was estimated to contain 2.8 million short tons of ore estimated at 800,000 tons of boria (B_2O_3). During 1982, Justice investigated the proposed sale but had not reached a decision by yearend.

The Environmental Protection Agency continued to develop new performance standards under Section III of the Clean Air Act. A draft of the new standards covered 18 mineral industries, including the borate industry.

DOMESTIC PRODUCTION

Borate production from Kern County, Calif., provided over three-quarters of the supply, and San Bernardino and Inyo Counties provided the balance. According to the three major borate producers, sales to domestic and foreign customers amounted to 607,000 tons of B_2O_3 valued at $385 million in 1982.

At Boron, in Kern County, the open pit tincal-kernite mine and adjacent refining plant of U.S. Borax, a member of the RTZ Group of London, England, continued to be the primary world supplier of sodium borates. U.S. Borax processed crude and refined hydrated sodium borates, their anhydrous derivatives, and anhydrous boric acid at the Boron refinery. A second plant at Boron produced technical-grade boric acid from a proprietary process using kernite ore. Reserves at Boron were estimated to be 140 million tons containing 38.8 million tons of B_2O_3.

U.S. Borax decreased output and sales of all primary borate products in 1982. Output of refined decahydrate, pentahydrate, and anhydrous borax for domestic and foreign customers accounted for about one-half of the company's total sales. Crude sodium borates—Rasorite 46, a pentahydrate, and its anhydrous derivative—were produced for foreign markets. Boric acid production at the Boron plant decreased 23% in 1982 compared with that of 1981.

U.S. Borax announced the construction of an electrical cogeneration facility at Boron in cooperation with Southern California Edison Co. Exhaust gas from natural gas turbines was to be used to produce approximately 50% to 60% of the company's steam needs. The natural gas turbines were planned to produce 48,000 kilowatts per hour of electricity. The $30 million plant was expected to be operational by early 1984.

Facilities at Wilmington, Los Angeles County, served as a warehouse and overseas shipping point for bulk shipments. A large percentage of U.S. Borax's exports was shipped throughout Europe by way of a warehouse and distribution facility at Botlek, near Rotterdam, Netherlands. RTZ Borax, Ltd., another member of the RTZ Group, maintained this facility. U.S. Borax operated a plant and warehousing facility at Burlington, Iowa, for compounding, packaging, and distributing household soaps and other consumer products to the Eastern and Midwestern United States.

Kerr-McGee operated the Trona and Westend plants at Searles Lake, in San Bernardino County, to produce refined sodium borate compounds and boric acid from the mineral-rich lake brines. Coproducts included potassium compounds, soda ash, and salt cake. At the Trona plant, Kerr-McGee utilized its differential evaporative process to produce boric acid, and pentahydrate and anhydrous borax. In March, production of decahydrate borax was discontinued. The plant was not able to compete economically with newer, more efficient plants. At yearend, two of the evaporative boilers used to produce pentahydrate borax were being operated to yield distilled water necessary for another process. Additional boric acid was produced from weak brines and recycled plant liquors by solvent extraction. The carbonation process at the Westend plant produced sodium borates, some of which were subsequently used to manufacture boric acid.

As a result of curtailments at the Trona plant, production of anhydrous borax decreased from 60,000 to 40,000 tons, and boric acid decreased from 47,000 to 36,000 tons. Production and sales of both plants combined decreased in 1982. Total production and sales were 23% below the 1981 levels.

American Borate, a wholly owned subsidiary of Owens-Corning Fiberglas Corp., increased sales of colemanite ($Ca_2B_6O_{11} \cdot 5H_2O$), a calcium borate, and ulexite-probertite, two similar sodium-calcium borates mined and sold as one. Completion of the Billie Mine in Death Valley National Monument early in the year brought production capacity to 25,000 tons per month. Water inflow through numerous faults in the mine was evaporated by evaporative ponds underground and on the surface. Water from the lakes was also used for dust control. Reserves have been estimated to be 3 million tons of 27% B_2O_3 and 13 million tons of 21% B_2O_3.[2]

Colemanite, destined primarily for textile-grade glass-fiber manufacture, was processed at the washing and calcining plant at Lathrop Wells, Nev. The mill had a monthly capacity of 6,300 tons of end product. A flotation plant adjacent to existing facilities at Lathrop Wells processed colemanite by a patented process. During the year, ore grinding facilities were moved from the storage and shipping facilities at Dunn, Calif., to Lathrop Wells. Ulexite-probertite ore was ground, screened, and blended to specification at storage and shipping facilities at Dunn, then transported by rail to customers. Most shipments went to manufacturers of glass-fiber insulation.

Duval Corp. continued a pilot project to recover colemanite by solution mining near Barstow, Calif. The colemanite is located 1,200 feet below the surface and contains 8% to 14% boria. Duval leased some of the land from NL Industries, Inc., which mined hectorite on adjacent property.

CONSUMPTION AND USES

U.S. consumption of borates in 1982 was 29% less than that in 1981. Insulation production and glass-fiber-reinforced plastics continued to be the most important consuming sectors.

The weak market for thermal insulation decreased demand by 44% for borates (mostly borax pentahydrate and ulexite-probertite) in the manufacture of glass-fiber insulation, the largest area of demand for borates. Cellulosic insulation was the third largest area of demand.

The second major market for borates was textile-grade glass fibers. U.S.-produced colemanite, orthoboric acid, ulexite-probertite, borax pentahydrate, and Turkish colemanite were essential raw materials for manufacturing high-tensile-strength glass-fiber composites for use in a range of products that include aircraft, automobiles, and sports equipment.

Consumption of borates (colemanite, anhydrous borax, borax decahydrate and pentahydrate, orthoboric acid, and anhydrous boric acid) in the manufacture of special borosilicate glasses has remained a major end use, although demand declined in 1982. Boron compounds in cleaning and bleaching have been an important but declining consumption sector. About one-quarter of these compounds was used to produce sodium perborate detergents. Boron compounds find application in the manufacture of biological growth control chemicals for use in water treatment, algicides, fertilizers, herbicides, and insecticides. Boron compounds were also used in metallurgical processes as fluxes, as shielding slag in the nonferrous metallurgical industry, and as components in plating baths in the electroplating industry. Small amounts of boron and ferroboron were constituents of certain nonferrous alloys and of specialty steels, respectively.

Many important but small-percentage end uses for borates and boron-containing chemical derivatives comprised a diverse miscellaneous category. Another group of borate compounds was sold to chemical distributors, and their ultimate end uses were unknown.

Table 2.—U.S. consumption of boron minerals and compounds, by end use

(Short tons of boron oxide content)[1]

End use	1981	1982
Glass-fiber insulation	103,500	57,800
Fire retardants:		
Cellulosic insulation	34,300	31,100
Other	2,800	1,900
Textile-grade glass fibers	57,500	31,600
Borosilicate glasses	44,000	30,600
Soaps and detergents	29,100	27,000
Enamels, frits, glazes	11,700	11,400
Agriculture	16,600	10,800
Metallurgy	6,800	3,400
Nuclear applications	400	700
Miscellaneous uses	25,400	21,900
Sold to distributors, end use unknown	40,500	38,000
Total[2]	372,700	266,100

[1]Includes imports of boric acid, colemanite, and ulexite.
[2]Data may not add to totals shown because of independent rounding.

Table 3.—U.S. consumption of orthoboric acid, by end use

(Short tons of boron oxide content)

End use	1981	1982
Fire retardants:		
Cellulosic insulation[1]	13,974	11,790
Other	1,284	1,218
Textile-grade glass fibers	17,154	7,379
Insulation-grade glass fibers	--	50
Borosilicate glasses	9,654	6,591
Metallurgy	1,485	696
Soaps and detergents	111	210
Enamels, frits, glazes	780	1,129
Nuclear applications	300	511
Agriculture	84	155
Miscellaneous uses	14,188	13,454
Sold to distributors, end use unknown	15,678	10,313
Total	74,692	53,496

[1]Includes imports of 629 tons in 1981.

PRICES

Prices for basic boron compounds increased between 2% and 14% during the year. The price discrepancy between 1981 and 1982 for anhydrous boric acid was due to a change in quality of the product. U.S. Borax discontinued selling technical-grade boric acid in 1982 and produced only a high-quality product.

Table 4.—Borate prices per short ton[1]

Product	Price, Dec. 31, 1982 (rounded dollars)
Borax, technical, anhydrous, 99%, bulk, carlots, works[2]	564
Borax, technical, granular, pentahydrate, 99.5%, bulk, carlots, works[2]	201
Borax, technical, granular, decahydrate, 99.5%, bulk, carlots, works[2]	175
Boric acid, technical, granular, 99.9%, bulk, carlots, works[2]	552
Boric acid, technical, granular, 99.9%, bags, carlots, works[2]	597
Boric acid, U.S. Borax & Chemical Corp., anhydrous, 96% B_2O_3, bulk, carlots, Boron, Calif	2,161
Colemanite, American Borate Co., calcined and screened, minus 70-mesh, 42% B_2O_3, bulk, carlots, Dunn, Calif	468
Colemanite, American Borate Co., flotation concentrate (uncalcined), 37% B_2O_3, bulk, carlots, Dunn, Calif	318
Colemanite, Turkish, 40%-42% B_2O_3, crude, lump, f.o.b. railcars, U.S. east coast port	400
Ulexite-probertite, American Borate Co., screened, minus 7-mesh, 21% B_2O_3, bulk, carlots, Dunn, Calif	53

[1]U.S. f.o.b. plant or port prices per short ton of product. Other conditions of final preparation, transportation, quantities, and qualities not stated are subject to negotiation and/or somewhat different price quotations.
[2]Chemical Marketing Reporter. Current Prices of Chemicals and Related Materials. V. 222, No. 26, Dec. 27, 1982, p. 25.

FOREIGN TRADE

In 1978, the U.S. Bureau of the Census discontinued publishing export statistics on refined sodium borate compounds. Export data from the Bureau of Mines canvass are presented in table 5.

U.S. imports from Turkey of commercial-grade colemanite and ulexite ($NaCaB_5O_9 \cdot 16H_2O$), principally for textile-grade and insulation-grade glass-fiber manufacture, continued in 1982. Owing to a change of reporting, 1982 colemanite imports are not comparable with those of previous years.

Table 5.—U.S. exports of boric acid and refined sodium borate compounds in 1982, by country

Country	Boric acid[1]		Refined sodium borates[2] (short tons)
	Quantity (short tons)	Value (thousands)	
Argentina	22	$25	--
Australia	2,435	1,101	7,734
Austria	--	--	417
Belgium-Luxembourg	--	--	3,608
Brazil	353	216	6,120
Canada	7,831	3,809	55,153
Chile	15	16	28
China	12	5	--
Colombia	131	94	834
Costa Rica	10	11	44
Czechoslovakia	--	--	755
Denmark	169	102	693
Ecuador	9	8	148
Egypt	246	244	--
Finland	21	13	308
France	6	451	14,660
German Democratic Republic	--	--	1,391
Germany, Federal Republic of	--	--	11,195
Greece	--	--	44
Guatemala	4	4	35
Honduras	25	8	--
Hong Kong	178	109	2,518
Hungary	--	--	805
Indonesia	143	89	2,146
Ireland	3	1	1,213
Israel	31	25	216
Italy	--	--	3,385
Ivory Coast	--	--	803
Japan	15,435	8,511	54,244
Korea, Republic of	559	376	6,628
Madagascar	--	--	150
Malawi	--	--	113
Malaysia	90	62	1,558
Mexico	3,382	1,631	19,452
Netherlands	254	174	2,546
New Guinea	323	172	132
New Zealand	754	413	4,500
Nicaragua	--	--	47
Nigeria	3	1	57
Norway	--	--	699
Pakistan	--	--	285
Philippines	604	244	1,561
Portugal	--	--	486
Puerto Rico	--	--	67
Saudi Arabia	11	4	344
Singapore	186	107	375
South Africa, Republic of	31	30	4,622
Spain	--	--	813
Sri Lanka	18	11	19
Sweden	--	--	1,933
Switzerland	--	--	266
Taiwan	1,086	596	5,720
Thailand	162	119	554
United Arab Emirates	83	30	--
United Kingdom	11	12	4,525
Uruguay	6	4	66
Venezuela	356	233	1,189
Yugoslavia	--	--	151
Other	32	24	48
Total[3]	35,030	19,082	227,404

[1]U.S. Bureau of the Census.
[2]U.S. exporters of sodium borates.
[3]Data may not add to totals shown because of independent rounding.

Table 6.—U.S. imports for consumption of boric acid, by country

Country	1981 Quantity (short tons)	1981 Value[1] (thousands)	1982 Quantity (short tons)	1982 Value[1] (thousands)
Argentina	--	--	734	$264
Canada	(2)	$1	(2)	1
France	1,123	757	52	40
Germany, Federal Republic of	(2)	4	(2)	3
Italy	--	--	470	203
Japan	(2)	1	--	--
Sweden	--	--	20	4
Turkey	--	--	3,086	1,389
United Kingdom	(2)	1	--	--
Total[3]	1,124	763	4,362	1,903

[1]U.S. Customs declared values.
[2]Less than 1/2 unit.
[3]Data may not add to totals shown because of independent rounding.

Source: U.S. Bureau of the Census.

WORLD REVIEW

Argentina.—The Tincalayú Mine in north-central Salar del Hombre Muerto, Salta Province, which was owned by Boroquímica Samicaf, was the largest borate producer in South America. Capacity in 1982 was estimated at 150,000 tons per year of borax and kernite. The ore was shipped to a processing plant at Campo Quijano, 250 miles away. At Tincalayú, the general relationship of the two minerals is similar to that of Boron, Calif. Kernite in an irregular body more than 33 feet thick in places underlies the main borax deposit. Thin layers of clay and silt reduce the boria content from the 36.5% of pure borax to as low as 20%. The average ore grade is 26% or greater. The stripping ratio was reported to be 3:1. Reserves were reported to be 2 million tons measured, 3.5 million tons demonstrated, and 5 million tons inferred.

Brazil.—Metalur brought onstream a 1,200-ton-per-year plant at São Roque in São Paulo State to produce master alloys, including aluminum-boron and aluminum-titanium-boron. The company estimated a domestic market of 600 tons per year and planned to export the surplus.[3]

Bulgaria.—A 20,000-ton-per-year sodium bicarbonate plant, which also produced borax, was reported operating at Devnia, 30 kilometers west of the Black Sea Port of Varna.

Chile.—Enormous reserves of borates occur in the Salar de Atacama, where a lithium and potash project using brine from the salar could produce borates as a byproduct. Sociedad Chilena de Litio Ltda., 55% owned by Foote Mineral Co. and 45% owned by Corporación de Fomento de la Producción, planned a $61 million plant to produce lithium carbonate. Tenders were being sought for a 31,000-ton-per-year boric acid plant.

Table 7.—Boron minerals: World production, by country[1]

(Thousand short tons)

Country	1978	1979	1980	1981[p]	1982[e]
Argentina	140	147	172	139	[2]152
Chile	[r]30	3	3	3	3
China[e]	30	30	30	30	30
Peru[e]	7	13	23	18	15
Turkey	[r]955	[r]775	883	929	[2]876
U.S.S.R.[e]	220	220	220	220	220
United States[3]	1,554	1,590	1,545	1,481	1,234
Total	[r]2,936	[r]2,778	2,876	2,820	2,530

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through Apr. 18, 1983.
[2]Reported figure.
[3]Minerals and compounds sold or used by producers, including both actual mine production and a marketable ore equivalent of brine products.

China.—The Qaidam Basin in Qinghai Province is rich in boron. The Qarham Salt Lake contains 41% of China's known reserves of boron.[4]

Indonesia.—Indu-American Industries announced that a 22,000-ton-per-year borosilicate glass plant went onstream in 1982. The plant reportedly cost $10 million.

Mexico.—U.S. Borax and Material Primas Monterrey continued a joint venture named Material Primas Magdalena to explore for borates. Numerous claims on a colemanite and howlite deposit near Magdalena have been filed, but no commercial development had been announced at yearend.

Peru.—The Government adopted measures to prevent the financial collapse of small and medium-size mines. The measures (1) excluded mining companies from payroll taxes, goods and services taxes that affect exports, and a current 9% export tax, and (2) included an increase in the Banco Mineros Mining Compensation Fund to $120 million, an increase from 20% to 50% of export value that mining companies can request from the mining fund, a 6-month freeze on requests from mining companies to lay off workers, and a 6-month extension of all wage contracts.

Boratos del Peru S.A., a privately owned Peruvian mining concern, mined ulexite at San Juan de Tarucane in Arequipa Province.

Barex, Ltd., which sought joint-venture partners in developing a ulexite deposit at Laguna Salinas, reported that The Anaconda Copper Co. decided not to pursue its interest in the deposit. Barex continued to look for investment partners.

Turkey.—Etibank continued building a plant at Kirka that was planned to be operational by 1983. The plant was designed to produce 160,000 tons per year of pentahydrate borax, 60,000 tons per year of anhydrous borax, and 17,000 tons per year of decahydrate borax. At the Bandirma boric acid plant, an additional 100,000 tons per year of boric acid was planned to be onstream by 1984. Bulk shipments of refined borate products will be exported from the port at Bandirma.

No announcement was made in 1982 concerning the future of boron mineral operations nationalized in 1978. The Government favored private sector foreign participation and investment in boron minerals, but the nationalization decree forbids such participation.

U.S.S.R.—Borates continued to be mined in the outer core of Permian salt domes in the Inder region. The domes cover an area of 250 square kilometers. Gypsum was interbedded with clay and borates at a depth of 160 feet.

In the southern area of the domes lies the Inder Salt Lake, an area of about 115 square kilometers, which contains no brine in the summer. The second and fourth horizons of the lake are boraciferous. The borate was contained as hydroboracite ($CaMgB_6O_{11} \cdot 6H_2O$), ulexite, inyoite ($Ca_2B_6O_{11} \cdot 13H_2O$), colemanite, pandermite ($Ca_4B_{10}O_{19} \cdot 7H_2O$), B-ascharite ($MgHBO_3$), and inderite ($Mg_2B_6O_{11} \cdot 15H_2O$). Two types of deposits occur, massive ores containing 25% B_2O_3 and disseminated ores of 2% to 5% B_2O_3. Reserves of high-grade ores were estimated at 400,000 tons. Rich ores have been found only in horizontal zones of gray argillaceous gypsum and fissures of secondary gypsum are filled with syngenetic hydroboracite. The width of the fissures ranges from 0.5 millimeter to 2 centimeters.

Asharite and mixed asharite-hydroboracite ores also occur. The hydroboracite is highly soluble in water upon boiling and readily dissolves in sulfuric acid at approximately room temperature (80° F). The ascharite and mixed ores are processed with sulfuric acid only, after the ore is pulverized to particles less than 2 millimeters in diameter.

TECHNOLOGY

A study by the Brookhaven National Laboratory reported minimal adverse health effects on test animals from breathing glass fibers. The results were consistent with a previous study by the Los Alamos Laboratory. Discrepancies between these later studies and earlier studies were explained by the method by which the fibers were introduced into the animals' lungs. Earlier studies used surgery to place the fibers in the lungs; later studies introduced the glass fibers through the animals' windpipe, which would be the natural way for fibers to enter the lungs.[5]

An X-ray diffractometer and an X-ray spectrometer were combined to provide three-dimensional maps of elemental and mineral distributions. The system's capabilities are advantageous for identifying and analyzing minerals in fine-grained sediments. Duval's industrial minerals group used the system for borate exploration.[6]

Oak Ridge National Laboratory developed aluminide alloys having reduced brittleness associated with the addition of microalloying agents such as boron. Boron additions of less than 1,000 parts per million improved the cohesive strength of the alloys' grain boundaries. Use of aluminides is advantageous because of their light weight and relatively high melting points.[7]

Allied Corp. continued to develop technology using Metglas, a rapidly cooled molten alloy containing carbon, boron, or silicon metalloids. Iron-nickel-molydenum-boron alloys showed high-yield strengths in laboratory tests, and titanium-boron alloys showed high strength combined with low density. Because Metglas is amorphous, it requires less energy to become magnetized and demagnetized than do conventional electrical steels.[8]

Filtration of boron in waste was investigated in the Southeastern United States. The waste water contained between 0.4 and 0.6 milligram per liter of boron. Test results showed that boron as borate anion is not retained by a soil-turf filter.[9]

Sodium borohydride (SBH) demonstrated advantages as a blowing agent for injection-molded high-impact polystyrene structural foams. SBH produced 10 to 20 times more gas than equal weight of a commercial nitrogen blowing agent; did not leave any toxic or staining residue; and produced only one byproduct, which was odorless and nontoxic. Gas evolution was independent of processing temperatures.[10]

Trace quantities of boron in coal ash were of special concern because of their environmental effects. Boron concentrations exceeding 2 milligrams per liter can cause plant toxication. Boron concentration in coal ranged between 5 and 200 milligrams per kilogram, of which 71% could become airborne upon combustion.[11]

Movement through the ground of calcined oxides of fission products and actinide elements (uranium, neptunium, plutonium, americium, and curium) incorporated in a borosilicate glass matrix and cast in stainless steel canisters were investigated.[12] The project was funded by the University of California and the U.S. Department of Energy.

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Bromine

By Phyllis A. Lyday[1]

Domestic production of bromine sold or used during 1982 was estimated at 401 million pounds valued at $103 million. The largest single use for bromine was in the manufacture of ethylene dibromide (EDB), much of which was used as a scavenger for lead in gasoline. During the year, the Environmental Protection Agency (EPA) set new regulations for lowering permissible levels of lead in gasoline, which adversely affected demand for EDB.

Domestic Data Coverage.—Domestic production data for bromine are developed by the Bureau of Mines from a voluntary domestic survey of U.S. operations. Of the nine operations to which a survey request was sent, 22% responded, representing an estimated 25% of the total production data shown in table 1. Production for the remaining seven nonrespondents was estimated based on 9 months of production data.

Table 1.—Salient bromine and bromine compound statistics

(Thousand pounds and thousand dollars)

	1978	1979	1980	1981	1982
United States:					
Bromine sold:[1]					
Quantity	r53,168	67,600	r52,192	r60,790	(2)
Value	$11,300	$15,100	$12,500	$11,000	(2)
Bromine used:					
Quantity	r393,375	429,700	325,978	r316,307	(2)
Value	$88,700	$98,200	$83,100	$75,100	(2)
Exports:[3]					
Elemental bromine:					
Quantity	6,400	10,100	8,100	W	NA
Value	$1,300	$2,100	$1,700	W	NA
Bromine compounds:					
Gross weight	106,000	92,800	85,400	r67,500	455,600
Contained bromine	87,900	77,600	70,400	r56,000	447,200
Value	$38,500	$35,500	$35,900	r$33,100	4$21,100
Imports:[5]					
Elemental bromine:					
Quantity	669	34	1	(6)	(6)
Value	$102	$5	$5	(6)	(6)
Ethylene dibromide:					
Quantity	589	193	861	644	--
Value	$102	$33	$165	$139	--
Potassium bromide:					
Quantity	119	794	667	107	281
Value	$84	$536	$457	$80	$204
Sodium bromide:					
Quantity	320	2,190	310	20	645
Value	$175	$1,056	$201	$12	$423
World: Production	r796,060	888,785	756,073	p753,494	e837,790

eEstimated. pPreliminary. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data.

[1]Elemental bromine sold as such to nonproducers, including exports, or used in the preparation of bromine compounds by primary U.S. producers.

[2]Bromine preliminary production estimated at 401.1 million pounds, valued at $102.6 million.

[3]Exports reported to the Bureau of Mines by primary producers.

[4]U.S. Bureau of the Census. Includes methyl bromine and ethylene dibromide. During 1981 and 1982, 165,000 and 390,000 pounds of potassium bromate were reported, respectively.

[5]U.S. Bureau of the Census.

[6]Negligible amount.

Legislation and Government Programs.—EPA adopted new regulations for lead levels in gasoline effective November 1. The quantity of lead from large refineries was limited to 1.10 grams per gallon. Small refineries will be allowed to sell gasoline with 2.50 grams of lead per gallon. The new definition of a small refinery was expected to decrease the number of firms in that category from 159 to 74. EPA predicted 1990 airborne lead levels to be reduced by 34% more under the new regulation than under the previous regulation. The domestic market for tetraethyl lead and tetramethyl lead in gasoline was expected to decrease from 316 million pounds in 1982 to 77 million pounds in 1990,[2] therefore seriously weakening the high volume market for bromine products. The bromine-to-lead ratio used in the United States averages 0.386, or 1 pound of bromine for approximately every 2.59 pounds of lead.[3]

At yearend, EPA listed as top priority for cleanup 418 hazardous waste sites of the more than 14,000 sites in the United States. Top priority listing of a site means that the waste problems become eligible for remedial action under provisions of the Resource Conservation and Recovery Act of 1976. Bromine is 1 of 42 substances whose producers are taxed to provide funds to clean up hazardous waste sites. Brominated compounds were identified in waste sites in Ohio and Michigan, but it was not known how many other sites contain bromine or bromine compounds.[4]

EPA reclassified Michigan and Arkansas disposal wells for spent brine after halogen extraction as Class 5 wells. The Oil and Gas Commission in Arkansas has responsibility for regulation of the wells. In Michigan, the State Geological Survey regulates the wells as Class 3 or solution mining wells under State law, Act 315.

In April, the Federal district court of Bay City, Mich., ruled that an EPA aerial surveillance of The Dow Chemical Co.'s Midland plant was an unreasonable search and seizure, and therefore a violation of Dow's fourth amendment rights. EPA ordered the flyover in 1977 after Dow refused to allow agency officials to inspect and photograph the plant.[5]

EPA reported that industrial and other surface impoundments for noxious materials may pose a much greater threat to the Nation's supplies of ground water for drinking than previously supposed. Over 180,000 surface impoundments were studied and 90% of these were potential contaminators of drinking water.[6]

Dibromochloropropane (DBCP), EDB, dibromochloromethane, and bromoform are 4 of 33 common synthetic organic chemicals that contaminate ground water frequently and pose a risk to human health. Only DBCP and EDB have been proved animal carcinogens by the National Cancer Institute. Chlorinated surface water usually contains trihalomethanes, including bromoform, bromodichloromethane, and dibromochloromethane, that form when the chlorine reacts with naturally occurring organic compounds.[7]

EPA proposed exempting nearly one-half of the new chemicals developed each year from the premanufacturing review process because the agency considered them to be "low risk." The proposed exemption categories were chemicals produced in volumes of 22,000 pounds per year or less, polymers the agency considers not likely to be absorbed into living tissue, and chemical intermediates used to produce other chemicals.[8] Many bromine specialty products fall into one or more of the proposed exemption categories.

In September 1981, the Occupational Safety and Health Administration proposed new EDB standards of 15 parts per billion from the prevailing standard of 20 parts per million. A less rigorous standard of 130 parts per billion was adopted. Decisions on EDB are difficult to make since the compound offers high risk and high benefits. EDB is a fruit and vegetable fumigant, but tests indicate it is a carcinogen and mutagen and causes reproductive problems.

About 10% of the EDB manufactured is used in pesticides. EDB is regulated under the Federal Insecticide, Fungicide, and Rodenticide Act. Under the law, the benefits of continued use must be weighed against the potential hazards.[9] The use of EDB in California as a citrus fumigant for the Mediterranean fruit fly (medfly) raised economic and political questions and prompted interstate and international trade problems. Proposals to ban EDB in 1983 were expected to face difficulty because no alternatives or substitutes are available.

In November, an occurrence of the khapra beetle in New York City caused concern. The beetle is potentially more dangerous than the medfly because it eats more than just citrus fruits and flourishes in a wider variety of climates. The beetle can live without food for as long as 3 years and can retreat to the larvae stage. Methyl bromide was used to eradicate the pest.

The Consumer Product Safety Commission agreed to the Upholstered Furniture Action Council's proposed program for testing and research to develop voluntary industry standards for fire safety. Stricter Federal fire safety standards for construction and furniture materials could increase the market for many types of brominated flame retardants.[10] California has already passed tougher flammability standards on furniture upholstered with flexible urethane foam.

A study, which was part of a State program to monitor the health of the general population for a 10-year period, revealed that polybrominated biphenyls (PBB) appeared in 97% of a representative cross section of the Michigan population. The residents were exposed to PBB contamination in the summer of 1973 when an estimated 1,000 pounds of PBB was accidentally substituted for a livestock feed additive. The PBB was produced by Velsicol Chemical Corp. and used as a flame retardant. The long-term health effects of the contamination are not known.[11] In December, Velsicol agreed to pay $38.5 million to county, State, and Federal agencies to cover the cost of cleaning up the accident.[12]

In March, the U.S. Trade Representative denied Israel lower duty under the Generalized System of Preference for TBBA. For further details see the Bromine chapter of the 1981 Minerals Yearbook.

DOMESTIC PRODUCTION

Domestic production of elemental bromine during 1982 increased approximately 6% over that of 1981. Five companies operated nine plants in two States. An increase in bromine production in the leading State of Arkansas was attributed to rising demand for bromine in flame retardants and well-drilling fluids. Michigan experienced a decrease in production of bromine. The major bromine producer in Michigan produced bromine as a byproduct of salt, iodine, and magnesium, all of which experienced decreased demand during 1982.

During the year, Dow sold $700 million in assets. Dow planned to freeze expansion of basic chemical production and increase its market share in specialty chemicals.

Dowell Schlumberger Corp., the largest user of brominated well-drilling fluids, continued actively in the drilling and completion of oil and gas wells. Dowell Schlumberger is a joint venture with Schlumberger Ltd. and the Dowell Div. of Dow. During 1982, Dow converted the Dowell Div. in the United States and Canada to a wholly owned subsidiary. The division generated approximately 8% of Dow's worldwide sales in 1981. The Dowell Div. expanded its range of products and services by acquiring Anadarko Mud Service, Inc. The acquisition represented Dowell Div.'s first move into this particular sector of the oil and gas well-drilling business.

Dow announced plans to resume the construction of a calcium bromide solution plant in Magnolia, Ark. Construction began in 1979 but was halted as demand for oil and gas declined. The facility was to begin production in early 1985, with an annual capacity of 120 million pounds of solution. Calcium bromide is used by the oil and gas industry as a clear high-density, solids-free completion, packer, and workover fluid. Calcium bromide-based brines were first marketed in 1972 as clear completion fluids for use in high-pressure undersea formations in the Gulf of Mexico.[13] Dow's decision to increase capacity was based on improving market prospects, especially in onshore applications.

Ethyl Corp. announced plans to build two bromine compound plants at Magnolia, Ark. The plants were to use bromine feedstock from existing production capacity. Ethyl planned to increase its calcium bromide capacity by 40% in 1983 in a plant that will also produce sodium bromide. Construction of a 15-million-pound-per-year TBBA and 8-million-pound-per-year methyl bromide plant was also announced. The TBBA will be marketed as a flame retardant for epoxy resins under the trade name Saytex RB-100.

Ethyl was one of four producers of leaded antiknock additives for gasoline. The 1982 EPA regulations on lead were expected to decrease demand for bromine as a scavenger for lead. Ethyl planned to expand other bromine specialty markets to stabilize its bromine production.

Great Lakes Chemical Corp. paid $13.6 million for shares of stock in Oilfield Services of America, a Houston-based marketer of bromine-based, clear well-completion fluids. The clear fluids fill the well bore to minimize damage to the formation.

In September, Great Lakes announced construction of a $3 million addition to its research facility at West Lafayette, Ind. It will provide space for about 70 people when fully occupied.

Great Lakes began construction on a Halon 1301 and 1211 plant in El Dorado, Ark. Halon 1211 is used in portable fire extinguishers and Halon 1301 is a fire extinguishing agent in automatic systems. The technology was acquired from Onoda Cement Co., Ltd., and Japan Halon. Great Lakes had signed a contract with Péchiney Ugine Kuhlmann of France to market Halon in the United States during 1976, but the contract was terminated when foreign exchange rates shifted to reduce the profit margin. Great Lakes reentered the Halon market in 1981 by selling materials toll produced under an agreement with E. I. du Pont de Nemours & Co., the sole domestic manufacturer. The plant, which will produce several thousand tons of Halon per year, was scheduled for completion in 1983. It will provide 20 additional jobs.

Other significant events during 1982 for Great Lakes included record sales of the pyrethroid intermediate MPBZ in Europe and expanded production of the brominated flame retardant PHT-4 "Diol" used in rigid urethane foams.

The Federal Trade Commission continued to investigate Great Lakes' 1981 acquisition of Velsicol. Although, at yearend, a trial date was tentatively set for June, Great Lakes believed that an out-of-court compromise to license the 140 patents gained in the acquisition would settle the investigation.[14]

Proctor & Gamble Co. bought the pharmaceutical division of Morton-Norwich Products Inc. for $371 million in cash. Rhône-Poulenc, Inc., filed a lawsuit claiming the proposed sale breached a 1978 agreement with Morton in which Rhône bought 20.3% of Morton's stock and in return Morton marketed Rhône's pharmaceuticals in the United States. Morton filed a countersuit to prevent Rhône from selling its stock on the open market without gaining Morton's approval. By yearend, Morton had agreed to repurchase 2,755,000 shares of its stock from Rhône for $135 million.

PPG Industries, Inc. (PPG), planned to close its antiknock fluids production unit at Beaumont, Tex., in early 1983 and withdraw from the business. PPG was one of four domestic producers of lead additives for gasoline. The decision was based on declining sales of lead for use in gasoline antiknocks, as mandated by EPA.

Table 2.—Bromine-producing plants in the United States in 1982

State and company	County	Plant	Production source	Elemental bromine capacity[1] (million pounds)
Arkansas:				
Arkansas Chemicals, Inc	Union	El Dorado	Well brines	50
The Dow Chemical Co	Columbia	Magnolia	do	110
Ethyl Corp	do	do	do	160
Great Lakes Chemical Corp	Union	El Dorado	do	105
Do	do	Marysville	do	80
Do	do	El Dorado	do	50
Michigan:				
The Dow Chemical Co	Mason	Ludington	do	20
Do	Midland	Midland	do	85
Morton Chemical Co	Manistee	Manistee	do	[2]5

[1]Chemical Marketing Reporter. Chemical Profile. V. 221, No. 17, Apr. 26, 1982, p. 58.
[2]Chemical Marketing Reporter. Chemical Profile. V. 203, No. 20, May 14, 1973, p. 9.

CONSUMPTION AND USES

Derived demand for EDB increased during 1982 as a consequence of the lower prices and increased availability of gasoline, which prompted increased travel. The EPA regulation on lead in gasoline, effective in November, was expected to decrease demand for EDB in 1983.

Oilfield chemicals experienced an outstanding year in 1982. A total of 84,693 wells were completed, an alltime calendar year high for the Nation. The 1982 figure represented a 7.4% increase over that of the previous year and comprised all drilled oil and gas wells for which final status was determined. The completion rate did not represent the decline in drilling activity throughout most of 1982.[15]

Several new brominated chemicals were introduced during 1982. Crado Synthetic Chemicals Co. introduced 2-bromo thiophen as an intermediate and agrichemical. Peboc Co. introduced 3-bromo, 4-hydroxy, 5-methoxy benzaldehyde as a pharmaceutical intermediate.

Flame retardant demand increased significantly during 1982. Great Lakes, Dow, and Ethyl produced TBBA for use in printed circuit boards. Ethyl and Great Lakes produced decabromodiphenyl oxide, primarily used in high-impact polystyrene television set bodies. Great Lakes produced octabromodiphenyl oxide for use in acrylonitrile-butadiene-styrene (ABS). In 1981, an estimated 50 million pounds of brominated hydrocarbons accounted for 360 million pounds of flame retardants consumed: 9.5 million pounds was used in ABS, 18.5 million pounds in epoxy, 18.5 million pounds in polystyrene, and 3.5 million pounds in other materials.[16]

PRICES

During 1982, Dow raised prices to cover the rapidly increasing costs of bromine manufacture and future capital requirements associated with drilling new brine wells. Great Lakes and Ethyl also increased prices during the year. The prices of selected compounds are shown in table 3.

Table 3.—Yearend prices for elemental bromine and selected compounds

Product	Value per pound (cents)
Bromine, purified:	
Carlots, truckloads, delivered	75
Drums, carlots, truckloads, delivered east of the Rocky Mountains[1]	87
Bulk tank car, tank trucks (45,000-pound minimum), delivered east of the Rocky Mountains[1]	31- 32.5
Ammonium bromide, national formulary (N.F.), granular, drums, carlots, truckloads, freight equalized	106
Bromochloromethane, drums, carlots, f.o.b. Midland	107
Bromoform, pharmaceutical-grade, 5-gallon drums, f.o.b. works	270
Calcium bromide, bulk, 14.2 pounds per gallon at 60° F, f.o.b. works[2]	22- 32.5
Ethyl bromide, technical, 98%, drums, carlots, freight allowed, East	72
Ethylene dibromide, drums, carlots, freight equalized	38- 46
Hydrobromic acid, 48%, drums, carlots, truckloads, f.o.b. works	39- 41
Hydrogen bromide, anhydrous, cylinders, 130 pounds, f.o.b. works	700
Methyl bromide, distilled, tanks, 140,000-pound minimum, freight allowed	57
Potassium bromate, granular, powdered, 200-pound drums, carlots, f.o.b. works	106
Potassium bromide, N.F. granular, drums, carlots, f.o.b. works	107
Sodium bromide, 99% granular, 400-pound drums, freight, f.o.b. works	99

[1]Delivered prices for drums and bulk shipped west of the Rockies, 1 to 2.5 cents per pound higher. Bulk truck prices 1 cent per pound higher for 30,000-pound minimum and 4 to 5.5 cents per pound higher for 15,000-pound minimum. Price f.o.b. Midland and Ludington, Mich., freight equalized, 1 cent per pound lower.

[2]Reported to the Bureau of Mines by primary producers.

Source: Chemical Marketing Reporter. Current Prices of Chemicals and Related Materials. V. 222, No. 26, Dec. 27, 1982, pp. 24-32.

FOREIGN TRADE

In 1982, approximately 67% of U.S. imports reported in four bromine categories by the U.S. Bureau of the Census were from Israel. The United States imported additional bromine and bromine compounds from France, 28%; the United Kingdom, 3%; and other countries, 2%. Imports reported by the Bureau of the Census included small amounts of high-purity elemental bromine from Sweden, 61%; Japan, 33%; and the Federal Republic of Germany, 6%. Imports of potassium bromate were from Israel, 48%; the United Kingdom, 48%; and the Federal Republic of Germany, 4%. Imports of potassium bromide were from Israel, 54%; France, 31%; the United Kingdom, 13%; and other countries, 2%.

Because U.S. imports of bromine compounds are classified into multiproduct categories, some compounds are not easily identified through census data. Bromine compounds reported by the Chemical Marketing Reporter as entering the Port of New York City during 1982 totaled approximately 3.7 million pounds gross weight. The bromine content was calculated to be 2.6 million pounds. Industry sources estimated that the total bromine content of imported compounds could range from 7 to 8 million pounds.

Exports of EDB reported by the Bureau of the Census included 47,241,078 pounds valued at $14,985,632. These exports were shipped to Canada, 30%; Greece, 30%; the United Kingdom, 16%; the Republic of South Africa, 8%; and other countries, 16%. Exports of methyl bromide totaled 8,329,549 pounds valued at $6,113,428. These exports went to Brazil, 20%; Japan, 10%; the Republic of South Africa, 9%; and other countries, 61%.

WORLD REVIEW

France.—Restructuring of the nationalized chemical industry occurred in October. Rhône, the largest chemical company in France and the eighth largest in Europe, was one of three companies nationalized. Rhône is the U.S. selling agent for and major shareholder of Potasse et Produits Chimiques (PPC), which is Europe's largest producer of inorganic and organic bromine compounds. During 1982, PPC manufactured bromine products, some of which were exported to the United States, from Israeli-produced bromine. Rhône planned to step up activities in the United States, where Rhône seeks a joint-venture partner. Produits Chimie Ugine Kuhlmann (PCUK) announced plans to increase production of Halon 1301, a brominated gaseous fire-extinguishing agent. Production capacity of the Rhône plant at Pierre-Benet was to increase from 6.6 to 9.9 million pounds per year by 1983. At yearend, Société Nationale Elf Aquitaine gained control of PCUK and the whole range of halogens, including bromine. During 1982, PCUK sold approximately 30% of its Halon products in the United States under the trade name Pyrofo-rane.

Rhône's Bronate herbicide has been marketed since 1968, but was doing poorly until 1979, when the company decided to reposition it as a high-yield product. Bronate can be applied to wheat or barley at an earlier stage of growth than 2, 4-D, and thus save more of the harvest.

During 1982, Rhône sold to Morton its 20.3% share of Morton for $135 million, which was under a purchase agreement with Proctor & Gamble. (See Domestic Production section.)

Germany, Federal Republic of.—Germany reduced the lead content of gasoline to 1.51 grams per gallon in 1972, and 0.57 gram per gallon in 1976.

Hungary.—During 1980, imports of bromine were 1.2 million pounds from the German Democratic Republic, 52%; Israel, 32%; and the U.S.S.R., 16%.

Israel.—Sales of bromine in 1982 reached $60 million, $52 million of which were exported. Production reached 154 million pounds per year of bromine and 121 million pounds of compounds. The closer proximity of Israel to major foreign markets gave Israeli producers advantages in transportation costs compared with U.S. exporters. Construction of chemical tank facilities was under way in Haifa. A total of 102 tanks with capacities ranging from 130 to 34,000 cubic yards were under construction.

Jordan.—In September, Arab Potash Co. started a 1.4-billion-pound-per-year potash unit at Ghor-Al-Safi, just across the Dead Sea from the Israeli potash plant. Arab was considering doubling the capacity to 2.9 billion pounds by 1984. Jacobs Engineering Group Inc. of Pasadena, Calif., was responsible for the engineering, design, procurement, and overall construction management of the project, including feasibility studies for an associated bromine plant. Great Lakes had originally planned a 25% share in a proposed plant to produce 66 million pounds per year of bromine from the potash waste bitterns, but the plans were postponed.

Mexico.—Mexico's state oil company, Petróleos Mexicanos, was producing more unleaded gasoline to reduce lead contamination in Mexico. Under the new program, lead content will be reduced from 2.63 to 0.16 gram per gallon in regular gasoline. The decreased demand for lead will reduce demand for bromine as a scavenger.

U.S.S.R.—The capacity of the Nebit-Dag iodine and bromine plant was to be expanded in the current 5-year plan. Production was reported to have increased 13% during 1982. After the expansion, the plant will be the largest in the U.S.S.R. The Government Institute of Chemistry was studying ways to extract other valuable chemical elements from the brines.

The figure reported in table 5 may be

closer to the quantity consumed rather than produced. The U.S.S.R. is believed to import most of its consumption. Industry sources believe bromine capacity in the U.S.S.R. is about 30 million pounds.

Experiments on the toxicometry of Halon 1301 (Khalon 13B in Soviet text) studied the inhalation effect of white mice and rats exposed to Halon in a normal oxygen atmosphere. A significant feature of Halon is that people can live in the halogenated hydrocarbon atmosphere required to extinguish a fire.

United Kingdom.—The United Kingdom was considering a proposal to reduce the lead content in gasoline from 1.51 to 0.57 gram per liter. The country's only bromine producer, Associated Octel Co. Ltd., which supplies about 70% of world requirements for gasoline additives, excluding those of North America, would be adversely affected by the proposed regulation.

Table 4.—World bromine plant capacities and sources

Country and company	Location	Capacity (million pounds)	Source
Australia:			
NA	Adelaide	NA	Seawater.
China:			
NA	Iksaydam	NA	Underground brines.
France:			
Société Octel-Kuhlmann	Port-de Bouc	30	Seawater.
Mines de Potasse d'Alsace S.A	Mulhouse	19	Bitterns of mined potash production.
Germany, Federal Republic of:			
Kali und Salz AG:			
Wintershall Mine	Herfa	9	Do.
Siegfried-Giesen Mines	Hannover		
India:			
Hindustan Salts Ltd	Jaipur		
Tata Chemicals	Mithapur	1.6	Seawater bitterns from salt production.
Mettur Chemicals	Mettur Dam		
Israel:			
Dead Sea Bromine Ltd	Beersheba	154	Bitterns of potash production from surface brines.
Italy:			
Societa Azionaria Industrial Bromo Italiano	Margherita di Savoia.	2	Seawater bitterns from salt production.
Japan:			
Asahi Glass Co., Ltd., Inc	Kitakyushu	9	Seawater bitterns.
Toyo Soda Manufacturing Co., Ltd	Nanyo	26	Do.
Spain:			
Derivados del Etilo, S.A	Villaricos	2	Seawater.
U.S.S.R.:			
NA	NA	150	Underground brines.
United Kingdom:			
Associated Octel Co. Ltd	Amlwch	66	Do.

NA Not available.

Table 5.—Bromine: World production, by country[1]

(Thousand pounds)

Country[2]	1978	1979	1980	1981[p]	1982[e]
France	35,714	41,888	36,332	[e]36,000	35,000
Germany, Federal Republic of	8,583	8,862	[e]8,800	[e]8,800	8,800
India	1,014	660	736	[e]770	770
Israel	76,170	101,000	97,133	97,047	154,000
Italy[e]	1,300	1,300	1,300	1,280	1,320
Japan[e]	26,500	26,500	26,500	26,500	26,500
Spain[e]	900	900	900	900	800
U.S.S.R.[e]	144,000	146,000	148,000	150,000	150,000
United Kingdom	55,336	64,375	58,202	[e]55,100	59,500
United States[3]	[r]446,543	497,300	378,170	377,097	[4]401,100
Total	[r]796,060	888,785	756,073	753,494	837,790

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through Apr. 1, 1983.
[2]In addition to the countries listed, several other nations produce bromine, but output data are not reported and available general information is inadequate for formulation of reliable estimates of output levels.
[3]Sold or used by producers.
[4]Preliminary production estimate.

TECHNOLOGY

Johnson Controls Inc. and Exxon Research & Engineering have agreed to develop a zinc-bromine battery. The battery is capable of powering an electric vehicle and storing electricity during times of low demand to use during times of high demand. The agreement was a result of 10 years of research by Exxon. The Department of Energy at Sandia National Laboratory has helped financially with the battery research. The battery features circulating electrolyte, bromine complexing agents, conductive carbon plastic electrodes, and a bipolar electrode stack using shunt current protection.[17]

Merck Chemical Div. of Calgon Corp., a subsidiary of Merck & Co., announced a new all-purpose biocide. The compound is a halogenated nitrile derivative, 1, 2-dibromo-2, 4-dicyanobutane, that is recognized for its killing power and long-lasting effectiveness. It has potential to replace mercurial biocides, which EPA determined to be toxic. Use of mercurial biocides has been curtailed since 1976. The new biocide, trade name Tektamer 38, will be used in paints, emulsions, pigments, adhesives, metalworking fluids, cosmetics, paper, inks, waxes, and household products.[18]

Researchers in greater Bombay, India, investigated the bromine-to-lead ratios in particulate matter suspended in air. The Br:Pb ratio ranged from 0.12 to 0.45, with an average of 0.25 + 0.08, compared with 0.39 in antiknock fuel additives. A positive correlation was obtained between lead concentrations and vehicular traffic density.[19]

Vapor pressure affects the capability of an environmental contaminant or pesticide to partition into the atmosphere. To predict environmental behavior of existing chemicals, a knowledge of their vapor pressures is essential. Vapor pressure data were given for 72 compounds, including 1, 2-dibromomethane, bromoform, bromobenzene, 2-bromoethylbenzine, and 1, 4-bromochlorobenzene.[20]

Recent findings with the insecticide profenofos—ortho-(4-bromo-2-chlorophenyl) ortho-ethyl s-propyl phosphorothiolate—have prompted renewed interest in possible bioactivation of phosphorothiolates. One chemical form is more toxic to mice and insects than the other form. Peracid oxidation converts profenofos into a strong phosphorylating agent.[21]

The Dual Spectrum sensing and suppression system, which uses Halon fire suppressant, has been evaluated in New York Transit Authority tollbooths. The sensor detects and suppresses a fire bomb explosion in one-tenth of a second.[22]

Studies were conducted on the safety of bromotrifluoromethane ($CBrF_3$) when used as a fire extinguisher in aircraft, spacecraft, and submarines, where crewmen might be exposed to low concentrations of the chemical for periods up to 7 days.[23]

Vanton Pump Co. designed a vertical centrifugal pump that prevented leakage of corrosive fumes and was extremely reliable. The corrosion resistance of the PVDF Sump-Gard sump pump makes it suitable for use with chemicals such as bromine.[24]

The Bureau of Mines reported on a solution to test formation enthalpies of chalcocite and covellite samples. The samples were oxidized with bromine in a moderately acidic, aqueous solution.[25]

Other areas of research include a synthetic route to produce morphine and codeine using 1-bromonor-dihydrothebainone as an intermediate.[26] Low levels of deoxyribonucleic acid (DNA) replication have been detected by monoclonal antibodies specific for 5-bromodeoxyuridine.[27] The effects of fermentation time and bromate level showed fermentation requirements were substantially reduced for each bromate level added.[28] Ammonium bromide was used to study nitrate movement into tile lines.[29] An oscillating bromate-based reaction agreed quantitatively with certain theoretical predictions. This is the best understood chemical oscillator. The system consists of bromate and bromide ions and a catalyst.[30] Animal research was conducted on a brominated compound that cleared genital herpes infections and prevented transmission of the disease.[31]

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Cadmium

By Patricia A. Plunkert[1]

Domestic production of cadmium metal decreased in 1982, but shipments by domestic producers increased, thereby lowering the level of inventories held at yearend. However, despite the increase in domestic shipments, apparent consumption was lower in 1982 than in 1981. Four companies operating five plants produced all of the domestic cadmium during 1982. Foreign trade decreased in 1982 with both import and export levels being lower than those in 1981. The producer price of cadmium, at $1.40 per pound at the beginning of the year, declined to $1 by yearend.

Domestic Data Coverage.—Domestic metal production data for cadmium are developed by the Bureau of Mines from a voluntary survey of U.S. operations. Of the five metal-producing plants to which a survey request was sent, all responded, representing 100% of the total cadmium metal production shown in tables 1 and 5.

Table 1.—Salient cadmium statistics

	1978	1979	1980	1981	1982
United States:					
Production[1] metric tons	1,653	1,823	1,578	1,603	1,007
Shipments by producers[2] do	1,957	2,468	1,271	1,382	1,832
Value thousands	$5,906	$9,498	$5,219	$3,838	$2,628
Exports metric tons	326	211	236	239	11
Imports for consumption, metal do	2,881	2,572	2,617	3,090	2,305
Apparent consumption do	4,510	5,099	3,534	[r]4,378	3,707
Price: Average per pound[3]	$2.45	$2.76	$2.84	$1.93	$1.11
World: Production metric tons	[r]17,310	[r]18,654	17,953	[p]17,242	[e]16,140

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Primary and secondary cadmium metal. Includes equivalent metal content of cadmium sponge used directly in production of compounds.
[2]Includes metal consumed at producer plants.
[3]Average quoted price for cadmium sticks and balls in lots of 1 to 5 tons.

Legislation and Government Programs.—On December 3, 1982, the Environmental Protection Agency (EPA) issued final regulations under the Clean Water Act covering the effluents from the mining of ores. The regulation requires the use of best available technology to handle the disposal of waste waters. Cadmium is one of five metals for which the EPA has issued specific effluent limitations. The cadmium limitations are 0.1 milligram per liter maximum for any 1 day and 0.05 milligram per liter average of daily values for 30 consecutive days.[2]

EPA also proposed new regulations to limit effluent discharges from plants engaged in battery manufacturing. The purpose of the proposed regulations is to provide effluent guidelines based on best practical technology and best available technology and to develop new source performance and pretreatment standards. Cadmium is one of seven metals for which the EPA has proposed effluent limitations. After considering comments received in response to this proposal, EPA will promulgate a final rule.[3]

The strategic stockpile goal remained at 5,307 metric tons. No inventory acquisition or sales were made during the year, and as of December 31, 1982, the stockpile inventory was 2,871 tons.

DOMESTIC PRODUCTION

Domestic production of cadmium metal decreased significantly in 1982 owing to a decrease in demand. However, the production of cadmium compounds other than cadmium sulfide, which includes both electroplating salts and cadmium oxide, increased compared with 1981 levels. The production of cadmium sulfide, including cadmium sulfoselenide and lithopone, continued to decline in 1982 to a level that was less than one-half that produced in 1980.

Table 2.—Primary cadmium producers in the United States in 1982

Company	Plant location
AMAX Lead & Zinc, Inc	Sauget, Ill.
ASARCO Incorporated	Corpus Christi, Tex., and Denver, Colo.
Jersey Minière Zinc Co	Clarksville, Tenn.
National Zinc Co	Bartlesville, Okla.

Table 3.—U.S. production of cadmium compounds other than cadmium sulfide[1]

(Metric tons)

Year	Quantity (cadmium content)
1978	708
1979	912
1980	826
1981	885
1982	971

[1]Includes plating salts and oxide.

Table 4.—Cadmium sulfide[1] produced in the United States

(Metric tons)

Year	Quantity (cadmium content)
1978	698
1979	813
1980	801
1981	527
1982	374

[1]Includes cadmium lithopone and cadmium sulfoselenide.

CONSUMPTION AND USES

Apparent consumption of cadmium decreased significantly from that of 1981 because of the continued slowdown in the economy. Cadmium continued to be used in the following categories: coating and plating, batteries, pigments, plastics and synthetic products, and alloys. The largest users of products from these categories were the transportation and defense industries.

Table 5.—Supply and apparent consumption of cadmium

(Metric tons)

	1980	1981	1982
Stocks, Jan. 1	1,343	1,768	1,844
Production	1,578	1,603	1,007
Imports, metal	2,617	3,090	2,305
Total supply	5,538	6,461	5,156
Exports	236	239	11
Stocks, Dec. 31	1,768	r1,844	1,438
Apparent consumption[1]	3,534	r4,378	3,707

rRevised.
[1]Total supply minus exports and yearend stocks.

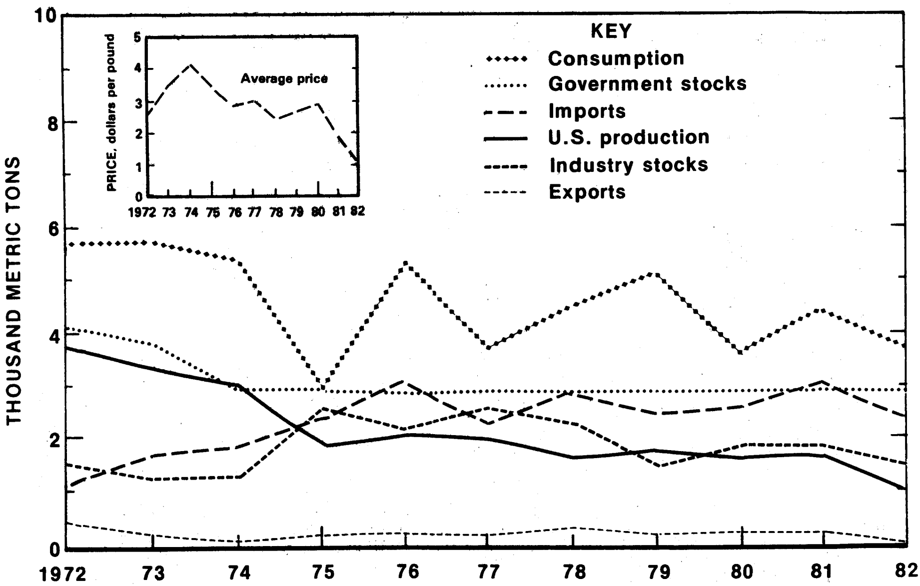

Figure 1.—Trends in production, consumption, yearend stocks, exports, imports, and average price of cadmium metal in the United States.

STOCKS

Inventories of cadmium metal held by metal producers decreased each quarter during the year, while metal held by cadmium compound manufacturers increased during 1982. The quantity of both cadmium metal and cadmium in compounds held by merchants and distributors of these products decreased during 1982. On an annual basis, total stocks of cadmium decreased significantly in 1982 from those of yearend 1981.

Table 6.—Industry stocks, December 31

(Metric tons)

	1981		1982	
	Cadmium metal	Cadmium in compounds	Cadmium metal	Cadmium in compounds
Metal producers	1,077	W	635	W
Compound manufacturers	[r]68	[r]476	167	480
Distributors	[r]215	8	150	6
Total	[r]1,360	[r]484	952	486

[r]Revised. W Withheld to avoid disclosing company proprietary data; included with "Compound manufacturers."

PRICES

At the beginning of 1982, AMAX Lead & Zinc, Inc., was the only domestic producer with a published price for cadmium metal. However, on March 19, 1982, the National Zinc Co., which had abandoned publishing prices on January 20, 1981, after several other producers had suspended list prices, published a price of $1.10 per pound for cadmium metal. AMAX then lowered its price for cadmium metal from $1.40 per pound to $1.20 per pound. In late May, AMAX lowered its price to $1.10 per pound. By the end of June, both AMAX and National Zinc had lowered their prices to $1 per pound. Published producer prices remained at this level through the end of the year.

Dealer prices in January were listed at $1.25 to $1.35 per pound for cadmium metal. They fell steadily throughout the year with an occasional narrowing of the price range. During May, the price of cadmium metal dropped below $1 per pound for the first time since 1946. By yearend, the dealer price had declined to $0.65 to $0.70 per pound, the lowest cadmium price level since 1939.

FOREIGN TRADE

Exports of cadmium metal and cadmium in alloys, dross, flue dust, residues, and scrap decreased drastically to just a fraction of that exported in 1981 owing to the depressed state of the cadmium market worldwide. Principal recipient countries during 1982 were Canada, Portugal, and Italy.

Cadmium metal imports also decreased significantly in 1982, ending a 3-year trend of increasing metal imports. The principal supplying countries in 1982 were Australia, Canada, Peru, and the Federal Republic of Germany.

Imports of metal and flue dust from most favored nations (MFN) and imports of flue dust from non-MFN continued to be duty free. A statutory duty of $0.15 per pound continued to be imposed on cadmium metal imported from non-MFN.

Table 7.—U.S. exports of cadmium metal and cadmium in alloys, dross, flue dust, residues, and scrap

Year	Quantity (metric tons)	Value (thousands)
1980	236	$464
1981	239	332
1982	11	126

Table 8.—U.S. imports for consumption[1] of cadmium metal, by country

Country	1981 Quantity (metric tons)	1981 Value (thousands)	1982 Quantity (metric tons)	1982 Value (thousands)
Australia	693	$2,571	446	$951
Belgium-Luxembourg	60	225	78	185
Canada	843	3,759	375	890
China	80	270	161	515
Finland	50	185	95	173
France	86	326	83	174
Germany, Federal Republic of	231	748	241	340
India	6	29	--	--
Italy	36	103	--	--
Japan	18	73	--	--
Korea, Republic of	367	3,006	110	225
Mexico	188	674	171	248
Netherlands	[2]89	300	113	226
Norway	5	17	5	11
Peru	166	532	[2]306	482
South Africa, Republic of	16	74	--	--
Spain	121	375	40	95
United Kingdom	--	--	81	169
Yugoslavia	5	24	--	--
Zaire	30	78	--	--
Total	3,090	13,369	[3]2,305	4,684

[1]General imports and imports for consumption were the same in 1981 and 1982.
[2]Includes waste and scrap (gross weight).
[3]Does not include 11 metric tons of cadmium contained in flue dust from Canada.

WORLD REVIEW

Heath Steele Mines Ltd. announced that plans to build a new zinc refinery at Belledune, New Brunswick, Canada, in cooperation with Brunswick Mining & Smelting Corp. have been delayed indefinitely. In addition to producing zinc, the plant would have manufactured cadmium and sulfuric acid as byproducts.

In June 1982, production began at the Real de Angeles Mine, which is one of the world's largest open pit silver mines and is located in Zacatecas, Mexico. Production at the rate of 10,000 tons of ore per day was expected to result in an annual production of 7 million ounces of silver and 31,000 tons of lead from lead concentrates, along with 26,000 tons of zinc and 415 tons of cadmium from zinc concentrates. The lead concentrates were scheduled to be sent to the Peñoles smelter at Torreón, Coahuila State, Mexico, and the zinc concentrates were to be shipped to Yugoslavia and Greece. Ore reserves were estimated at 85 million tons.

Aegean Metallurgical Industries, Ltd., was considering plans to build a smelter in Greece with an annual capacity of 50,000 tons of zinc and 50,000 tons of lead. The initial design capacity also provided for the recovery of about 100,000 troy ounces per year of gold, 3.8 million troy ounces per year of silver, 200 tons per year of cadmium, and small quantities of copper and bismuth. New mines that were to be developed in northern Greece were expected to be sufficient to provide the concentrate requirements of the complex. Most of the production from the smelters was expected to be consumed in the domestic market.

The Danish Environmental Ministry was considering a partial ban on certain uses of cadmium similar to the Swedish Government's ban. The Ministry proposed a ban on the manufacture and import of products containing cadmium as a pigment, stabilizer, or surface treatment to take effect on January 1, 1984. However, stabilizers for polyvinylchloride for outdoor use would be exempt through 1987, while stabilizers for other plastics for outdoor use, paint pigments, and surface coatings would be exempt through 1986. Until further notice, all other products would be exempted from the ban provided the authorities were notified before manufacture or use commenced.

The Parliament of the European Communities approved a draft regulation that sets limits on the disposal of cadmium into water. To strengthen the regulations, amendments were added, including a ban on the use of cadmium as a pigment, a reduction in the cadmium limits, and stronger controls on the manufacture of nickel-cadmium batteries and plastic stabilizers. However, some members believed it unlikely that these amendments would be accepted. The regulation could be approved by the Council of Ministries in 1983 and would probably go into effect in 1984 or 1985.

Table 9.—Cadmium: World production, by country[1]

(Metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Algeria	[r]34	[r]64	60	65	65
Argentina	22	36	18	--	--
Australia (refined)	747	804	1,012	1,050	990
Austria	33	34	36	55	60
Belgium	1,164	1,440	1,524	1,176	900
Brazil	10	21	41	45	70
Bulgaria[e]	210	210	210	210	210
Canada (refined)	1,265	[r]1,455	1,033	1,274	1,210
China[e]	220	225	225	225	225
Finland	611	590	581	621	621
France	[r]694	[r]689	789	664	650
German Democratic Republic[e]	18	15	[r]16	16	16
Germany, Federal Republic of	1,182	1,266	1,194	[r e]1,074	1,000
India	113	166	89	113	100
Italy	378	527	568	482	450
Japan	2,531	2,597	2,173	1,977	1,994
Korea, North[e]	150	150	150	150	150
Korea, Republic of	40	50	365	325	300
Mexico (refined)	897	830	778	590	550
Namibia	79	81	69	--	--
Netherlands[e]	402	416	455	518	485

See footnotes at end of table.

Table 9.—Cadmium: World production, by country[1] —Continued

(Metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Norway	120	115	130	117	117
Peru	169	190	172	307	380
Poland	761	773	698	580	580
Romania[e]	90	90	85	85	80
Spain	253	222	309	303	300
U.S.S.R.[e]	2,800	2,850	2,850	2,900	2,900
United Kingdom	291	424	375	278	278
United States[2]	1,653	1,823	1,578	1,603	1,007
Yugoslavia	187	289	201	208	205
Zaire	186	212	168	230	246
Zambia	--	--	1	1	1
Total	[r]17,310	[r]18,654	17,953	17,242	16,140

[e]Estimated. [p]Preliminary. [r]Revised.

[1]This table gives unwrought production from ores, concentrates, flue dusts, and other materials of both domestic and imported origin. Sources generally do not indicate if secondary metal (recovered from scrap) is included or not; where known, this has been indicated by footnote. Data derived in part from World Metal Statistics (published by World Bureau of Metal Statistics, London) and from Metal Statistics (published by Metallgesellschaft Aktiengesellschaft, Frankfurt am Main). Cadmium is found in ores, concentrates, and/or flue dusts in several other countries, but these materials are exported for treatment elsewhere to recover cadmium metal; therefore, such output is not reported in this table to avoid double counting. Table includes data available through Mar. 11, 1983.

[2]Includes secondary.

TECHNOLOGY

As part of a continuing effort to maximize metal recovery from domestic secondary resources, the Bureau of Mines investigated a process for recovering the metallic portion of scrap alkaline batteries. A pyrometallurgical method for recovering nickel and cadmium from nickel-cadmium battery scrap, previously developed on a laboratory scale, was scaled up to 25- and 43-pound charges. The method employed reduction and/or decomposition in a retort using a minimum of 2.5% carbon as a reductant. Metallic cadmium was distilled at atmospheric pressure at a minimum of 900° C. Minimum purity of the recovered cadmium was 99.8%, and the nickel-iron residue contained less than 0.02% cadmium.[4]

The Bureau of Mines also investigated a hydrometallurgical technique to recover metal values from lead smelter matte. The metals were converted from insoluble sulfides to soluble chlorides using a hydrochloric acid-chlorine-oxygen leaching system. Extraction of copper, lead, nickel, cobalt, and cadmium ranged from 92% to 98%, with concomitant extractions of iron and arsenic of less than 0.1%. The copper and lead were recovered electrolytically as metals, and the nickel, cobalt, and cadmium were recovered as mixed hydroxides.[5]

The Bureau of Mines developed a technique to separate and recover the three major components, lead, zinc, and cadmium, from lead smelter flue dust. The laboratory process utilizes sulfation roasting of the flue dust followed by water leaching to extract over 95% of the cadmium and zinc. Cadmium recovery from solution by cementing with zinc dust was 99%, and zinc was electrowon from the resulting solution after purification. Of the lead contained in the residue, 95% was converted to electrolyte for recovery by electrowinning. The process also separates and concentrates the accessory minerals, such as cobalt and nickel, into a leach liquor and three leach residues.[6]

Developments in cadmium technology were abstracted in Cadmium Abstracts, a quarterly publication available through the Cadmium Association, 34 Berkeley Square, London W1X 6AJ, England. Progress reports of the projects supported by the International Lead Zinc Research Organization, Inc., were published in the Cadmium Research Digest.

[1]Physical scientist, Division of Nonferrous Metals.

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Calcium and Calcium Compounds

By Lawrence Pelham[1]

Calcium, the fifth most abundant element in the Earth's crust, is very active, and therefore occurs in nature in combination with other elements. The Bureau of Mines publishes individual reports for several of these calcium minerals and compounds. The commercial name for calcium fluorite is fluorspar; calcium carbonate is known as limestone; and calcium oxide is called lime or quicklime. Information on these materials can be obtained in the Fluorspar, Stone, and Lime chapters of the Minerals Yearbook, respectively. Other calcium compounds are covered in the chapter concerning the element with which it is combined; for example, calcium bromide is discussed in the Bromine chapter. This chapter covers primarily calcium metal, calcium chloride, and various other calcium compounds not covered elsewhere.

Calcium metal was manufactured by one company in Connecticut. Natural calcium chloride was produced by three companies in California and three companies in Michigan. Synthetic calcium chloride was manufactured by one company in Louisiana, one company in New York, and two companies in Washington.

Domestic Data Coverage.—Domestic production data for calcium chloride was developed by the Bureau of Mines by means of a voluntary survey entitled "Calcium Chloride and Calcium-Magnesium Chloride." Of the 9 canvassed companies with 11 operating plants, 89% responded, and an estimated 37% of total production data shown in table 1 were represented. The production for the remaining nonrespondents was estimated using prior year production levels adjusted by economic trends and other guidelines.

DOMESTIC PRODUCTION

Pfizer, Inc., produced calcium metal at Canaan, Conn., by the Pidgeon process—an aluminothermic process in which high-purity calcium oxide produced by calcining limestone and aluminum powder are briquetted and heated in vacuum retorts. In a furnace with a temperature range between 1,000° and 1,300° C, the calcium oxide is reduced to calcium metal, which vaporizes and is subsequently collected as "crowns" in a water-cooled condenser at about 700° C. Pfizer accounts for an estimated 50% of total calcium metal production in market economy countries.

Pfizer produced commercial-grade calcium of 90% purity in seven shapes, high-purity redistilled metal in four variations, an 80% calcium-20% magnesium alloy, and other calcium alloys. Elkem Metal Co., a Norwegian-owned company at Niagara Falls, N.Y., produced calcium alloys, including a calcium-silicon alloy containing about 30% calcium, 65% silicon, and 5% iron, and two proprietary alloys that contain barium, and barium and aluminum, respectively. This plant was purchased by Elkem from Union Carbide Corp. The Foote Mineral Co. at Exton, Pa., and ASARCO Incorporated at New York, N.Y., also produced calcium alloys. Pesses Co. produced calcium alloys for use in the production of iron, steel, and nickel alloys.

Some calcium alloys, including lead-calcium and lead-calcium-tin, were produced directly using calcium metal. Other calcium alloys contained calcium from other sources. For example, production of calcium-silicon alloys involved the use of lime or calcium carbide; calcium-aluminum alloys employed lime or a mixture of calcium chloride, calcium fluoride, and aluminum fluoride; lead alloys used calcium chlorides. The compound calcium hydride was made from calcium metal.[2]

National Chloride Co. of America, Cargill, Inc., Leslie Salt Co., and Hill Bros. Chemical Co. produced calcium chloride from dry-lake brine wells in San Bernardino County, Calif. Total output in California decreased 29% in 1982 compared with that of 1981. The Dow Chemical Co. and Wilkinson Chemical Corp. recovered calcium chloride from brines in Lapeer, Mason, and Midland Counties, Mich. Total output in Michigan decreased 12% in 1982 compared with that of 1981. Total 1982 production of natural calcium chloride decreased 13% compared with 1981 production.

Allied Chemical Corp. recovered synthetic calcium chloride as a byproduct of soda ash production at its Solvay plant near Syracuse, N.Y., and as a byproduct at its Baton Rouge, La., plant using excess hydrochloric acid and limestone; Texas United Chemical Corp. produced calcium oxide from purchased hydrochloric acid and limestone at its plant near Lake Charles, La.; Reichold Chemicals, Inc., recovered synthetic calcium chloride as a byproduct of pentachlorophenol manufacture at Tacoma, Wash.; and Occidental Chemical Corp. manufactured calcium chloride at Tacoma using limestone and hydrochloric acid. Total 1982 output of synthetic calcium chloride increased 12% compared with the 1981 level.

Calcium hypochlorite was produced by two U.S. companies: Olin Corp. and PPG Industries, Inc. Total capacity was estimated at 80,000 short tons. Olin's 25,000-ton-per-year plant in Niagara Falls, N.Y., was closed in August for an indefinite period. PPG announced plans to construct a 28,000-ton-per-year calcium hypochlorite plant at Natrium, W. Va. The plant, scheduled for completion in late 1983, would increase PPG's nameplate capacity to 36,500 tons per year.

W. R. Grace & Co. of New York, N.Y., was building a calcium nitrite plant in Wilmington, N.C., scheduled to come onstream in early 1983. The plant will be the first of its kind in North America.[3]

Table 1.—Production of calcium chloride (75% $CaCl_2$ equivalent) in the United States

Year	Natural		Synthetic		Total	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1978	773,138	$53,868	257,763	$21,172	1,030,901	$75,040
1979	719,709	51,884	261,052	22,566	980,761	74,450
1980	581,012	47,950	230,123	26,150	811,135	74,100
1981	704,691	61,692	212,299	27,086	916,990	88,778
1982	[e]616,513	[e]61,483	236,894	31,279	853,407	92,762

[e]Estimated.

CONSUMPTION AND USES

Calcium metal was used in the manufacture of batteries; as an aid in removing bismuth in lead refining; as a desulfurizer and deoxidizer in steel refining; as an additive to high-tensile-strength steels; to form calcium alloys; as a reducing agent to recover refractory metals such as tantalum, uranium, and zirconium from their oxides; and in the manufacture of calcium hydride for use in the production of chromium, titanium, and zirconium. Some minor uses were in the preparation of vitamin B and chelated calcium supplements, and as a cathode coating in some types of photo tubes. The nuclear applications of calcium metal give it strategic significance; foreign sales must be approved by the U.S. Department of State. State Department approval has been denied to countries that were not a signatory of the United Nations Nuclear Nonproliferation Treaty.

Calcium chloride was used for road and pavement deicing, dust control and road base stabilization, and industrial uses, including coal and other bulk material thawing, oil and gas drilling, concrete-set acceleration, tire ballasting, and miscellaneous uses. The most rapidly growing end use for calcium chloride and calcium bromide was in well completion fluids in oil and gas recovery.

The principal use of calcium chloride was to melt snow and ice from roads, streets, bridges, and pavements. Calcium chloride is more effective at lower temperatures than rock salt and is used mainly in the Northern and Eastern States. Because of its considerably higher price, it is used in conjunction with rock salt for maximum effectiveness and economy.

Calcium hypochlorite was used to disinfect swimming pools and in other municipal and industrial bleaching and sanitation processes; 76% was used domestically, and 24% was exported.[4]

Calcium nitrate was used as a concrete additive to inhibit corrosion of steel reinforcement bars and to accelerate setting time.

Calcium carbide and calcium silicon were used to remove sulfur from molten pig iron as it was carried in transfer ladles from the blast furnace to the steelmaking furnace.

PRICES AND SPECIFICATIONS

During 1982, calcium metal crowns remained at the $3.05 per pound price for quantities greater than 20,000 pounds, reached on October 15, 1981, when it increased from $2.78 per pound. The per pound price of redistilled calcium metal, for quantities greater than 20,000 pounds, ranged from approximately $10 to $15. The price of calcium-silicon alloy decreased on August 1, 1982, from $0.82 to $0.66 per pound. The former price had been in effect since January 2, 1981. Yearend published prices and specifications were as follows:

	Value per pound	
	1981	1982
Calcium metal, 1-ton lots, 50-pound full crowns, 10 by 18 inches, Ca+Mg 99.5%, Mg 0.7%	$3.05	$3.05
Calcium-silicon alloy, 32% calcium, carload lots, f.o.b. shipping point	.82	.66

Source: Metals Week. V. 52, No. 52, Dec. 28, 1981, p. 5; Metals Week. V. 53, No. 52, Dec. 27, 1982, p. 5.

Calcium metal is usually sold in the form of crowns, broken crown pieces or nodules, or billets, which are crowns produced in an argon atmosphere. The metal in these forms is over 98% pure. Higher purity metal is obtained by redistillation.

Calcium metal is usually shipped in polyethylene bags enclosed by an airtight 55-gallon steel drum flushed with argon.

U.S. import duties in effect during 1982 for calcium metal were 5.8% ad valorem for countries having most-favored-nation status, 3.0% ad valorem for less developed and developing countries, and 25% ad valorem for other nations.

Calcium chloride is usually sold either as solid flake or pellet averaging about 75% $CaCl_2$, or as a liquid concentrate averaging 40% $CaCl_2$. Yearend published prices and specifications for 1982 were as follows:

	Value per ton[1]
Calcium chloride, regular grade, 77% to 80%, flake, bulk, carload, works	$99.00-$114.00
Calcium chloride, liquid, 40% to 45%, tank car or tank truck, works	38.75- 45.00

[1]Differences between high and low price are accounted for by differences in quantity, quality, and location. 1982 price quotations were the same as those of 1981. See Source.

Source: Chemical Marketing Reporter. V. 220, No. 26, Dec. 28, 1981, p. 29; Chemical Marketing Reporter. V. 222, No. 26, Dec. 27, 1982, p. 25.

FOREIGN TRADE

Exports of calcium chloride to 52 countries in 1982 increased 68% in quantity and decreased 15% in value compared with 1981 exports. Eleven countries received more than 500 tons of calcium chloride from the United States; they are listed in table 2.

Exports of calcium phosphates in 1982 were 61,000 tons valued at $36.5 million compared with 56,000 tons valued at $33.4 million in 1981. The leading destinations were Venezuela, Colombia, and Mexico, with material being sent to a total of 54 countries.

Exports of other calcium compounds, including precipitated calcium carbonate, totaled 31,000 tons valued at $15.6 million in

1982 compared with 26,000 tons and $11.7 million in 1981. Material in this category was sent to 72 countries, with the largest quantities going to the United Kingdom, the Netherlands, and Canada.

Imports of calcium and calcium compounds in 1982 amounted to 227,000 tons valued at $33.1 million compared with 367,000 tons valued at $48.3 million in 1981. Calcium metal was imported from Canada, France, and China. Imports of calcium chloride were mainly from Canada and Mexico. Imports of other calcium compounds included 121,000 tons of calcium nitrate valued at $8.7 million, mainly from Norway; 10,000 tons of calcium carbide valued at $3.8 million from Canada; 3,500 tons of calcium hypochlorite valued at $4.3 million, mainly from Japan; 9,100 tons of calcium carbonate chalk whiting valued at $942,000, mainly from France; and 8,600 tons of precipitated calcium carbonate valued at $2.3 million, mainly from France and the United Kingdom.

Table 2.—U.S. exports of calcium chloride, by country

Country	1981		1982	
	Short tons	Value	Short tons	Value
Angola	15	$3,933	19,232	$1,046,846
Brazil	801	453,967	698	243,840
Cameroon	284	38,264	1,685	601,926
Canada	8,819	1,483,424	9,555	1,951,557
Mexico	10,270	2,219,076	2,428	528,077
Saudi Arabia	46	30,967	3,024	2,189,317
Sweden	r2,153	23,620	648	135,021
Switzerland	242	115,141	1,043	174,801
Trinidad and Tobago	1,356	433,107	1,342	270,134
United Arab Emirates	r1,314	674,830	5,472	2,155,333
Venezuela	453	1,804,914	2,448	744,073
Other	r7,041	r5,722,761	7,482	1,024,475
Total	r32,794	r13,004,004	55,057	11,065,400

rRevised.

Table 3.—U.S. imports for consumption of calcium and calcium chloride

Year	Calcium		Calcium chloride	
	Pounds	Value[1]	Short tons	Value[1]
1978	523,835	$825,008	42,523	$2,101,794
1979	717,726	1,015,183	58,091	3,018,443
1980	227,814	581,525	46,439	2,071,463
1981	235,436	751,456	86,865	4,088,361
1982	333,054	966,665	60,623	3,010,212

[1]U.S. Customs import value, generally representing value in foreign country, and, therefore, excluding U.S. import duties, freight, insurance, and other charges incurred in shipping merchandise to the United States.

Table 4.—U.S. imports for consumption of calcium chloride, by country

Country	1981		1982	
	Short tons	Value[1]	Short tons	Value[1]
Canada	28,956	$1,407,143	22,509	$1,062,599
Germany, Federal Republic of	68	68,807	55	56,422
Mexico	57,833	2,335,440	37,939	1,482,344
Other	8	276,971	120	408,847
Total	86,865	4,088,361	60,623	3,010,212

[1]U.S. Customs import value, generally representing value in foreign country, and, therefore, excluding U.S. import duties, freight, insurance, and other charges incurred in shipping merchandise to the United States.

WORLD REVIEW

Calcium metal was produced in Canada, France, China, Japan, and the U.S.S.R., in addition to the United States. The market economy country production of calcium metal was estimated to be about 1,500 tons. Total world production was an estimated 2,000 tons.

Canada.—Chromasco Ltd. produced calcium metal at its Haley smelter near Renfrew, Ontario. Industrial sources suggest that Chromasco accounts for about 35% of the calcium metal produced in market economy countries. Chromasco exports most of its output. The company's exports averaged 85% of production in the 1960's and 60% in the 1970's.

China.—Calcium metal was produced in China by China Nuclear Energy Industry Corp. In 1982, China exported a total of 190,434 pounds of calcium metal to the United States through the Los Angeles, Calif., customs district.

France.—France exported 24,139 pounds of calcium metal to the United States in 1982. French calcium metal was produced by Planet Wattohm S.A., a subsidiary of Compagnie de Mokta, using the Pidgeon process.

Japan.—Lead-calcium alloy was produced by the Mitsubishi Metal Corp. and the Toho Zinc Co. Ltd.; both companies have patent license contracts with St. Joe Minerals Corp. of the United States. Calcium metal was produced in Japan by Furukawa Magnesium Co. Ltd.[5]

U.S.S.R.—Substantial quantities of calcium metal are believed to be produced in the U.S.S.R. in 1982. None was believed to be exported.

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[1]Physical scientist, Division of Industrial Minerals.
[2]Roskill Information Services Ltd. The Economics of Calcium Metal. 1st ed. 1982. London, England, 1982.
[3]Phillips, L. Pfizer Plays Vital Role in Nuclear Industry. Winsted Evening Citizen, Winsted, Conn., Feb. 26, 1982.
[4]Chemical Marketing Reporter. Chemical Profile. V. 223, No. 6, Feb. 7, 1983.
[5]Chemical Engineering. CPI News Briefs. V. 89, No. 4, Feb. 22, 1982, p. 28.

Cement

By Wilton Johnson[1] and Sandra T. Absalom[2]

U.S. cement production and consumption in 1982 declined to a 20-year low, reflecting reduced activity by the construction industry and continued weakness in the U.S. economy. According to a U.S. Department of Commerce report, the value of U.S. construction put in place in 1982 decreased 4% to $229 billion. Housing starts decreased 2% to 1,062,000 units.

Imports, a sensitive indicator of domestic cement demand, declined 27% to 2.9 million tons and accounted for 4% of consumption. Clinker imports were 16% of the total compared with 31% in 1981. One terminal, located in Stockton, Calif., and operated by Delta Cement Co., closed during the year.

Shipments of portland and masonry cement from U.S. plants in 1982, excluding Puerto Rico, decreased 11% to 64 million tons. Shipments decreased to all geographical regions except New England, which remained unchanged. Shipments to the Middle Atlantic and West South Central regions declined 4% and 2%, respectively. Shipments declined most severely to Pacific (down 17%), Mountain (down 15%), South Atlantic (down 14%), and East North Central (down 13%) regions.

Plant expansions and modernizations in three States, Florida, Nebraska, and Texas, added 2.3 million tons to domestic cement production capacity. Despite these additions, total U.S. portland cement production capacity increased only 1% from that of 1981 because of plant closures in Pennsylvania and Mississippi that effectively retired 1.2 million tons of grinding capacity.

Foreign ownership of U.S. cement production capacity continued to increase. By yearend 1982, approximately 24% of clinker production capacity and 25% of finishing grinding capacity had been acquired by foreign interests.

Domestic Data Coverage.—Domestic production and consumption data for cement were developed by means of the portland and masonry cement voluntary survey. Of the 155 cement manufacturing plants to which an annual survey collection request was made, 100% responded, representing 100% of the cement production and consumption data shown in table 1.

Table 1.—Salient cement statistics

(Thousand short tons unless otherwise specified)

	1978	1979	1980	1981	1982
United States:[1]					
Production[2]	83,986	84,491	75,224	71,710	63,355
Shipments from mills[2 3]	86,557	85,747	76,242	71,748	64,066
Value[2 3 4] thousands	$3,543,996	$3,991,580	$3,886,488	$3,723,095	$3,263,585
Average value per ton[2 3 4]	$40.94	$46.55	$50.98	$51.89	$58.94
Stocks at mills,[2] Dec. 31	5,320	6,600	6,825	7,372	6,753
Exports	55	149	186	300	201
Imports for consumption	6,577	9,393	5,244	3,963	2,911
Consumption, apparent[5 6]	87,619	87,799	77,599	73,321	65,623
World: Production	[r]940,212	[r]961,309	974,800	[p]983,250	[e]982,670

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Excludes Puerto Rico and the Virgin Islands.
[2]Portland and masonry cement only.
[3]Includes imported cement shipped by domestic producers.
[4]Value received, f.o.b. mill, excluding cost of containers.
[5]Quantity shipped, plus imports, minus exports.
[6]Adjusted to eliminate duplication of imported clinker and cement shipped by domestic cement manufacturers.

DOMESTIC PRODUCTION

During 1982, 1 State agency and 47 companies operated 155 plants in 40 States. In addition, two companies operated two plants in Puerto Rico, manufacturing one or more kinds of hydraulic cement.

Some of the tables show statistical data arranged by State or by groups of States that form cement districts. A cement district may represent a group of States or a portion of a State. The States of California, New York, and Pennsylvania have, on some tables, been divided to provide additional marketing information. Divisions for these States are as follows:

California, Northern.—Points north and west of the northern borders of San Luis Obispo and Kern Counties and the western borders of Inyo and Mono Counties.

California, Southern.—All other counties in California.

New York, Western.—All counties west of a dividing line following the eastern boundaries of St. Lawrence, Lewis, Oneida, Madison, Chenango, and Broome Counties.

New York, Eastern.—All counties east of the above dividing line, except metropolitan New York.

New York, Metropolitan.—The five counties of New York City (Bronx, Kings, New York, Queens, and Richmond) plus Westchester, Rockland, Suffolk, and Nassau Counties.

Pennsylvania, Eastern.—All counties east of the eastern boundaries of Potter, Clinton, Centre, Huntingdon, and Franklin Counties.

Pennsylvania, Western.—All other counties in Pennsylvania.

PORTLAND CEMENT

Clinker production in the United States, excluding Puerto Rico, decreased 11% to 59.3 million tons in 1982, and clinker imports reported by U.S. cement producers decreased 60% to 525,000 tons. A total of 61.1 million tons of portland cement was ground in the United States in 1982. Stocks at mills decreased by 517,000 tons to 6.4 million tons at yearend.

Production Capacity.—By yearend 1982, multiplant operations were being run by 25 companies. The size of individual companies, as a percentage of total U.S. clinker production capacity, ranged from 12.9% to 0.31%. The 5 largest producers provided 37% of the total 1982 production; the 10 largest producers provided a combined 58%. The 10 largest companies, in terms of 1982 clinker production, were (1) Lone Star Industries, Inc., (2) Ideal Basic Industries, Inc., (3) General Portland, Inc., (4) Martin Marietta Corp., (5) Lehigh Portland Cement Co., (6) Gifford-Hill and Co., Inc., (7) Kaiser Cement Corp., (8) Dundee Cement Co., (9) Texas Industries, Inc., and (10) Southwestern Portland Cement Co. The top four companies were unchanged from 1981.

At yearend 1982, 291 kilns located at 136 plants were being operated by 42 companies and 1 State agency in the United States, excluding Puerto Rico. Annual clinker production capacity at yearend was 86.8 million tons, compared with 89.4 million tons in 1981. An average of 50 days' downtime was reported for kiln maintenance and replacing refractory brick. The industry operated at 68% of its apparent capacity, compared with 75% in 1981. Average annual clinker capacity of U.S. kilns was 298,000 tons, average plant capacity was 638,000 tons, and average company capacity was about 2.1 million tons. Five plants produced white cement. In addition, nine plants operated grinding mills using only imported or purchased clinker or interplant transfers of clinker. Of these, seven produced portland cement only, and two ground clinker for both masonry and portland cement. Based on the fineness necessary to grind Types I and II cements and allowing for downtime for maintenance, the U.S. cement industry had an estimated annual grinding capacity of 104 million tons of cement, about 1% more than that of 1981.

During 1982, clinker was produced by wet-process kilns at 62 plants and by dry-process kilns at 68 plants; 6 additional plants operated both wet and dry kilns. Most new plants that came onstream in 1982 and those currently under construction were dry-process, preheater- or precalciner-equipped single kiln systems with annual capacities in excess of 500,000 tons of clinker. Cement producers reported a decrease of 3 suspension and the addition of 1 grate preheaters in 1982, bringing the yearend totals to 55 suspension and 20 grate preheaters.

Capacity Added in 1982.—Ash Grove Cement Co. completed a $25 million expansion of its Louisville, Nebr., plant by adding a new line designed to produce 600,000 tons per year. The new system has a four-stage suspension preheater, precalciner, 12.5- by 164-foot coal-fired kiln with indirect firing system, and grate cooler. The process control and monitoring system features the latest design in digital process control and programable motor control.

Atlantic Cement Co., Inc., began operating its slag cement plant at Bethlehem Steel Corp.'s complex at Sparrows Point, Md. The plant was expected to consume about 800,000 tons annually of water-granulated blast furnace iron slag. The process was claimed to use six times less energy than that required to manufacture portland cement. The comminuted product was to be blended with portland cement at the point of use.

Florida Mining and Materials Corp. doubled the capacity of its plant in Brooksville, Fla., to 1.2 million tons per year. A second 1,700-ton-per-day counterflow preheater kiln and grinding line were dedicated in June. The company also added six storage silos with a total capacity of 24,000 tons of cement and installed a 1,000-bag-per-hour packaging plant for masonry and portland cement. Both kilns feature a direct-fired coal system.

Santee Portland Cement Corp., a subsidiary of Dundee Cement Co., began operating a new grinding, storage, and handling system.

Southwestern Portland completed a $2.3 million process modification project at its Amarillo, Tex., plant. The modifications were expected to increase annual clinker capacity by 25,000 tons to about 233,000 tons and improve fuel efficiency. Also, the plant was converted to coal as the primary kiln fuel.

Capacity Additions Scheduled To Be Completed in 1983.—Centex Corp. planned to double annual capacity of its Texas Cement Co. plant in Buda, Tex., to 1.1 million tons of cement by July 1983. Fuller Co. received a $9 million contract to design and manufacture production equipment for the plant.

Kaiser Cement's $150 million expansion and conversion from wet to dry process of its Cushenbury plant at Lucerne Valley, Calif., was scheduled for completion in early 1983. The expansion was designed to increase annual capacity from 1.0 to 1.5 million tons.

Capacity Additions Scheduled for After 1983.—Columbia Cement Corp. delayed implementation of its plans to conduct an estimated $75 million expansion of its plant at Bellingham, Wash. Cement capacity was to have been approximately doubled to 750,000 tons per year. The firm also postponed its program to modernize equipment at the Zanesville, Ohio, plant.

Dal-Tex Cement Corp., a new firm, announced plans to build a 1-million-ton-per-year cement plant near Midlothian, Tex., pending success in obtaining financial support.

Florida Crushed Stone Co. announced plans to build a 600,000-ton-per-year cement plant in Brooksville, Fla. The $80 million plant would incorporate fly ash into its product.

Genstar Cement and Lime Co.'s $50 million project to modernize and expand its San Andreas, Calif., cement plant to 700,000 tons per year was delayed until economic conditions improve. The expansion was initially scheduled for completion in 1984.

Gifford-Hill, planned an expansion of its Oro Grande, Calif., plant from 1.1 to 2.0 million tons per year. The expansion was scheduled to be completed in 1985.

Las Vegas Portland Cement, Inc., a private firm started by local businessmen, delayed plans to build a $90 million cement plant near Jean, Nev. The plant had been scheduled originally to go onstream in 1983. It was to be the first cement plant in southern Nevada and the second plant in the State.

Mineral Reserves Inc., of Dallas, Tex., postponed plans to build a 600,000-ton-per-year plant near Pueblo, Colo., until the economic outlook becomes clearer.

Monolith Portland Cement Co.'s expansion and conversion from wet to dry process at its Monolith, Calif., plant was designed to double capacity to 1.0 million tons per year. The project, which had been scheduled originally for completion in 1982, was delayed.

Southwestern Portland scheduled a $100 million modernization and expansion of its Victorville, Calif., plant, to be completed in late 1984. Annual clinker capacity was to increase from 1.1 to 1.4 million tons.

Plant Closings.—Permanent closure of cement plants in 1982 effectively retired 1.2 million tons of grinding capacity. Reasons cited for plant closings were poor cement markets and high operating costs.

Bessemer Cement Co., a subsidiary of Louisville Cement Co., closed its Bessemer, Pa., plant in October.

Lehigh Portland closed its white cement plant in Northhampton, Pa., after purchasing the white cement plant of Medusa Cement Co. in York, Pa.

Marquette Cement Co. closed its Brandon, Miss., plant in April and converted it to a distribution terminal. The company's new Cape Girardeau, Mo., plant was expected to supply the Brandon construction market.

Table 2.—Portland cement production, capacity, and stocks in the United States, by district[1]

District	1981 Plants active during year[2]	1981 Production[2] (thousand short tons)	1981 Capacity[3] Finish grinding (thousand short tons)	1981 Capacity[3] Percent utilized	1981 Stocks[4] at mills, Dec. 31 (thousand short tons)	1982 Plants active during year	1982 Production[2] (thousand short tons)	1982 Capacity[3] Finish grinding (thousand short tons)	1982 Capacity[3] Percent utilized	1982 Stocks[4] at mills, Dec. 31 (thousand short tons)
New York and Maine	7	3,645	4,559	80.0	434	7	3,054	4,584	66.6	266
Pennsylvania, eastern	10	3,840	5,846	65.7	456	10	3,750	5,401	69.4	395
Pennsylvania, western	4	1,262	2,345	53.8	190	4	1,008	2,403	41.9	145
Maryland and West Virginia	4	1,945	2,811	69.2	236	4	1,760	2,796	62.9	225
Ohio	6	1,571	2,500	62.8	161	6	1,381	2,506	55.1	158
Michigan	6	3,931	7,126	55.2	356	6	3,293	7,226	45.6	326
Indiana	4	1,752	3,188	55.0	305	4	1,673	3,110	53.8	251
Illinois	4	1,701	2,588	65.7	361	4	1,544	2,644	58.4	198
Tennessee	4	1,049	2,017	52.0	105	4	601	1,990	30.2	85
Kentucky, North Carolina, Virginia	3	1,626	2,482	65.5	228	3	1,596	2,482	64.3	165
South Carolina	3	1,789	3,130	57.2	114	3	1,621	3,190	50.8	89
Florida	6	3,367	4,057	83.0	204	6	2,641	4,364	60.5	213
Georgia	3	1,167	1,750	66.7	101	2	W	W	W	W
Alabama	6	2,218	3,408	65.1	287	6	2,677	4,927	54.3	360
Louisiana and Mississippi	3	1,363	1,485	91.8	57	2	W	W	W	W
Nebraska and Wisconsin	3	707	1,580	44.7	111	4	708	1,625	43.6	133
South Dakota	1	464	1,806	25.7	64	1	523	1,806	29.0	66
Iowa	4	1,713	2,734	62.7	340	4	1,461	3,001	48.7	270
Missouri	7	3,621	5,844	62.0	460	5	3,104	4,925	63.0	357
Kansas	5	1,843	2,318	79.5	294	5	1,608	2,432	66.1	259
Oklahoma and Arkansas	5	2,819	3,620	77.9	235	5	2,754	3,620	76.1	266
Texas	20	9,952	11,950	83.3	551	20	9,448	12,396	76.2	656
Wyoming, Montana, Idaho	4	1,118	1,575	71.0	196	4	845	1,575	53.7	172
Colorado, Arizona, Utah, New Mexico	9	3,589	6,047	59.4	211	9	3,447	5,918	58.2	306
Washington	4	1,679	2,104	79.8	127	4	1,250	2,075	60.2	189
Oregon and Nevada	3	1,011	1,775	57.0	103	3	W	W	W	W
California, northern	4	2,297	3,797	60.5	235	4	2,099	3,797	55.3	286
California, southern	8	5,581	7,990	69.8	304	8	4,408	8,174	53.9	292
Hawaii	2	311	560	55.5	48	2	223	560	39.8	44
Other	--	--	--	--	--	--	2,594	4,515	57.5	185
Total or average	152	68,931	102,992	66.9	6,874	149	61,071	104,042	58.7	6,357
Puerto Rico	2	1,222	2,209	55.3	36	2	986	2,210	44.6	36

W Withheld to avoid disclosing company proprietary data; included with "Other."

[1]Includes Puerto Rico. Includes data for five white cement facilities: Texas (two); Pennsylvania (two); and California (one). Includes data for nine grinding plants in 1982 and seven in 1981 as follows: Florida (one); Michigan (two); New York (one); Oregon (one in 1982 only); Pennsylvania (one); Texas (one); and Wisconsin (two in 1982 and one in 1981).

[2]Includes cement produced from imported clinker (1981—1,276,000 tons; 1982—525,000 tons).

[3]Grinding capacity based on fineness necessary to grind Types I and II cement, making allowance for downtime required for maintenance.

[4]Includes imported cement. Source of imports withheld to avoid disclosing company proprietary data.

Table 3.—Clinker capacity and production in the United States, by district, as of December 31, 1982[1]

District	Active plants: Process used: Wet	Active plants: Process used: Dry	Active plants: Process used: Both	Active plants: Total	Number of kilns	Daily capacity (thousand short tons)	Average number of days for maintenance	Apparent annual capacity[2] (thousand short tons)	Production[3] (thousand short tons)	Percent utilized
New York and Maine	4	1	--	5	6	11.8	48	3,743	2,924	78.1
Pennsylvania, eastern	2	6	--	8	20	15.9	55	4,935	3,669	74.3
Pennsylvania, western	2	1	--	3	6	4.3	49	1,360	925	68.0
Maryland and West Virginia	2	2	--	4	10	6.2	45	1,982	1,732	87.4
Ohio	2	3	1	6	10	7.9	61	2,401	1,317	54.9
Michigan	2	2	--	4	13	16.8	35	5,540	2,962	53.5
Indiana	2	2	--	4	9	9.9	41	3,210	1,563	48.7
Illinois	--	4	--	4	8	8.6	31	2,875	1,499	52.1
Tennessee	3	1	--	4	6	4.5	11	1,592	541	34.0
Kentucky, North Carolina, Virginia	1	2	--	3	8	6.8	50	2,141	1,540	71.9
South Carolina	2	1	--	3	7	7.6	51	2,385	1,711	71.7
Florida	4	1	--	5	10	11.6	41	3,755	2,460	65.5
Georgia	--	1	1	2	4	W	W	W	W	W
Alabama	1	5	--	6	8	13.7	89	3,778	2,586	68.4
Louisiana and Mississippi	2	--	--	2	3	W	W	W	W	W
Nebraska and Wisconsin	1	--	1	2	6	W	W	W	W	W
South Dakota	--	--	1	1	4	3.3	58	1,013	670	66.1
Iowa	1	3	--	4	8	9.4	66	2,811	1,377	49.0
Missouri	2	3	--	5	7	14.4	51	4,525	3,085	68.2
Kansas	3	2	--	5	15	7.5	43	2,416	1,583	65.5
Oklahoma and Arkansas	3	2	--	5	12	9.4	44	3,019	2,741	90.8
Texas	9	8	1	18	37	32.1	46	10,251	9,338	91.1
Wyoming, Montana, Idaho	4	--	--	4	6	4.0	40	1,300	823	63.3
Colorado, Arizona, Utah, New Mexico	3	6	--	9	20	17.5	56	5,400	3,465	64.2
Washington	3	1	--	4	7	3.8	41	1,230	1,110	90.2
Oregon and Nevada	--	2	--	2	3	W	W	W	W	W
California, northern	1	3	--	4	6	11.1	80	3,169	2,001	63.1
California, southern	2	5	1	8	30	22.2	47	7,067	4,325	61.2
Hawaii	1	1	--	2	2	1.8	58	553	228	41.2
Other	--	--	--	--	--	13.7	48	4,348	3,151	72.5
Total or average	62	68	6	136	291	275.8	50	86,799	59,326	68.3
Puerto Rico	2	--	--	2	9	7.4	100	1,962	928	47.3

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes Puerto Rico and white cement-producing facilities.
[2]Calculated on individual company data; 365 days, minus average days for maintenance, times the reported 24-hour capacity.
[3]Includes production reported for plants that added or shut down kilns during the year.

Table 4.—Daily clinker capacity, December 31[1]

Short tons per 24-hour period	Number: Plants	Number: Kilns[2]	Total capacity (short tons)	Percent of total capacity
1981:				
Less than 600	2	3	728	0.3
600 to 1,150	22	34	18,698	6.3
1,150 to 1,700	40	82	57,275	19.3
1,700 to 2,300	29	64	57,441	19.4
2,300 to 2,800	21	47	51,850	17.5
2,800 and over	30	97	110,286	37.2
Total	144	327	296,278	100.0
1982:				
Less than 600	2	3	900	0.3
600 to 1,150	24	41	20,601	7.3
1,150 to 1,700	33	63	46,621	16.5
1,700 to 2,300	30	60	56,984	20.1
2,300 to 2,800	25	55	65,731	23.2
2,800 and over	24	78	92,346	32.6
Total	138	300	283,183	100.0

[1]Includes Puerto Rico and white cement-producing facilities.
[2]Total number in operation at plants.

Table 5.—Raw materials used in producing portland cement in the United States[1]

(Thousand short tons)

Raw materials	1980	1981	1982
Calcareous:			
Limestone (includes aragonite, marble, chalk)	78,289	73,026	71,307
Cement rock (includes marl)	24,991	26,627	18,593
Oystershell and coral	3,388	3,090	1,773
Argillaceous:			
Clay	6,220	5,742	5,007
Shale	4,193	3,649	3,282
Other (includes staurolite, bauxite, aluminum dross, pumice, alumina, volcanic material, other)	313	212	209
Siliceous:			
Sand and calcium silicate	1,994	1,794	1,568
Sandstone, quartzite, other	668	734	508
Ferrous: Iron ore, pyrites, millscale, other iron-bearing material	1,175	1,144	958
Other:			
Gypsum and anhydrite	3,859	3,600	3,148
Blast furnace slag	132	95	69
Fly ash	601	757	550
Other, n.e.c	171	162	108
Total	125,994	120,632	107,080

[1]Includes Puerto Rico.

Corporate Changes.—Alpha Portland Industries, Inc., terminated its cement manufacturing business with the sale of its two remaining plants. The Cementon, N.Y., cement plant was sold to Lehigh Portland, and the Lime Kiln, Md., cement plant was sold to Coplay Cement Co. Both new owners were subsidiaries of European cement producers.

Canada Cement Lafarge Ltd. was required by the U.S. Federal Trade Commission to sell the Chattanooga, Tenn., plant acquired in its 1981 takeover of General Portland, Inc. The sale, to Signal Mountain Cement Co., which is controlled by European interests, was completed in September 1982.

Columbia Cement ownership changed from Filtrol Corp. to Ashland Technology, Inc., a subsidiary of Ashland Oil, Inc.

Lehigh Portland purchased the white cement plant of Medusa Cement in addition to the Alpha Portland plant mentioned previously.

Lone Star regained its standing as the largest North American cement producer with several acquisitions in 1982. In April, it purchased Marquette Cement, which had six operating plants, from Gulf + Western Industries, Inc. In October, it purchased Cyprus Hawaiian Cement Corp., which had one plant on Oahu. In December, Lone Star purchased Genstar Stone Products Co.'s masonry cement plant in Frederick, Md.

Penn-West Cement Co., Inc., which had one plant in West Winfield, Pa., became

Armstrong Cement and Supply Corp.

MASONRY CEMENT

Production of masonry cement totaled 2.3 million tons, a decrease of 18% from that of 1981. At yearend, 96 plants were manufacturing masonry cement in the United States. Three plants producing masonry cement exclusively were Cheney Lime & Cement Co., Allgood, Ala.; Genstar Stone, Frederick, Md.; and Riverton Corp., Riverton, Va.

Table 6.—Masonry cement production and stocks in the United States, by district

District	1981			1982		
	Plants active during year	Production (thousand short tons)	Stocks[1] at mills, Dec. 31 (thousand short tons)	Plants active during year	Production (thousand short tons)	Stocks[1] at mills, Dec. 31 (thousand short tons)
New York and Maine	3	71	12	3	61	11
Pennsylvania, eastern	7	228	41	7	180	26
Pennsylvania, western	4	85	17	4	71	12
Maryland and West Virginia	4	102	14	4	103	15
Ohio	4	112	27	4	79	20
Michigan	4	181	72	4	140	44
Indiana	3	261	59	3	W	W
Illinois	1	W	W	1	W	W
Tennessee	3	64	9	2	W	W
Kentucky, North Carolina, Virginia	4	164	21	4	158	18
South Carolina	2	W	W	2	W	W
Florida	5	286	22	5	218	17
Georgia	3	87	15	2	W	W
Alabama	5	195	25	5	146	23
Louisiana and Mississippi	2	W	W	2	W	W
Nebraska and Wisconsin	1	W	W	2	W	W
South Dakota	1	6	2	1	6	4
Iowa	3	42	18	1	W	W
Missouri	4	96	22	3	75	10
Kansas	5	72	33	5	43	25
Oklahoma and Arkansas	5	100	8	5	126	15
Texas	13	229	22	13	218	22
Wyoming, Montana, Idaho	3	9	4	3	4	4
Colorado, Arizona, Utah, New Mexico	6	112	9	6	90	9
Washington	3	17	5	2	W	W
Oregon and Nevada	--	--	(2)	--	--	(2)
California, southern	--	--	--	1	W	W
Hawaii	2	12	3	2	6	3
Other	--	248	38	--	560	118
Total	100	[3]2,779	498	96	[4]2,284	396

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes imported cement.
[2]Less than 1/2 unit.
[3]Includes 2,445,000 tons produced from clinker and 334,000 tons produced from cement.
[4]Includes 2,018,000 tons produced from clinker and 266,000 tons produced from cement.

ALUMINOUS CEMENT

Aluminous cement, also known as calcium aluminate cement, high-alumina cement, and Ciment Fondu, is a nonportland hydraulic cement. It continued to be produced at the following three plants in the United States: Lehigh Portland, Buffington, Ind.; Lone Star Lafarge, Inc., Chesapeake, Va.; and Aluminum Co. of America, Bauxite, Ark.

ENERGY

The trend toward energy conservation continued during 1982. Most new or modernized plants featured coal-burning and dry-process systems with preheaters and precalciners to promote efficiency in fuel consumption.

In 1982, 81% of the energy consumed in cement production was in the form of fuel for kiln firing to produce clinker. Average energy consumption per ton of clinker decreased 5.0% to 5.0 million British thermal units (Btu).

The average consumption of electrical energy increased 1% to 146.3 kilowatt-hours per ton. Assuming a 40% energy efficiency in conversion of fuel to electrical energy, this represented a fuel equivalent of 1.2 million Btu per ton. Thus, average fuel consumption for kiln firing plus electrical energy (primarily for finish grinding) was approximately 6.2 million Btu per ton in 1982.

Average fuel consumption in kiln firing in wet-process plants, 5.8 million Btu per ton, was 32% higher than average fuel consumption in dry-process plants, 4.4 million Btu per ton. Approximately 53% of clinker production in 1982 was by the dry-process, compared with 50% in 1981.

Kilns without preheaters averaged 5.5 million Btu per ton of clinker produced; those with suspension preheaters averaged 4.2 million Btu per ton, and those with grate-type preheaters averaged 5.0 million Btu per ton.

Table 7.—Clinker produced in the United States, by fuel[1]

Fuel	Clinker produced			Fuel consumed		
	Plants active during year	Quantity (thousand short tons)	Percent of total	Coal[2] (thousand short tons)	Oil (thousand 42-gallon barrels)	Natural gas (thousand cubic feet)
1981:						
Coal	32	14,539	21.5	3,251	--	--
Oil	2	1,100	1.6	--	1,185	--
Natural gas	4	1,568	2.3	--	--	11,067,620
Coal and oil	27	11,849	17.5	2,219	281	--
Coal and natural gas	56	25,285	37.3	4,924	--	19,717,338
Oil and natural gas	5	1,292	1.9	--	122	6,171,226
Coal, oil, natural gas	22	12,082	17.9	2,095	581	6,635,182
Total	148	67,715	100.0	12,489	2,169	43,591,366
1982:						
Coal	24	11,637	19.3	2,495	--	--
Oil	2	928	1.5	--	976	--
Natural gas	3	761	1.3	--	--	7,607,179
Coal and oil	29	11,912	19.8	2,160	376	--
Coal and natural gas	54	22,334	37.1	4,354	--	11,285,363
Oil and natural gas	3	505	.8	--	152	2,569,257
Coal, oil, natural gas	24	12,177	20.2	2,062	536	4,903,188
Total	139	60,254	100.0	11,071	2,040	26,364,987

[1]Includes Puerto Rico.
[2]Includes 96.9% bituminous and 3.1% petroleum coke in 1981; 0.6% anthracite, 96.3% bituminous, and 3.1% petroleum coke in 1982.

Table 8.—Clinker produced and fuel consumed by the portland cement industry in the United States, by process[1]

Process	Clinker produced			Fuel consumed		
	Plants active during year	Quantity (thousand short tons)	Percent of total	Coal[2] (thousand short tons)	Oil (thousand 42-gallon barrels)	Natural gas (thousand cubic feet)
1981:						
Wet	72	31,257	46.1	6,466	1,455	24,490,040
Dry	68	31,800	47.0	5,296	616	12,134,282
Both	8	4,657	6.9	727	98	6,967,044
Total	148	[3]67,715	100.0	12,489	2,169	43,591,366
1982:						
Wet	64	25,207	41.8	5,186	1,204	14,974,907
Dry	69	31,981	53.1	5,318	810	8,564,900
Both	6	3,066	5.1	567	26	2,825,180
Total	139	60,254	100.0	11,071	2,040	26,364,987

[1]Includes Puerto Rico.
[2]Includes 96.9% bituminous and 3.1% petroleum coke in 1981; 0.6% anthracite, 96.3% bituminous and 3.1% petroleum coke in 1982.
[3]Data do not add to total shown because of independent rounding.

Table 9.—Electric energy used at portland cement plants in the United States, by process[1]

Process	Electric energy used: Generated at portland cement plants: Active plants	Generated at portland cement plants: Quantity (million kilowatt-hours)	Purchased: Active plants	Purchased: Quantity (million kilowatt-hours)	Total: Quantity (million kilowatt-hours)	Total: Percent	Finished cement produced (thousand short tons)	Average electric energy used per ton of cement produced (kilowatt-hours)
1981:								
Wet	--	--	72	4,424	4,424	43.7	32,928	134.4
Dry[2]	4	366	74	4,634	5,000	49.3	32,487	153.9
Both	--	--	8	710	710	7.0	4,738	150.0
Total	4	366	154	9,768	10,134	100.0	70,153	144.5
Percent of total electric energy used	--	3.6	--	96.4	--	--	--	--
1982:								
Wet	--	--	67	3,551	3,551	39.1	26,711	132.9
Dry[2]	4	316	78	4,723	5,039	55.5	32,338	155.8
Both	--	--	6	489	489	5.4	3,010	162.5
Total	4	316	151	8,763	9,079	100.0	[3]62,057	146.3
Percent of total electric energy used	--	3.5	--	96.5	--	--	--	--

[1]Includes Puerto Rico. Includes grinding plants and white cement facilities.
[2]Includes data for grinding plants.
[3]Data do not add to total shown because of independent rounding.

In 1982, coal accounted for 87% of kiln fuel consumption compared with 84% in 1981; natural gas accounted for 9% compared with 12% in 1981; and oil remained unchanged at 4%.

Interest continued in the use of energy-saving additives such as fly ash and iron and steel slag. Atlantic Cement completed and put into operation a slag cement plant in Baltimore, Md., during 1982. The use of fly ash in cement decreased 27% to 550,000 tons. The use of slags also decreased 27% to 69,000 tons in 1982.

TRANSPORTATION

U.S. shipments of portland cement to consumers were primarily in bulk, 94%; by truck, 93%; and made directly from cement manufacturing plants, 72%, rather than distribution terminals. This pattern of cement transport did not differ significantly from that of recent years.

With respect to shipments of cement from plants to terminals, the preferred modes of transportation were railroads, 46%, and waterways, 43%. Transportation by truck accounted for 8%. Cement used at producing plants accounted for the remaining 3%.

Table 10.—Shipments of portland cement from mills in the United States, in bulk and in containers, by type of carrier[1]

(Thousand short tons)

Type of carrier	Shipments from plant to terminal: In bulk	Shipments from plant to terminal: In containers	Shipments to ultimate consumer: From terminal to consumer: In bulk	From terminal to consumer: In containers	From plant to consumer: In bulk	From plant to consumer: In containers	Total shipments
1981:							
Railroad	7,582	140	412	3	3,451	98	3,964
Truck	1,442	115	16,883	591	43,346	3,720	64,540
Barge and boat	7,527	75	120	--	645	9	774
Unspecified[2]	478	--	261	21	638	30	950
Total	17,029	330	17,676	615	48,080	3,857	[3]70,228
1982:							
Railroad	7,688	116	226	--	3,207	57	3,490
Truck	1,379	100	16,307	569	38,101	3,310	58,287
Barge and boat	7,182	84	64	2	260	13	339
Unspecified[2]	507	--	216	5	321	13	555
Total	16,756	300	16,813	576	41,889	3,393	[4] [5]62,672

[1]Includes Puerto Rico.
[2]Includes cement used at plant.
[3]Bulk shipments were 93.6%, and container (bag) shipments were 6.4%.
[4]Bulk shipments were 93.7%, and container (bag) shipments were 6.3%.
[5]Data do not add to total shown because of independent rounding.

CONSUMPTION AND USES

Cement consumption in the United States, excluding Puerto Rico, decreased 11% in 1982 to 65.6 million tons. The decline in cement demand reflected reduced activity in the construction industry and general weakness in the U.S. economy. Domestic producers shipped 64.1 million tons in 1982, an 11% decrease from that of 1981. This included 1.1 million tons of cement and clinker imported and sold or used by domestic producers. Additional imports of 1.5 million net tons of cement imported by certain other importers accounted for the difference between consumption and domestic shipments.

Domestic cement shipments to all regions of the United States decreased except New England, which remained unchanged. Receipts in the Middle Atlantic and West South Central regions declined less than 5% each. Shipments to destinations in all other regions were depressed, with decreases ranging from 10% to 20% below the 1981 level. No significant cement shortages occurred in the United States during 1982.

The end-use distribution pattern for portland cement did not differ significantly from that of recent years. Ready-mix concrete producers were the primary consumers, accounting for 69% of the total quantity shipped by domestic producers. Manufacturers of concrete products used 12% of the total to produce concrete blocks, pipe, and precast, prestressed, and other concrete products. The remainder was used by highway contractors; building contractors; cement dealers; Federal, State, and other government agencies; and miscellaneous.

According to the U.S. Department of Commerce, the value of U.S. construction put in place in 1982 decreased 4% to $229 billion.[3] Of this total value, 32% was in private housing, 28% was in private industrial and commercial building (including farms), 7% was in public buildings, 6% was in highways, and the remainder was in other public construction.

Total private construction put in place decreased 4% to $179 billion. The value of residential units put in place decreased 13% to $76 billion, and industrial-commercial construction put in place increased 2% to $103 billion. Total public construction put in place decreased 6% to $50 billion, of which public buildings decreased 6% to $17 billion, highway construction decreased 1% to $13 billion, and other public construction decreased 1% to $20 billion.

Housing starts decreased 2% to 1.062 million units, consisting of 662,000 single units and 400,000 multiunits, according to the U.S. Department of Commerce. Single-family housing starts decreased 6%. On a regional basis, housing starts increased 5% in the South to 591,000 units and decreased 1% in the Northeast to 116,000 units, 15% in the West to 205,000 units, and 10% in the North Central region to 149,000 units.

Table 11.—Portland cement shipped by producers in the United States, by district[1]

District	1981			1982		
	Quantity (thousand short tons)	Value (thousands)	Average per ton	Quantity (thousand short tons)	Value (thousands)	Average per ton
New York and Maine	3,369	$130,690	$38.79	3,057	$119,238	$39.00
Pennsylvania, eastern	3,860	162,122	42.00	3,771	170,217	45.14
Pennsylvania, western	1,290	53,760	41.67	1,029	42,729	41.52
Maryland and West Virginia	1,894	85,316	45.05	1,772	81,054	45.74
Ohio	1,461	69,517	47.58	1,326	59,598	44.95
Michigan	3,871	180,641	46.67	3,254	149,533	45.95
Indiana	1,538	59,344	38.59	1,523	58,055	38.12
Illinois	1,574	61,536	39.10	1,757	78,444	44.65
Tennessee	974	39,378	40.43	763	36,689	48.09
Kentucky, North Carolina, Virginia	1,562	72,325	46.30	1,487	63,963	43.01
South Carolina	1,765	79,407	44.99	1,624	66,385	40.88
Florida	3,518	199,064	56.58	2,651	136,190	51.37
Georgia	1,149	45,423	39.53	W	W	W
Alabama	2,270	89,216	39.30	2,558	104,461	40.84
Louisiana and Mississippi	1,317	75,859	57.60	W	W	W
Nebraska and Wisconsin	746	39,944	53.54	685	38,873	56.75
South Dakota	450	23,290	51.76	520	27,978	53.80
Iowa	1,779	92,099	51.77	1,622	82,225	50.69
Missouri	3,732	168,567	45.17	3,205	120,339	37.55
Kansas	1,641	81,792	49.84	1,549	79,558	51.36
Oklahoma and Arkansas	2,703	138,336	51.18	2,540	132,367	52.11
Texas	10,262	567,391	55.29	9,732	545,679	56.07
Wyoming, Montana, Idaho	1,120	68,673	61.32	810	47,253	58.34
Colorado, Arizona, Utah, New Mexico	3,697	234,404	63.40	3,352	218,686	65.24
Washington	1,560	100,845	64.64	1,154	75,988	65.85
Oregon and Nevada	897	54,671	60.95	W	W	W
California, northern	2,413	152,933	63.38	2,039	117,990	57.87
California, southern	5,483	366,033	66.76	4,425	283,893	64.16
Hawaii	302	23,024	76.24	227	18,122	79.83
Other	--	--	--	2,647	128,931	48.71
U.S. total or average[2]	68,197	3,515,600	51.55	61,080	[3]3,084,439	50.50
Foreign imports[4]	805	44,691	55.52	605	32,574	53.84
Puerto Rico	1,226	105,420	85.99	986	81,822	82.98
Grand total or average	70,228	3,665,711	52.20	[3]62,672	3,198,835	51.04

W Withheld to avoid disclosing company proprietary data; included with "Other."

[1]Includes Puerto Rico. Includes data for five white cement facilities: Texas (two); Pennsylvania (two); and California (one). Includes data for nine grinding plants in 1982 and seven in 1981 as follows: Florida (one); Michigan (two); New York (one); Oregon (one in 1982 only); Pennsylvania (one); Texas (one); and Wisconsin (two in 1982 and one in 1981).

[2]Includes cement produced from imported clinker.

[3]Data do not add to total shown because of independent rounding.

[4]Cement imported and distributed by domestic producers only.

Table 12.—Masonry cement shipped by producers in the United States, by district[1]

District	1981 Quantity (thousand short tons)	1981 Value (thousands)	1981 Average per ton	1982 Quantity (thousand short tons)	1982 Value (thousands)	1982 Average per ton
New York and Maine	78	$4,317	$55.35	66	$4,104	$62.18
Pennsylvania, eastern	207	11,619	56.13	182	10,800	59.34
Pennsylvania, western	86	3,180	36.98	74	3,248	43.89
Maryland and West Virginia	111	6,518	58.72	101	5,474	54.20
Ohio	105	7,129	67.90	86	6,170	71.74
Michigan	173	10,584	61.18	136	8,752	64.35
Indiana	252	10,972	43.54	W	W	W
Illinois	W	W	W	W	W	W
Tennessee	67	3,209	47.90	W	W	W
Kentucky, North Carolina, Virginia	168	8,570	51.01	146	9,200	63.01
South Carolina	W	W	W	W	W	W
Florida	288	20,757	72.07	231	16,267	70.42
Georgia	89	4,392	49.35	W	W	W
Alabama	193	10,721	55.55	150	9,086	60.57
Louisiana and Mississippi	W	W	W	W	W	W
Nebraska and Wisconsin	W	W	W	W	W	W
South Dakota	6	454	r75.67	4	383	95.75
Iowa	41	3,227	78.71	W	W	W
Missouri	103	5,495	53.35	88	4,855	55.17
Kansas	51	2,835	55.59	46	2,628	57.13
Oklahoma and Arkansas	101	6,295	62.33	118	7,892	66.88
Texas	229	15,699	68.55	236	16,440	69.66
Wyoming, Montana, Idaho	7	525	75.00	4	324	81.00
Colorado, Arizona, Utah, New Mexico	109	8,684	79.67	91	7,238	79.54
Washington	15	1,284	85.60	W	W	W
Oregon and Nevada	(2)	25	78.00	(2)	18	96.65
Hawaii	10	807	80.70	6	554	92.33
Other	249	14,521	58.32	599	31,739	52.99
U.S. total or average	2,738	161,819	59.10	2,364	145,172	61.41
Foreign imports[3]	8	985	123.13	17	1,400	82.35
Grand total or average	2,746	162,804	59.29	2,381	146,572	61.56

r Revised.
W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Does not include quantities produced on the job by masons.
[2]Less than 1/2 unit.
[3]Cement imported and distributed by domestic producers only. Source of imports withheld to avoid disclosing company proprietary data.

Table 13.—Cement shipments, by destination and origin[1]

(Thousand short tons)

Destination and origin	Portland cement[2] 1980	Portland cement[2] 1981	Portland cement[2] 1982	Masonry cement 1980	Masonry cement 1981	Masonry cement 1982
Destination:						
Alabama	1,133	988	930	93	76	64
Alaska[3]	94	137	171	W	--	W
Arizona	1,457	1,479	1,245	W	W	W
Arkansas	758	668	553	49	39	31
California, northern	3,012	2,535	2,170	(4)	--	(4)
California, southern	5,226	4,733	3,864	(4)	--	--
Colorado	1,404	1,532	1,464	28	27	24
Connecticut[3]	614	590	611	16	16	13
Delaware[3]	132	124	154	7	6	7
District of Columbia[3]	117	116	139	4	2	2
Florida	5,412	5,335	4,081	408	389	317
Georgia	2,050	1,882	1,775	159	151	145
Hawaii	365	302	229	13	10	6
Idaho	362	311	241	2	2	1
Illinois	2,664	2,323	2,309	90	70	54
Indiana	1,323	1,146	1,015	85	71	61
Iowa	1,294	1,147	1,158	19	16	12
Kansas	1,207	1,086	956	24	22	18
Kentucky	954	915	888	80	75	66
Louisiana	2,735	2,597	2,453	73	70	67
Maine	221	227	198	9	9	8
Maryland	1,290	1,165	1,069	115	97	89
Massachusetts[3]	959	997	991	35	36	32
Michigan	1,993	1,729	1,313	109	86	58
Minnesota	1,447	1,238	1,112	43	38	33
Mississippi	861	841	673	65	51	39

See footnotes at end of table.

Table 13.—Cement shipments, by destination and origin[1] —Continued

(Thousand short tons)

Destination and origin	Portland cement[2] 1980	Portland cement[2] 1981	Portland cement[2] 1982	Masonry cement 1980	Masonry cement 1981	Masonry cement 1982
Destination —Continued						
Missouri	1,430	1,426	1,249	38	34	29
Montana	292	300	228	2	2	1
Nebraska	828	667	678	14	12	9
Nevada	565	574	405	--	--	--
New Hampshire[3]	221	242	288	10	10	9
New Jersey[3]	1,486	1,267	1,235	57	57	53
New Mexico	600	661	543	11	11	10
New York, eastern	669	542	447	24	24	20
New York, western	788	809	753	34	34	32
New York, metropolitan[3]	905	1,061	1,072	35	36	38
North Carolina	1,463	1,455	1,379	184	173	153
North Dakota[3]	271	318	266	6	6	6
Ohio	2,659	2,334	2,040	151	124	99
Oklahoma	1,626	1,827	1,857	56	55	55
Oregon	831	626	573	1	1	1
Pennsylvania, eastern	1,583	1,458	1,391	55	48	44
Pennsylvania, western	920	832	816	72	64	59
Rhode Island[3]	126	118	129	5	4	4
South Carolina	883	905	755	107	89	81
South Dakota	257	239	194	6	4	3
Tennessee	1,369	1,192	1,055	134	108	99
Texas	8,839	9,202	9,185	224	219	243
Utah	799	699	598	2	2	1
Vermont[3]	125	125	110	4	5	4
Virginia	1,788	1,531	1,357	147	130	108
Washington	1,374	1,292	1,016	8	8	6
West Virginia	546	478	457	41	34	30
Wisconsin	1,544	1,331	1,048	46	41	32
Wyoming	478	503	403	3	3	2
U.S. total	74,349	70,157	63,289	3,003	2,697	2,378
Foreign countries[5]	296	593	363	86	84	60
Puerto Rico	1,414	1,151	950	--	--	--
Total shipments	76,059	71,901	64,602	3,089	2,781	2,438
Origin:						
United States[6]	71,610	68,197	61,080	3,044	2,738	2,364
Puerto Rico	1,482	1,226	986	--	--	--
Foreign:[7]						
Domestic producers	1,580	805	605	10	8	17
Others	1,387	1,673	1,931	35	35	57
Total shipments	76,059	71,901	64,602	3,089	2,781	2,438

W Withheld to avoid disclosing company proprietary data; included with "Foreign countries."

[1]Includes cement produced from imported clinker and imported cement shipped by domestic producers, Canadian cement manufacturers, and other importers. Includes Puerto Rico.

[2]Excludes cement (1980—283,000 tons; 1981—192,000 tons; and 1982—158,000 tons) used in the manufacture of prepared masonry cement.

[3]Has no cement-producing plants.

[4]Less than 1/2 unit.

[5]Direct shipments by producers to foreign countries and U.S. possessions and territories; includes States indicated by symbol W.

[6]Includes cement produced from imported clinker by domestic producers.

[7]Imported cement distributed by domestic producers, Canadian cement manufacturers, and other importers. Origin of imports withheld to avoid disclosing company proprietary data.

Table 14.—Cement shipments, by region and subregion[1]

Region and subregion[2]	Portland cement: Thousand short tons 1981	Portland cement: Thousand short tons 1982	Portland cement: Percent of total 1981	Portland cement: Percent of total 1982	Masonry cement: Thousand short tons 1981	Masonry cement: Thousand short tons 1982	Masonry cement: Percent of total 1981	Masonry cement: Percent of total 1982
Northeast:								
New England	2,299	2,327	3.3	3.7	80	70	3.0	2.9
Middle Atlantic	5,969	5,714	8.5	9.0	263	246	9.7	10.4
Total	8,268	8,041	11.8	12.7	343	316	12.7	13.3
South:								
Atlantic	12,991	11,166	18.5	17.6	1,071	932	39.7	39.2
East Central	3,936	3,546	5.6	5.6	310	268	11.5	11.3
West Central	14,294	14,048	20.4	22.2	383	396	14.2	16.6
Total	31,221	28,760	44.5	45.4	1,764	1,596	65.4	67.1
North Central:								
East	8,863	7,725	12.7	12.2	392	304	14.5	12.8
West	6,121	5,613	8.7	8.9	132	110	4.9	4.6
Total	14,984	13,338	21.4	21.1	524	414	19.4	17.4
West:								
Mountain	6,059	5,127	8.6	8.1	47	39	1.8	1.6
Pacific	9,625	8,023	13.7	12.7	19	13	.7	.6
Total	15,684	13,150	22.3	20.8	66	52	2.5	2.2
Grand total	70,157	63,289	100.0	100.0	2,697	2,378	100.0	100.0

[1]Includes imported cement shipped by domestic and Canadian cement manufacturers and other importers.
[2]Geographic regions as designated by the U.S. Department of Commerce, Bureau of the Census.

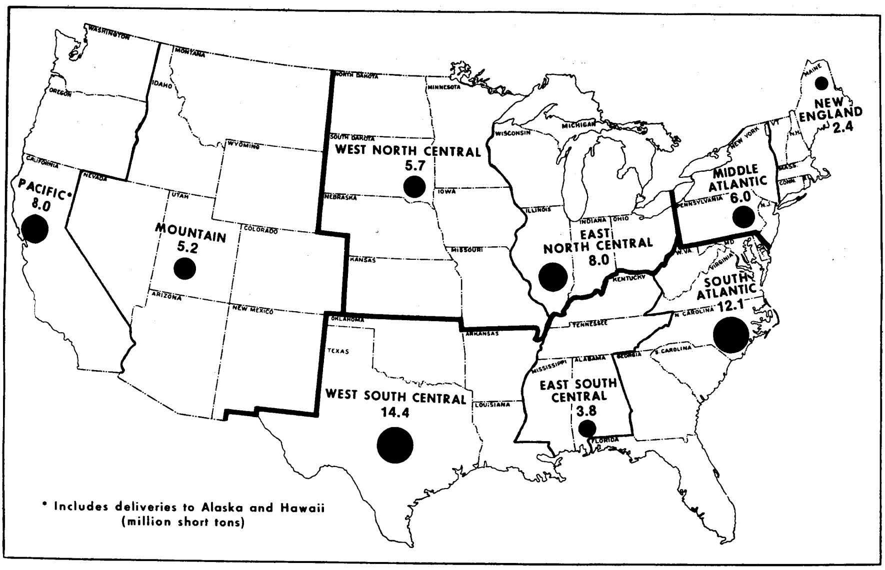

Figure 1.—Shipments of cement by geographic region of destination in 1982.

Table 15.—Portland cement shipments in 1982, by district of origin and type of customer[1]

District of origin	Building material dealers		Concrete product manufacturers		Ready-mixed concrete		Highway contractors		Other contractors		Federal, State, and other government agencies		Miscellaneous including own use		Total (thousand short tons)
	Quantity (thousand short tons)	Percent	Quantity (thousand short tons)	Percent	Quantity (thousand short tons)	Percent	Quantity (thousand short tons)	Percent	Quantity (thousand short tons)	Percent	Quantity (thousand short tons)	Percent	Quantity (thousand short tons)	Percent	
New York and Maine	134	4.4	458	15.0	2,251	73.6	154	5.0	51	1.7	1	(2)	8	0.3	3,057
Pennsylvania, eastern	350	9.3	741	19.6	2,492	66.1	65	1.7	55	1.5	14	0.4	54	1.4	3,771
Pennsylvania, western	102	9.9	136	13.2	674	65.5	60	5.8	45	4.4	--	--	12	1.2	1,029
Maryland and West Virginia	149	8.4	263	14.8	1,263	71.2	42	2.4	35	2.0	2	.1	19	1.1	1,773
Ohio	62	4.7	258	19.5	942	71.0	43	3.2	15	1.1	--	--	6	.5	1,326
Michigan	127	3.9	465	14.3	2,398	73.7	115	3.5	114	3.5	14	.4	21	.7	3,254
Indiana	93	6.1	205	13.5	1,137	74.6	44	2.9	30	2.0	1	.1	13	.8	1,523
Illinois	61	3.5	171	9.7	1,361	77.5	93	5.3	44	2.5	--	--	27	1.5	1,757
Tennessee	50	6.5	156	20.4	544	71.3	2	.3	5	.7	4	.5	2	.3	763
Kentucky, North Carolina, Virginia	94	6.3	145	9.7	1,066	71.7	80	5.4	55	3.7	1	.1	46	3.1	1,487
South Carolina	53	3.3	253	15.6	1,136	69.9	112	6.9	24	1.5	2	.1	44	2.7	1,624
Florida	374	14.1	325	12.3	1,588	59.9	143	5.4	181	6.8	8	.3	32	1.2	2,651
Alabama	172	6.7	423	16.5	1,626	63.6	118	4.6	115	4.5	22	.9	82	3.2	2,558
Nebraska and Wisconsin	19	2.8	54	7.9	497	72.6	103	15.0	12	1.7	--	--	--	--	685
South Dakota	9	1.8	26	5.0	284	54.6	49	9.4	49	9.4	--	--	103	19.8	520
Iowa	48	3.0	295	18.2	1,102	67.9	136	8.4	27	1.7	1	(2)	13	.8	1,622
Missouri	34	1.1	329	10.3	2,460	76.7	282	8.8	49	1.5	--	--	51	1.6	3,205
Kansas	62	4.0	95	6.1	1,122	72.4	47	3.1	166	10.7	1	.1	56	3.6	1,549
Oklahoma and Arkansas	110	4.3	209	8.2	1,730	68.1	101	4.0	334	13.2	5	.2	51	2.0	2,540
Texas	500	5.1	697	7.2	5,843	60.0	355	3.7	1,826	18.8	89	.9	422	4.3	9,732
Wyoming, Montana, Idaho	21	2.6	43	5.3	564	69.6	44	5.4	126	15.6	--	--	12	1.5	810
Colorado, Arizona, Utah, New Mexico	176	5.3	338	10.1	2,473	73.8	72	2.1	224	6.7	2	(2)	67	2.0	3,352
Washington	36	3.1	126	10.9	893	77.4	53	4.6	35	3.0	2	.2	9	.8	1,154
California, northern	157	7.7	272	13.4	1,412	69.3	33	1.6	147	7.2	1	(2)	17	.8	2,039
California, southern	351	7.9	557	12.6	3,089	69.8	71	1.6	339	7.7	10	.2	8	.2	4,425
Hawaii	16	7.1	27	11.9	176	77.5	--	--	6	2.6	--	--	2	.9	227
Other[3]	182	6.9	241	9.1	1,583	59.8	319	12.0	248	9.4	30	1.1	44	1.7	2,647
Imports[4]	16	2.6	32	5.3	555	91.7	1	.2	1	.2	--	--	--	--	605
Total or average	3,558	5.8	7,340	11.9	42,261	68.5	2,737	4.4	4,358	7.1	210	.3	1,221	2.0	61,685
Puerto Rico	468	47.5	66	6.7	382	38.7	--	--	22	2.2	5	.5	43	4.4	986

[1]Includes Puerto Rico.
[2]Less than 1/2 unit.
[3]Includes Georgia, Louisiana, Mississippi, Nevada, and Oregon.
[4]Cement imported and distributed by domestic producers only. Source of imports withheld to avoid disclosing company proprietary data.

Table 16.—Portland cement shipped from plants in the United States, by type[1]

Type	1981			1982		
	Quantity (thousand short tons)	Value[2] (thousands)	Average per ton	Quantity (thousand short tons)	Value[2] (thousands)	Average per ton
General use and moderate heat (Types I and II)	62,543	$3,192,940	$51.05	56,191	$2,788,208	$49.62
High-early-strength (Type III)	2,567	135,214	52.67	2,171	115,931	53.40
Sulfate-resisting (Type V)	200	12,633	63.17	247	14,715	59.57
Oil well	3,272	203,990	62.34	2,539	165,733	65.27
White	332	42,721	128.68	285	36,947	129.64
Portland slag and portland pozzolan	683	38,189	55.91	673	36,085	53.62
Expansive	55	3,648	66.33	29	2,147	74.03
Miscellaneous[3]	576	36,376	63.15	536	39,069	72.89
Total or average	70,228	3,665,711	52.20	[4]62,672	$3,198,835	51.04

[1]Includes Puerto Rico.
[2]Mill value is the actual value of sales to customers, f.o.b. plant, less all discounts and allowances, less all freight charges to customer, less all freight charges from producing plant to distribution terminal if any, less total cost of operating terminal if any, less cost of paper bags and pallets.
[3]Includes waterproof, low-heat (Type IV), and regulated fast-setting cement.
[4]Data do not add to total shown because of independent rounding.

PRICES

The average reported mill value of all types of portland cement decreased 2% in 1982, following a 9% average annual rate of increase from 1978 to 1981. The average reported mill value of masonry cement prepared at cement plants increased 4%, following a 6% average annual rate of increase from 1978 to 1981.

According to Engineering News-Record (ENR), yearend prices of bulk portland cement for 20 U.S. cities averaged $62.32 per ton.[4] This was 21% above the average reported mill value obtained from the Bureau of Mines canvass of cement producers. The lowest ENR quotation was $52 per ton for Philadelphia, and the highest was $78.50 per ton for Seattle.

Table 17.—Average mill value, in bulk, of cement in the United States[1]

(Per short ton)

Year	Portland cement	Prepared masonry cement[2]	All classes of cement
1978	$40.70	$50.53	$41.17
1979	46.24	54.59	46.61
1980	50.89	62.11	51.32
1981	52.20	59.29	52.46
1982	51.04	61.56	51.43

[1]Includes Puerto Rico. Mill value is the actual value of sales to customers, f.o.b. plant, less all discounts and allowances, less all freight charges to customer, less all freight charges from producing plant to distribution terminal if any, less total cost of operating terminal if any, less cost of paper bags and pallets.
[2]Masonry cement made at cement plants only.

FOREIGN TRADE

This section contains U.S. trade data reported by the U.S. Department of Commerce, Bureau of the Census. Import and export totals contain data for the United States plus U.S. possessions and territories.

Exports of hydraulic cement and clinker decreased 33% in 1982. Of 203,366 tons exported, 66% was shipped to Canada; 27%, to Mexico; and 7%, to 57 other countries. These exports accounted for 0.32% of shipments from U.S. and Puerto Rican mills, compared with 0.41% in 1981.

Imports of hydraulic cement and clinker decreased 27% to 2.9 million tons; of this, 16% was clinker, compared with 31% in 1981. Canada supplied 71% of the total, followed by Spain, 8%; Mexico, 5%; France, 4%; Australia, 4%; and 11 other countries, 8%. U.S. net import reliance, excluding Puerto Rico and the Virgin Islands, was 5% of apparent consumption.

Imports of white nonstaining portland cement decreased to 90,000 tons, 23% below 1981 imports. Canada was the primary source in 1982, providing 54% of the total, followed by Spain, 30%; Belgium-Luxembourg, 11%; French West Indies, 3%; and seven other countries, 2%. White cement imports from Canada were 10% greater than that of 1981.

Delta Cement, a subsidiary of the West German trading company Stinnes AG, closed its 33,000-ton terminal at Stockton, Calif. The terminal had been opened in 1981 for transshipment of imported cement from the Nihon Cement Co. of Japan.

Table 18.—U.S. exports of hydraulic cement and cement clinker, by country

Country	1980 Quantity (short tons)	1980 Value (thousands)	1981 Quantity (short tons)	1981 Value (thousands)	1982 Quantity (short tons)	1982 Value (thousands)
Bahamas	1,073	$180	3,126	$300	515	$70
Canada	123,283	9,571	208,278	18,251	134,340	18,748
Ecuador	279	107	517	210	751	177
Haiti	24	3	346	37	576	52
Leeward and Windward Islands	603	53	1,422	160	1,906	199
Mexico	54,658	4,927	69,968	7,374	54,878	5,145
Peru	22	9	1,575	347	428	79
Saudi Arabia	944	332	4,157	1,429	2,336	877
Venezuela	329	74	2,528	699	4,027	1,143
Other[1]	r5,189	r1,741	r10,860	r2,757	3,609	966
Total	186,404	16,997	302,777	31,564	203,366	27,456

rRevised.
[1]Includes 49 countries in 1980; 53, in 1981; and 50, in 1982.

Source: Bureau of the Census, U.S. Department of Commerce.

Table 19.—U.S. imports for consumption of hydraulic cement and clinker, by country

(Thousand short tons and thousand dollars)

Country	1980 Quantity	1980 Value Customs	1980 Value C.i.f.[1]	1981 Quantity	1981 Value Customs	1981 Value C.i.f.[1]	1982 Quantity	1982 Value Customs	1982 Value C.i.f.[1]
Australia	1	67	113	67	2,158	3,223	116	4,027	5,833
Bahamas	298	12,108	13,279	4	195	223	57	2,245	2,666
Canada	2,635	90,597	100,330	2,338	83,660	97,390	2,074	76,798	82,432
Denmark	24	944	1,041	52	1,997	2,517	52	1,629	2,232
France	251	13,699	14,274	239	12,614	13,351	131	6,058	6,296
Japan	619	20,822	25,757	569	20,944	26,032	87	3,153	4,519
Korea, Republic of	--	--	--	--	--	--	19	748	757
Mexico	329	13,841	15,924	83	4,623	4,625	132	6,154	6,228
Spain	479	22,458	28,461	322	12,357	15,800	245	8,626	11,891
Other	627	21,037	28,827	323	12,692	16,098	16	1,448	2,059
Total	5,263	195,573	228,006	3,997	151,240	179,259	2,929	110,886	124,912

[1]Cost, insurance, and freight.

Source: Bureau of the Census, U.S. Department of Commerce.

Table 20.—U.S. imports for consumption of clinker, by country

(Thousand short tons and thousand dollars)

Country	1980 Quantity	1980 Value Customs	1980 Value C.i.f.[1]	1981 Quantity	1981 Value Customs	1981 Value C.i.f.[1]	1982 Quantity	1982 Value Customs	1982 Value C.i.f.[1]
Canada	800	25,787	27,998	578	19,421	21,570	320	11,326	12,621
France	249	13,554	14,114	239	12,605	13,336	130	6,057	6,296
Japan	506	16,797	20,838	374	12,938	16,442	--	--	--
Spain	298	16,270	18,629	34	1,152	1,359	--	--	--
Other	64	1,523	2,163	1	331	435	20	1,002	1,003
Total	1,917	73,931	83,742	1,226	46,447	53,142	470	18,385	19,920

[1]Cost, insurance, and freight.

Source: Bureau of the Census, U.S. Department of Commerce.

Table 21.—U.S. imports for consumption of hydraulic cement and clinker, by customs district and country

(Thousand short tons and thousand dollars)

Customs district and country	1981			1982		
	Quantity	Value		Quantity	Value	
		Customs	C.i.f.[1]		Customs	C.i.f.[1]
Anchorage: Canada	14	1,124	1,633	45	2,011	2,346
Baltimore:						
Germany, Federal Republic of	([2])	1	3	--	--	
Yugoslavia	1	131	139	--	--	--
Total[3]	1	132	143	--	--	--
Bridgeport: Canada	--	--	--	([2])	3	3
Buffalo:						
Canada	690	23,713	26,732	643	23,691	25,849
Ecuador	2	61	68	--	--	--
Italy	([2])	1	1	--	--	--
Total	692	23,775	26,801	643	23,691	25,849
Chicago:						
Canada	--	--	--	([2])	([2])	1
Germany, Federal Republic of	--	--	--	([2])	1	1
United Kingdom	([2])	([2])	2	--	--	--
Total	([2])	([2])	2	([2])	1	2
Cleveland: Canada	26	864	1,004	([2])	([2])	1
Detroit:						
Belgium-Luxembourg	([2])	1	3	--	--	--
Canada	492	17,298	18,990	239	11,957	12,582
Total[3]	492	17,300	r18,993	239	11,957	12,582
Duluth: Canada	5	148	238	86	2,921	3,285
El Paso:						
Germany, Federal Republic of	([2])	([2])	1	--	--	--
Mexico	1	61	61	22	1,129	1,129
Total	1	61	62	22	1,129	1,129
Galveston:						
Canada	27	1,065	1,331	--	--	--
Mexico	--	--	--	--	--	--
Spain	34	1,142	1,340	--	--	--
Total[3]	60	2,207	2,671	--	--	--
Great Falls: Canada	4	568	670	5	414	414
Honolulu: Japan	([2])	6	11	--	--	--
Houston:						
Germany, Federal Republic of	([2])	6	9	([2])	24	26
United Kingdom	([2])	148	190	--	--	--
Total[3]	([2])	155	r199	([2])	24	26
Laredo:						
Canada	([2])	23	23	--	--	--
China	--	--	--	([2])	7	8
Mexico	80	4,364	4,366	83	3,773	3,795
Total[3]	81	4,388	4,389	83	3,780	3,803
Los Angeles:						
Australia	67	W	W	116	W	W
Canada	([2])	W	W	--	--	--
Germany, Federal Republic of	([2])	W	W	([2])	W	W
Japan	([2])	W	W	--	--	--
Spain	1	W	W	([2])	W	W
Yugoslavia	([2])	W	W	2	W	W
Total	68	2,888	4,311	118	4,639	6,000
Miami:						
Bahamas	4	195	223	38	1,502	1,805
Belgium-Luxembourg	1	71	116	4	257	420
Canada	10	299	339	--	--	--

See footnotes at end of table.

Table 21.—U.S. imports for consumption of hydraulic cement and clinker, by customs district and country —Continued

(Thousand short tons and thousand dollars)

Customs district and country	1981 Quantity	1981 Value Customs	1981 Value C.i.f.[1]	1982 Quantity	1982 Value Customs	1982 Value C.i.f.[1]
Miami —Continued						
Colombia	47	1,226	2,129	--	--	--
Denmark	52	1,801	2,265	52	1,627	2,232
Italy	(2)	3	3	--	--	--
Mexico	--	--	--	6	217	245
Spain	211	6,536	8,577	146	4,229	6,036
Total[3]	325	10,131	13,653	246	7,832	10,738
Milwaukee: Canada	--	--	--	21	661	715
New Orleans:						
Canada	43	1,312	2,012	20	666	972
Germany, Federal Republic of	(2)	14	19	--	--	--
Hong Kong	--	--	--	(2)	52	53
Spain	4	102	158	--	--	--
United Kingdom	(2)	10	12	--	--	--
Total[3]	46	1,438	2,200	20	718	1,025
New York City: Norway	70	1,836	2,643	--	--	--
Nogales: Mexico	1	62	62	(2)	10	10
Norfolk:						
Canada	--	--	--	(2)	4	4
France	45	4,602	4,739	24	2,439	2,503
Germany, Federal Republic of	(2)	1	1	(2)	4	5
Total	45	4,603	4,740	24	2,447	2,512
Ogdensburg: Canada	72	2,330	2,582	163	5,043	5,043
Pembina: Canada	85	4,189	4,758	54	2,827	2,827
Philadelphia: Germany, Federal Republic of	(2)	6	7	--	--	--
Portland, Maine: Canada	13	387	389	10	337	337
Portland, Oreg.: Canada	10	498	529	--	--	--
St. Albans:						
Canada	396	11,404	14,859	468	14,112	14,112
South Africa, Republic of	(2)	2	2	--	--	--
Total	396	11,406	14,861	468	14,112	14,112
San Diego:						
Japan	65	3,197	3,409	70	2,583	3,672
Mexico	1	136	136	15	824	824
United Kingdom	72	3,666	3,839	--	--	--
Total[3]	139	6,999	7,384	85	3,407	4,496
San Francisco:						
Finland	(2)	28	45	--	--	--
Japan	112	4,038	5,404	18	569	838
Korea, Republic of	--	--	--	19	748	757
Total	112	4,066	5,449	37	1,317	1,595
San Juan, Puerto Rico:						
Belgium-Luxembourg	7	753	1,116	6	593	910
Canada	3	297	462	5	521	880
Colombia	1	101	122	1	65	74
France	(2)	4	8	--	--	--
Spain	8	891	1,426	3	249	395
Total[3]	19	2,047	3,134	15	1,428	2,259
Seattle:						
Canada	108	5,099	5,352	78	3,194	3,670
Japan	391	13,258	16,584	(2)	6	9
Total	499	18,357	21,936	78	3,200	3,679
Tampa:						
Bahamas	--	--	--	19	741	861
Canada	340	13,040	15,485	165	7,715	9,328
Denmark	1	230	290	--	--	--

See footnotes at end of table.

Table 21.—U.S. imports for consumption of hydraulic cement and clinker, by customs district and country —Continued

(Thousand short tons and thousand dollars)

Customs district and country	1981 Quantity	1981 Value Customs	1981 Value C.i.f.[1]	1982 Quantity	1982 Value Customs	1982 Value C.i.f.[1]
Tampa —Continued						
France	194	W	W	107	W	W
Mexico	--	--	--	6	206	233
Norway	76	2,459	2,970	--	--	--
Spain	64	W	W	96	W	W
Sweden	--	--	--	--	--	--
United Kingdom	30	1,016	1,195	70	39	54
Total	705	28,265	32,537	463	16,652	19,674
Virgin Islands of the United States:						
Dominican Republic	2	115	170	1	157	233
French West Indies	13	890	1,099	3	168	217
Total	15	1,005	1,269	4	325	450
Grand total[3]	3,997	151,240	179,259	2,929	110,886	124,912

W Withheld to avoid disclosing company proprietary data; included in "Total."
[1]Cost, insurance, and freight.
[2]Less than 1/2 unit.
[3]Data may not add to totals shown because of independent rounding.

Source: Bureau of the Census, U.S. Department of Commerce.

Table 22.—U.S. imports for consumption of cement and clinker

(Thousand short tons and thousand dollars)

Year	Roman, portland, other hydraulic cement Quantity	Roman, portland, other hydraulic cement Value (customs)	Hydraulic cement clinker Quantity	Hydraulic cement clinker Value (customs)	White nonstaining portland cement Quantity	White nonstaining portland cement Value (customs)	Total Quantity	Total Value (customs)
1978	3,589	119,048	2,968	69,264	40	2,330	6,597	190,642
1979	4,664	165,258	4,668	131,873	81	5,227	9,413	302,358
1980	3,232	115,271	1,917	73,931	114	6,371	5,263	195,573
1981	2,654	94,653	1,226	46,447	117	10,140	3,997	151,240
1982	2,369	81,710	470	18,385	90	10,791	2,929	110,886

Source: Bureau of the Census, U.S. Department of Commerce.

WORLD REVIEW

World cement production in 1982 remained essentially the same as in 1981. The continued slump in public works and private construction activity in most industrialized nations in 1982 was viewed as the primary contributor to the state of the cement industry that was reflected in the decline in plant expansions and construction. Less developed countries, however, continued a flurry of activity involving plant capacity expansions, construction, and modernizations; these countries were, in order of cement production, China, India, and the Republic of Korea.

Some countries continued attempts to develop new markets for the sale of their excess cement. For example, the German Democratic Republic continued to seek markets in Western Europe; Japan, Australia, and the Republic of Korea exported to the United States west coast markets; and Mexico continued attempts to capture a greater share of the United States markets by expanding exports beyond the California coast to include the gulf and Atlantic seaboards.

Energy conservation continued to be an area of concern to cement producers worldwide. This was reflected in the industry's switch to the dry-process and to the addition of preheaters. Also, the industry continued to reduce its dependence on oil by converting to coal as the major source of kiln fuel.

Rock Products magazine published its annual International Cement Review covering significant worldwide happenings in the cement industry.[5]

Argentina.—Although cement production in Argentina declined during the previous 4 years, the industry continued with new plant construction, as well as modifications to existing plants. Cementera Santa Cruz S.A. was completing work on its 1,900-ton-per-day cement plant in Santa Cruz Province; Cementos N.O.A.'s Rio Juramento cement plant near Salta was expected to open in 1983 with a capacity of 689,000 tons per year; and Juan Minetti S.A. completed construction of its 790,000-ton-per-year cement plant in Jujuy Province. Together, these plants were expected to increase Argentina's annual production capacity to 12.8 million tons.

Australia.—Northern Cement Pty. Ltd. announced the construction of a clinker grinding plant in Darwin, Northern Territory. Commissioning was expected in 1984. The firm was jointly owned by Adelaide Brighton Cement Ltd. and Burns Philip and Co. Ltd.

Benin.—A 550,000-ton-per-year plant built jointly for Benin and Nigeria was commissioned in 1982. The plant, the country's newest, was to be operated by Société des Ciments d'Onigbolo. Although the plant is located in Benin, most of the cement was to be exported to Nigeria.

Brazil.—Cement production capacity continued to increase because of plant construction and modernization. Camargo Correa Industrial S.A. was installing a coal-grinding system and new cement mills, including a new kiln at its Eldorado plant in Apiai; Cimento Mava S.A. opened its 2,200-ton-per-day plant in Contegalo. The latter facility was considered to be the most modern cement plant in South America. Cia. de Cimento Portland Rio Branco completed construction of two new 2,400-ton-per-day production lines at its plant at Curitiba in Parana; Cimento Santa Rita S.A. at Sao Paulo, increased clinker production at its No. 4 kiln from 880 to 1,490 tons per day; and Cimento Tupi S.A. added a precalcining system to its Pedra do Sino plant and increased its clinker production by 220 tons per day. Cimento Tupi formed, with a coal mining group, a joint venture to build a clinker grinding plant at Porto Alegre in the State of Grande do Sul; the plant, with a 330,000-ton-per-year grinding capacity, was to go into operation in mid-1983.

Canada.—Canadian cement shipments in 1982 decreased about 20% from those of 1981 because of canceled or postponed construction projects in Quebec and eastern Canada caused in part by decreased exports to the United States. Western Canada, which had enjoyed increased construction activity during the last decade, required 16% less cement in 1982 than that of 1981. Cement exports decreased 16%, while clinker exports decreased 45%.[6]

Chile.—Fábrica de Cemento el Melón S.A., owned by Blue Circle Industries Ltd., completed installation of a new preheater and precalciner four-stage kiln at its LaCalera plant, thereby raising its annual capacity by 100% to 1.6 million tons.

Germany, Federal Republic of.—West German cement producers continued to convert their plants from oil to coal. During the past 10 years, cement producers have reduced their dependence on oil from 80% to 8%.

West German cement production declined for the third consecutive year. According to Bundesverband der Deutschen Zementindustrie e.v., the industry did not foresee any improvement and expected to reach a production low in 1983.

Greece.—Cement production in Greece remained the same as in 1982. The Greek Government was reviewing applications for constructing eight cement plants in various parts of the country. If all applications are approved, the new plants were expected to add 14 million tons to the country's annual cement production capacity.

India.—The Indian cement industry continued to pursue an aggressive program of expansion by operating existing plants at production capacity, by modernizing others, and by establishing large modern cement plants as well as cement miniplants. Plans called for expanding existing production capacity by 49% to 48 million tons by 1985.

Indonesia.—Cement production, consumption, and imports increased for the fourth successive year, while exports declined. During 1982, the Indonesia Cement Association reported a production increase of 7% and a consumption increase of 8.5%. The difference between domestic supply and demand was balanced by imports from Japan, the Republic of Korea, and Singapore. Exports, which decreased 361% from those of 1981, went to India and Thailand. Plant expansions and modernizations scheduled to come onstream by 1985 were expected to more than double Indonesia's existing annual cement production capacity of 8.7 million tons.

Iraq.—With several new plants under development and an increase in capacity planned for some existing plants, Iraq planned to triple its cement production by 1987. Iraq produced about 6 million tons in 1982, and imports rose significantly.

Ireland.—Irish Cement Ltd. continued expansion of its Limerick cement plant, which, when completed, was expected to add 2,300 tons per day of capacity.

Japan.—A decline in both public works and private construction was viewed as the primary cause of decreases in cement production and shipments during 1982. Exports increased significantly, rising to 12.3 million tons, the highest level since 1979. Improvements in exports were attributed to increased sales to customers in Southeast Asia and the Middle East.

The Japanese cement industry completed its conversion from use of oil to coal.

Jordan.—Construction work continued on a 2.2-million-ton-per-year cement plant at Rashadiya in southern Jordan. The plant, which was expected to begin producing in 1984, was to produce cement for shipment to Iraq and Saudi Arabia.

Jordan Cement Factories Co. Ltd. completed expansion of a new 3,300-ton-per-day production line at the Fuhais plant and was planning an additional 3,300-ton-per-day production line at this same plant.

A 110,000-ton-per-year white cement facility built near Amman by a Jordanian-Syrian consortium was scheduled to go onstream in 1982.

Korea, Republic of.—Cement production in 1982 increased about 15%, while exports remained near the 1981 level. The Republic of Korea continued to build its export capabilities and began exporting to Hawaii. Most of its 1982 cement exports went to India, Hong Kong, Singapore, Saudi Arabia, and the United Arab Emirates.

Lebanon.—In the latter part of 1982, Société des Ciments Libanais announced plans to convert two production lines at its Chekka cement plant from wet to dry process. The conversion would increase each kiln capacity by 100% to 3,300 tons per day.

Malaysia.—Kedah Cement Sdn. Bhd. continued plans to build a 4,400-ton-per-day plant in Pulava Langkawi, Keda State. The plant was expected to begin production in 1984. Clinker from the plant was planned for export to Singapore. In other activity, Perak-Hanjoong Simen Sdn. Bhd. continued plans to build a 1.3-million-ton-per-year plant in Perak, due to go onstream in 1985. Associated Pan Malaysia Cement Sdn. Bhd. was building a new 550,000-ton-per-year dry-process line, scheduled to go onstream in 1984 to replace two wet-process lines at its Konthan plant; Blue Circle, which owned 30% of the company, was the consultant.

Mexico.—The Mexican cement industry continued work on plant construction and expansions that reportedly would result in a considerable amount of excess clinker production during 1983. Cementos Tabasco (Apasco Group) began operating its 830,000-ton-per-year plant in Macuspana, and Cementos de Chihuahua S.A. completed expansion of its Chihuahua plant by adding a 1,900-ton-per-day production line. Plant expansions by three other Mexican cement producers were expected to add 7,600 tons per day to capacity when completed in 1983.

Oman.—Oman Cement Co. continued construction of its 660,000-ton-per-year plant in Rusayal. The plant was expected to begin production in 1984. Another plant in the southern Province of Dhofar was under construction. The 230,000-ton-per-year plant was expected to supply the local needs of southern Oman.

Saudi Arabia.—Saudi Arabia's requirements for cement continued to grow. The country's needs were met principally by imports, which had increased about 15% during each of the past several years. Several companies were planning plant modernizations or new plant construction, which would add substantially to the country's cement production capacity. Saudi Kuwaiti Cement Manufacturing Co. was planning the largest cement plant ever to be built in Saudi Arabia, with a capacity of 8,400 tons per day. The plant, near Khursaniyah, was scheduled to begin production in 1984. In addition, a 220,000-ton-per-year white cement plant was being planned by Saudi White Cement Co. near Riyadh.

South Africa, Republic of.—Cement production in the Republic of South Africa remained the same in 1982, according to the South African Cement Producers Association. The Republic of South Africa's installed cement production capacity at the end of 1982 was 8.8 million tons. Several cement-producing companies planned plant expansions and construction, which, when completed, would substantially increase the country's cement production capacity.

Spain.—Spain, the world's leading exporter of cement, exported about 50% of its production. Most of these exports went to Saudi Arabia, Nigeria, and Egypt.

Switzerland.—The Swiss cement industry completed its switch from oil to coal firing in 1982.

Turkey.—Turkey's annual cement production capacity, 22 million tons, was expected to increase in 1983 when seven new dry-process cement plants, each with a 1,900-ton-per-day capacity, were scheduled to go onstream. The new plants are located at Edirne, Denizli, Ladik, Ergani, Adiyaman, Urfa, and Siirt.

United Kingdom.—Blue Circle announced plans to spend $74 million in 1983-84 as part of a $490 million, 5-year program to strengthen the company's cement production and distribution operations in the United Kingdom. Planned improvements included installation of air suspension precalcining processes; installation of improved process control equipment; and installation of new bagging, storage, and loading systems.

Blue Circle announced plans to update a plant that converts refuse to cement kiln fuel. The plant, at the company's Westbury Works in Wiltshire, had been the first commercial plant of its type in the world using processed refuse to replace about 10% of the coal used as the main kiln fuel. The project was expected to be completed in 1983.

Use of cement-extending materials was an area of consideration by cement producers in the United Kingdom. While the use of energy-saving extenders such as fly ash and furnace slag in cement manufacture and as additions to concrete mixes had been widely accepted in many parts of the world, particularly in Europe, these materials had seen only limited use in the United Kingdom. Because of continuing high energy costs in cement manufacture, increased use of extender materials in the United Kingdom was predicted.[7]

Table 23.—Hydraulic cement: World production, by country[1]

(Thousand short tons)

Country	1978	1979	1980	1981[p]	1982[e]
Afghanistan[2]	140	155	[e]55	[e]65	65
Albania[e]	[r]880	[r]930	1,100	1,200	1,200
Algeria	2,973	4,153	4,410	[e]4,630	4,630
Angola[e]	440	440	265	275	275
Argentina	6,962	7,349	7,863	7,328	[3]6,158
Australia	5,504	5,779	6,059	6,554	6,100
Austria	6,482	6,185	6,013	5,829	5,800
Bahamas	364	496	520	32	55
Bangladesh[4]	373	355	370	380	[3]359
Belgium	8,351	8,491	8,247	8,270	8,200
Bolivia	280	277	327	402	[3]330
Brazil	24,559	27,419	29,975	31,415	28,000
Bulgaria	5,676	5,954	5,907	5,989	6,200
Burma	280	431	426	420	340
Cameroon	[e]390	540	250	[e]300	300
Canada	11,374	12,969	11,571	11,183	[3]9,279
Cape Verde Islands[e]	17	17	17	18	18
Chile	1,297	1,491	1,727	2,036	1,200
China	71,914	81,461	88,030	92,600	104,000
Colombia	4,578	4,693	4,796	5,730	[3]5,545
Costa Rica	540	582	610	765	830
Cuba	2,989	2,879	3,121	3,629	[3]3,487
Cyprus	1,220	1,251	1,359	1,141	1,100
Czechoslovakia	11,248	11,307	11,624	11,735	11,400
Denmark	2,895	2,659	2,113	1,766	1,760
Dominican Republic	956	977	1,119	1,048	1,000
Ecuador	919	1,211	1,531	1,600	1,500
Egypt	3,307	3,260	3,338	[e]3,910	[3]4,696
El Salvador	502	642	573	550	550
Ethiopia	95	102	121	154	175
Fiji	90	106	93	101	105
Finland	1,878	1,928	1,976	1,970	2,000
France	30,892	31,774	32,082	31,117	28,800
Gabon	15	[r]101	121	165	190
German Democratic Republic	13,802	13,529	13,717	13,780	13,780
Germany, Federal Republic of	38,915	40,415	39,183	36,408	35,300
Ghana	[e]551	[r]298	265	442	440
Greece	12,434	13,336	14,495	14,880	14,880
Guatemala	568	632	627	626	600
Haiti	274	[r]261	268	252	254
Honduras	298	[r]255	490	248	275
Hong Kong	1,362	1,410	1,641	1,660	1,540
Hungary	5,251	5,354	5,137	5,110	[3]4,815
Iceland	147	139	134	134	130
India	21,561	20,133	19,511	22,885	24,800
Indonesia	4,072	5,179	6,417	7,544	8,200

See footnotes at end of table.

Table 23.—Hydraulic cement: World production, by country[1] —Continued

(Thousand short tons)

Country	1978	1979	1980	1981[p]	1982[e]
Iran	13,227	9,921	8,818	[e]8,820	10,470
Iraq	5,070	5,622	6,063	6,170	6,170
Ireland	1,991	2,278	2,059	2,136	2,100
Israel	2,200	2,116	2,302	2,271	2,200
Italy	42,144	43,309	46,046	45,804	[3]46,297
Jamaica	324	249	159	180	180
Japan	93,566	96,787	96,956	93,511	92,600
Jordan	622	882	882	983	880
Kampuchea[e]	11	--	--	--	--
Kenya	1,240	938	1,402	[e]1,430	1,430
Korea, North[e]	7,717	8,818	8,818	8,800	8,800
Korea, Republic of	16,681	18,092	17,230	17,215	19,717
Kuwait	685	1,146	1,441	1,707	1,700
Lebanon	1,522	2,239	[e]2,425	2,635	2,200
Liberia	146	150	117	[e]110	87
Libya[e]	3,527	3,527	3,527	3,530	4,400
Luxembourg	343	351	358	330	330
Madagascar	73	77	66	70	71
Malawi	114	114	101	86	88
Malaysia	2,421	2,497	2,589	3,123	3,300
Mali	38	29	22	[e]22	22
Mexico	15,494	16,731	17,924	19,914	19,842
Mongolia[e]	183	202	196	231	390
Morocco	3,107	3,611	3,915	[e]3,970	3,970
Mozambique	360	301	303	413	500
Nepal	40	24	34	34	28
Netherlands	4,319	4,080	4,128	3,858	4,000
New Caledonia	61	62	62	55	60
New Zealand	880	833	827	833	860
Nicaragua	219	95	170	110	110
Niger	[e]45	42	45	41	44
Nigeria	1,693	1,918	2,205	[e]2,800	2,800
Norway	[r]2,460	2,422	2,307	1,964	[3]1,879
Pakistan	3,420	3,768	3,677	3,900	4,200
Panama	331	562	623	573	580
Paraguay	183	171	195	177	170
Peru	[r]2,227	2,643	2,391	3,395	[3]2,855
Philippines[5]	4,784	4,354	4,941	4,508	4,400
Poland	23,920	21,138	20,330	15,680	17,680
Portugal	5,644	5,664	6,336	6,280	6,400
Qatar	229	[r]275	230	284	300
Romania	16,191	17,194	17,208	16,260	16,500
Saudi Arabia	1,984	2,425	3,858	5,510	6,600
Senegal	394	420	426	425	400
Singapore[e]	1,488	1,488	2,152	2,200	2,200
South Africa, Republic of	7,522	7,606	7,937	[e]8,800	8,800
Spain (including Canary Islands)[6]	33,326	30,768	30,875	31,693	32,000
Sri Lanka	634	653	629	708	720
Sudan	207	203	204	134	220
Suriname	66	68	76	78	80
Sweden	2,592	2,631	2,778	2,557	[3]2,538
Switzerland	4,075	4,336	4,687	4,800	4,600
Syria	1,580	2,036	2,199	2,458	2,480
Taiwan	12,633	13,115	15,501	15,810	[3]14,806
Tanzania	255	309	1,213	1,325	1,320
Thailand	5,612	5,793	5,883	6,904	7,300
Trinidad and Tobago	243	236	202	151	265
Tunisia	972	1,524	1,962	2,210	2,200
Turkey	16,914	15,194	14,192	16,582	16,600
Uganda	[e]88	55	11	22	33
U.S.S.R	139,945	135,605	137,843	140,180	[3]136,686
United Arab Emirates	[r]1,366	[r]1,400	1,896	2,447	3,300
United Kingdom	17,544	17,791	16,323	14,140	14,300
United States (including Puerto Rico)	85,480	85,904	76,709	72,932	[3]64,341
Uruguay	[r]756	[r]759	756	672	720
Venezuela	3,777	4,386	5,338	5,400	[3]6,166
Vietnam[e]	929	804	706	720	880
Yemen Arab Republic	69	99	89	90	94
Yugoslavia	9,588	[r]10,011	10,268	10,779	10,700
Zaire	520	496	449	[e]440	440
Zambia	136	220	176	154	[3]170
Zimbabwe	450	437	[e]440	[e]440	440
Total	[r]940,212	[r]961,309	974,800	983,250	982,670

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through June 22, 1983.
[2]Year beginning Mar. 21 of that stated.
[3]Reported figure.
[4]Data for year ending June 30 of that stated.
[5]Converted from officially reported data provided in terms of bags of cement. Conversion factor used assumes the bags reported are bags of 94 pounds, but this may be in error for at least a part of the total.
[6]Excludes natural cement.

TECHNOLOGY

Cement.—The Bureau of Mines completed an extensive characterization of dusts generated from cement kilns in the contiguous United States and Hawaii.[8] The mineralogical and chemical composition was determined for 113 cement kiln dust (CKD) samples taken from 102 plants. The hazardous waste potential of CKD was assessed by performing U.S. Environmental Protection Agency Extraction Procedure toxicity tests on all 113 CKD samples. Only one of the samples tested contained a leachate concentration that did not comply with the specification; it slightly exceeded the toxicity criterion for lead.

The Bureau of Mines determined the concentrations of fluoride, chloride, phosphate, nitrate, and sulfate in waste CKD. Utilizing 113 CKD samples evenly representing wet and dry rotary kiln processes, the Bureau developed a rapid analytical method for the determination of anions in CKD by ion chromatography (IC). The procedure employs a sodium carbonate fusion of the sample followed by a water leach. Excellent agreement was obtained with the National Bureau of Standards (NBS) certified values for fluoride, phosphate, and sulfate using seven NBS cement standards. In addition, good agreement was obtained for fluoride, chloride, and sulfate values in CKD when the IC method was compared to various wet-chemical methods.[9]

The Bureau of Mines published a report of investigations containing the results of tracer gas studies conducted at three facilities where bagger hoods had been installed several years ago.[10] Bagger hoods have specific application to packaging cement and other dry products that result in the displacement of dust-laden air. The objective of the studies was to reduce worker exposure to respirable dust without interfering with bag-filling operations. Results showed that bagger hoods and their related ventilation systems can be an effective method of removing airborne silica dust from the vicinity of the bagging operator. For optimum benefit, the study concluded that (1) makeup air must be evenly dispersed, (2) the hood enclosures and dust systems must be as airtight as possible, (3) the hood and collector must be designed so that a minimum velocity of 200 feet per minute is maintained in the front of the hood, and (4) the hoods and duct systems must be properly maintained.

Brookhaven National Laboratory researchers identified commercial calcium silicate-bearing portland cement Type III as a promising regenerative sorbent for the removal of sulfur in fluidized-bed combustion of coal. Experiments involved agglomeration of the cement in a drum to form pellets. Bench-scale testing indicated acceptable performance of the pellets as well as improved economy compared with that of the conventional limestone desulfurization process.[11]

Hercules Cement Co., Stockertown, Pa., began marketing a new Type V sulfate-resistant cement that has as its primary characteristic a tricalcium aluminate content of less than 5%. The cement is used primarily in construction of water and sewage treatment plants, chemical plants, concrete pipe, and other high-sulfate applications.[12]

Electric Power Research Institute completed initial development of an acid-leaching process to extract metals from fly ash and was planning a 3-year, $600,000 scale-up project to obtain more information on the economics of operating a large-scale extraction system. Research indicated that utilities can recover large quantities of aluminum and iron to augment income from the sale of limited quantities of fly ash to concrete manufacturers for use as a substitute for portland cement.[13]

Marketing Consultants International, a Frankfurt-based company, announced development of a new cementless structural material that is considerably cheaper than conventional concrete. Known as Gralitbeton, the material comprises a mixture of 96% sand, containing less than 2% calcium, and 4% resin binder and is similar in appearance to natural sandstone. Since water is not necessary for its manufacture, the material should have particular appeal to third world countries where neither the usual concrete ingredients or water are readily available.[14]

Concrete.—According to Bureau of Mines supported research conducted by the University of California, Los Angeles (UCLA), slate-limestone glasses made from rock wastes continue to look promising as an inexpensive substitute for asbestos as a cement reinforcement. High alkali resistance and low cost are primary virtues of asbestos when used as a cement reinforcing material, and the new glass fibers also appear to be alkali resistant. UCLA is continuing its research to identify reasons why the material is so alkali resistant. In addition, Mansville Service Corp., under contract with the Bureau of Mines, was demonstrating that the material can be produced under industrial conditions. A sufficient quantity to thoroughly test the material as a cement reinforcement was to be produced.[15]

SRI International concluded studies on the potential use of glass-reinforced concrete in solar collectors. The Menlo Park, Calif., research firm, under contract with the U.S. Department of Energy, developed a glass fiber-reinforced concrete solar collector substructure. The substructure was constructed using a mixture of sand-portland cement concrete and alkali-resisting glass fibers. The new technology promises a lightweight solar collector structure that is lower in cost than standard aluminum and steel solar collectors. This is particularly significant because material for the collector substructure accounts for 40% of the total cost of a solar thermal powerplant.[16]

A Sarasota, Fla., consulting engineer developed and patented a superhydrated process for production of pervious concrete pavement to overcome drainage problems. The material is both strength and wear resistant. Other distinct features of the material include its ability to produce high-strength, long-life concrete in relatively thin sections, 4 to 5 inches instead of 8 to 10 inches; its bending resilience, making it suitable as a concrete overlay; its skid-resistant qualities; and its rapid setting ability.[17]

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[1]Mineral specialist, Division of Industrial Minerals.

[2]Supervisory mineral specialist, Division of Industrial Minerals.

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[4]Engineering News-Record. ENR Materials Prices. V. 210, No. 1, Jan. 6, 1983, pp. 34-35.

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[8]Haynes, B. W., and G. W. Kramer. Characterization of U.S. Cement Kiln Dust. BuMines IC 8885, 1982, 19 pp.

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[11]Yoo, H., P. J. McGauley, and M. Steinberg. Calcium Silicate Cements for Desulfurization of Combustion Gases. Brookhaven Nat. Lab., Upton, N.Y., June 1981, 46 pp.; NTIS DE82003245.

[12]Rock Products. V. 85, No. 7, July 1982, p. 30.

[13]Mining Congress Journal. V. 68, No. 5, May 1982.

[14]Quarry Management and Products (Nottingham, England). V. 9, No. 10, October 1982, p. 670.

[15]Chemical & Engineering News. V. 61, No. 3, January 1983, p. 47.

[16]Engineering News-Record. V. 208, No. 25, June 24, 1982, p. 21.

[17]Page 12 of work cited in footnote 16.

Chromium

By John F. Papp[1]

In 1982, chromium consumption continued to decrease and was about 240,000 short tons, a drop of 29% from that of 1981 and at its lowest level since before 1955. The decrease is a reflection of the continued weak demand for steel. Imports of chromite dropped, reaching the lowest level since 1939, while imports of ferrochromium were at their lowest level in 11 years. Domestic ferrochromium production declined reaching its lowest level since before 1959.

As a result of weak demand and expiration of the penalty duty on imports of high-carbon ferrochromium, the price of both chromite and ferrochromium declined in 1982.

Domestic Data Coverage.—Domestic production data for chromium ferroalloys and metal are developed by the Bureau of Mines by means of two separate, voluntary domestic surveys. These two surveys are the monthly Chromite Ores and Chromium Products and the annual Ferroalloys. The eight metallurgical industry operations listed in table 3 represent 100% of domestic production shown in table 4. Eighty-eight percent of those operations responded to both the Chromite Ore and Chromium Products and the Ferroalloys surveys.

Table 1.—Salient chromium statistics

(Thousand short tons)

	1978	1979	1980	1981	1982
CHROMITE					
United States:					
Exports	23	27	6	71	8
Reexports	29	28	44	67	57
Imports for consumption	1,013	1,024	982	898	507
Consumption	1,010	r1,214	r977	889	545
Stocks, Dec. 31: Consumer	1,301	907	675	r728	545
World: Production	r12,064	r12,170	12,386	p11,736	e10,907
CHROMIUM FERROALLOYS[1]					
United States:					
Production	199	273	[2]239	[2]226	[2]119
Exports	12	15	32	14	5
Reexports	1	1	1	1	([3])
Imports for consumption	327	242	302	440	148
Consumption	486	528	412	423	262
Stocks, Dec. 31: Consumer	79	56	58	54	26
World: Production	3,033	3,458	3,490	p3,308	e3,016

eEstimated. pPreliminary. rRevised.
[1]High- and low-carbon ferrochromium plus ferrochromium-silicon.
[2]Includes chromium metal, exothermic chromium additives, and other miscellaneous chromium alloys.
[3]Less than 1/2 unit.

Legislation and Government Programs.—No new stockpile goals for chromium materials were set in 1982 by the Federal Emergency Management Agency. Current goals and inventories are shown in table 2. There were no stockpile acquisitions or disposals of chromium materials in 1982.

The U.S. Department of Commerce investigated the threat of imported ferroalloys to impair national security, including ferrochromium, at the request of The Ferroalloy Association under section 232 of the Trade Expansion Act of 1962. Commerce submitted its investigation report and recommendations to the President in August, whereupon the report was reviewed by the National Security Council and the Office of Management and Budget. In December, the President directed further investigation into the impact of duties, tariffs, and breakpoint prices on imports and foreign trade. At the same time, the President endorsed upgrading of stockpiled chromite, among other ores.

The Environmental Protection Agency (EPA) set out its final regulations in accordance with the Clean Water Act on pollutants discharged in wastewater from inorganic chemical plants. The regulations published in June became effective in August. EPA estimates that the final regulation will result in the removal of 3 million pounds of chromium from wastewater. Included in the regulation coverage are chrome pigments and sodium dichromate. Among the eight control and treatment options on which the final rule is based are sulfur dioxide, ferrous iron, or sulfide reduction to reduce hexavalent chromium to trivalent chromium in preparation for alkaline precipitation.

The penalty duty on the imported high-carbon ferrochromium valued at less than 38 cents per pound of contained chromium expired in November. That penalty duty had been in effect since 1978.

Table 2.—Stockpile goals and Government inventories for chromium as of December 31

(Thousand short tons)

Material	Stockpile goals	Inventory	
		Stockpile grade	Nonstockpile grade
Chromite, metallurgical	3,200	1,957	531
Chromite, chemical	675	242	--
Chromite, refractory	850	391	--
High-carbon ferrochromium	185	402	1
Low-carbon ferrochromium	75	300	19
Ferrochromium-silicon	90	57	1
Chromium metal	20	4	--

DOMESTIC PRODUCTION

The major marketplace chromium products are chromite, alloys, chemicals, and metal. In 1982, the United States produced alloys, chemicals, and metal from imported chromite. No chromite was mined domestically.

The U.S. Geological Survey reported on the mineral potential of Alaska. The Survey has begun a study of chromite, among several minerals, in the State. The Anaconda Minerals Company completed drilling chromite deposits at Red Mountain on the Kenai Peninsula, and the company entered into a 7-year exploration agreement with the Cook Inlet Native Corp.

In California, two chromite-related projects are in progress. Noranda Exploration Inc. is planning to investigate chromite deposits along the California-Oregon border owned by Baretta Mining Inc. California Nickel Corp. is continuing development of its nickel deposit near Gasquet in Del Norte County, Calif. Chromite concentrates, among other minerals, reportedly will be byproducts of the operation. California Nickel and Cook International Inc. formed a limited partnership for this development in which Cook International provides $4 million in return for 10% interest.

Chromium ferroalloy and metal production in 1982 was 119,285 tons. Macalloy, Inc., which stopped ferrochromium production in 1981, began negotiating a takeover by Philipp Bros., Inc. (Phibro), its major creditor. The takeover negotiations were terminated without action in February because Macalloy was unable to furnish a clear title. During negotiations, the question of conflict of interest arose publicly because Phibro is the exclusive U.S. sales agent for ferrochromium produced by Middelburg Steel and Alloys (Pty.) Ltd. of the Republic of South Africa. In February 1982, Macalloy filed for Chapter 11 protection under the Federal Bankruptcy Code. In March, the company resumed production under protection of Chapter 11 in one of its two furnaces.

Table 3.—Principal producers of chromium products

Company	Plant
Metallurgical industry:	
Chromasco, Ltd., Chromium Mining & Smelting Corp. Div	Woodstock, Tenn.
Elkem AS, Elkem Metals Co	Marietta, Ohio, and Alloy, W. Va.
Foote Mineral Co	Keokuk, Iowa, and Graham, W. Va.
Interlake, Inc., Globe Metallurgical Div	Beverly, Ohio.
Macalloy, Inc	Charleston, S.C.
Metallurg Inc., Shieldalloy Corp	Newfield, N.J.
SKW Alloys, Inc	Calvert City, Ky., and Niagara Falls, N.Y.
Satralloy Corp	Steubenville, Ohio.
Refractory industry:	
Basic, Inc	Maple Grove, Ohio.
Corhart Refractories Co., Inc	Pascagoula, Miss.
Davis Refractories, Inc	Jackson, Ohio.
General Refractories Co	Baltimore, Md., and Lehi, Utah.
Harbison-Walker Refractories, a division of Dresser Industries, Inc	Hammond, Ind., and Baltimore, Md.
Kaiser Aluminum & Chemical Corp	Moss Landing, Calif., and Columbiana, Ohio.
North American Refractories, Co., Ltd	Womelsdorf, Pa.
Chemical industry:	
Allied Chemical Corp	Baltimore, Md.
American Chrome & Chemical, Inc	Corpus Christi, Tex.
Diamond Shamrock Corp	Castle Haynes, N.C.

Table 4.—Production, shipments, and stocks of chromium ferroalloys and chromium metal in the United States

(Short tons)

	Net production		Net shipments	Producer stocks, Dec. 31
	Gross weight	Chromium content		
1981:				
Low-carbon ferrochromium; High-carbon ferrochromium	r164,040	r98,592	r134,766	45,680
Ferrochromium-silicon[r]; Other[r] [1]	62,456	28,498	53,880	16,304
Total[r]	226,496	127,090	188,646	61,984
1982:				
Low-carbon ferrochromium; High-carbon ferrochromium	91,905	55,900	82,353	W
Ferrochromium-silicon; Other[1]	27,380	13,561	36,961	63,631
Total	119,285	69,461	119,314	63,631

[r]Revised. W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes chromium metal, exothermic chromium additives, and other miscellaneous chromium alloys.

SKW Alloys, Inc., ceased ferrochromium-silicon production in October at its Niagara Falls, N.Y., plant when the last operating furnace was shut down. SKW hopes to resume production in 1983. Interlake, Inc. stopped production at its Beverly, Ohio, plant in November. Interlake was expected to resume production in 1983. General Refractories Co., a producer of chromium refractories, expected to avoid bankruptcy proceedings by continuing to reduce inventories, receivables, and payroll while restructuring its debt.

American Chrome & Chemical, Inc., brought its new chromium chemical plant in Corpus Christi, Tex., into production in 1982. The plant will produce sodium chromate and bichromate from chromite. Some of the bichromate will be consumed to produce chromic oxide in two grades, metallurgical and refractory. Metallurgical-grade chromic oxide is used to produce aluminothermic chromium metal, which is used in nonferrous alloying. Refractory-grade chromic oxide is used to produce corrosion-resistant refractory bricks and to color cement and concrete.

E. I. du Pont de Nemours & Co. began the second phase of construction of a chromium dioxide plant at Newport, Del. Plant construction was expected to be completed in 1983. Chromium dioxide is produced from other chromium-containing chemicals. The new plant will double existing capacity and will produce magnetic particles for use in audio, video, and data storage tapes.

CONSUMPTION AND USES

Domestic consumption of chromite ore and concentrate was 545,000 tons in 1982. Of the total chromite consumed, the metallurgical industry used 49%; the refractory industry, 15%; and the chemical industry, 36%. The metallurgical industry consumed 270,000 tons of chromite to produce 119,000 tons of chromium ferroalloy, metal, and other chromium-containing materials.

Chromium has a wide range of uses in the three primary consumer groups. In the metallurgical industry, its principal use was in stainless steel. Of the total 268,000 tons of chromium ferroalloys and metal consumed, stainless steel accounted for 71%; full-alloy steel, 15%; and high-strength, low-alloy and electrical steels, cast irons, and superalloys, each 3%. Total chromium ferroalloy and metal consumption in 1982 decreased by 38% compared with that of 1981.

Primary use of chromium in the refractory industry was in the form of chromite to make refractory bricks to line metallurgical furnaces. Chromite consumption by the refractory industry decreased 46% compared with that of 1981.

The primary consumer of chromium ferroalloys and metal, and metallurgical and refractory chromite was the steel industry. Steel production decreased in 1981 and 1982, resulting in decreased consumption of these chromium-containing materials. Consumption of refractory chromite was also affected by the changing methods of steel production. Steel used to be produced primarily in open hearth furnaces that are being replaced by electric furnaces and basic oxygen furnaces. The open hearth furnace uses more chromite refractories than the electric furnace, and the basic oxygen furnace uses virtually no chromite refractories. In addition, the technological innovation of using water-cooled panels on electric furnaces further reduces the need for chromite refractories.

The chemical industry consumed chromite for manufacturing pigments, chromic acid, and sodium and potassium chromate and bichromate. Sodium and potassium chromate and bichromate are base materials used to make a wide range of chromium chemicals. Chromite consumption by the chemical industry in 1982 decreased 18% compared with that of 1981.

Table 5.—Consumption of chromite and tenor of ore used by primary consumer groups in the United States

Year	Metallurgical industry		Refractory industry		Chemical industry		Total	
	Gross weight (thousand short tons)	Average Cr_2O_3 (percent)	Gross weight (thousand short tons)	Average Cr_2O_3 (percent)	Gross weight (thousand short tons)	Average Cr_2O_3 (percent)	Gross weight (thousand short tons)	Average Cr_2O_3 (percent)
1978	534	39.8	237	36.6	239	45.3	1,010	39.9
1979	774	r38.4	r198	r35.4	242	44.9	r1,214	r39.2
1980	r577	r35.9	r160	r35.8	240	r45.8	r977	r38.4
1981r	503	35.7	148	37.3	238	42.6	889	37.9
1982	270	35.1	80	36.4	195	44.9	545	38.8

rRevised.

Table 6.—U.S. consumption of chromium ferroalloys and metal in 1982, by end use

(Short tons, gross weight)

End use	Low-carbon ferrochromium	High-carbon ferrochromium	Ferrochromium silicon	Other	Total
Steel:					
Carbon	2,268	3,360	543	223	6,394
Stainless and heat-resisting	10,762	170,627	9,658	323	191,370
Full-alloy	10,128	26,978	2,511	1,210	40,827
High-strength, low-alloy and electric	3,000	1,934	1,828	1,478	8,240
Tool	252	1,664	63	--	1,979
Cast irons	713	5,984	46	314	7,057
Superalloys	2,669	2,952	101	1,852	7,574
Welding materials (structural and hard-facing)	432	728	W	119	1,279
Other alloys[1]	871	343	2	970	2,186
Miscellaneous and unspecified	909	161	13	81	1,164
Total	32,004	214,731	14,765	[2]6,570	268,070
Chromium content	21,214	126,031	5,421	4,545	157,211
Stocks, Dec. 31, 1982	3,459	21,793	1,237	[3]2,593	29,082

W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous and unspecified."
[1]Includes magnetic and nonferrous alloys.
[2]Includes 2,710 tons of chromium metal.
[3]Includes 476 tons of chromium metal.

STOCKS

Reported consumer stocks of chromite declined from 728,000 tons in 1981 to 545,000 tons in 1982. The greatest decline occurred in the metallurgical industry where chromite stocks were reduced by 48% compared with those of 1981. Producer stocks of chromium ferroalloys and metal increased 3% in 1982 compared with those of 1981, while consumer stocks declined by 48%. At the 1982 annual rate of chromium ferroalloy and metal consumption, producer plus consumer stocks represented a 4-month supply while consumer stocks alone represented a 1-month supply.

Stocks of chromium chemicals (sodium bichromite equivalent) at producer plants decreased from 20,301 tons (revised data) in 1981 to 18,421 tons in 1982.

Table 7.—U.S. consumer stocks of chromite, December 31

(Thousand short tons)

Industry	1978	1979	1980	1981	1982
Metallurgical	755	416	219	r230	120
Refractory	185	161	134	r128	112
Chemical	361	330	322	370	313
Total	1,301	907	675	r728	545

rRevised.

Table 8.—U.S. consumer stocks of chromium ferroalloys and chromium metal, December 31

(Short tons, gross weight)

Product	1978	1979	1980	1981	1982
Low-carbon ferrochromium	6,455	6,683	5,432	5,198	3,459
High-carbon ferrochromium	69,196	45,465	50,258	46,601	21,793
Ferrochromium-silicon	3,492	3,701	2,578	1,801	1,237
Other[1]	2,618	2,465	1,935	2,468	2,593
Total	81,761	58,314	60,203	56,068	29,082

[1]Includes chromium briquets, chromium metal, exothermic chromium additives, and other miscellaneous chromium alloys.

PRICES

There was some decrease in the price of South African chromite, while the price of Turkish chromite was unchanged. At the beginning of 1982, the published price of South African Transvaal chromite, 44% Cr_2O_3, no specified chromium-to-iron ratio, was $46 to $50 per ton, f.o.b. South African ports. In April, the price decreased to $44 to $47 per ton, a decrease of about 5%. From April through the end of the year, the price remained unchanged. The price of Turkish chromite, 48% Cr_2O_3, 3:1 chromium-to-iron ratio, was $100 per ton, f.o.b. Turkish ports throughout 1982.

The price of charge chrome, a high-carbon, low-chromium ferrochromium, decreased in 1982, while the price of other chromium ferroalloys and metal remained unchanged. Price decreases were led by imported ferrochromium. In September, the price of imported 50% to 55% charge chrome decreased by about 5 cents per pound. In November, the 50% to 55% material price decreased by about 5 cents per pound and the 60% to 65% material price decreased by 3 cents per pound. In December, charge chrome price decreases followed the expiration of the penalty duty on imported high-carbon ferrochromium. Chromium ferroalloy and metal prices as published in Metals Week are shown in table 9.

Table 9.—Price quotations for chromium materials at beginning and end of 1982

Material	January	December
	Cents per pound of chromium	
U.S. charge chromium (50% to 55% chromium)	47.5	38
Imported charge chromium (50% to 55% chromium)	46.5-47.5	36
Imported charge chromium (60% to 65% chromium)	48 -49.5	41
U.S. charge chromium (66% to 70% chromium)	52 -54	43
U.S. low-carbon ferrochromium (0.025% carbon)	100	100
U.S. low-carbon ferrochromium (0.05% carbon)	95	95
Imported low-carbon ferrochromium (0.05% carbon)	89 -95	89-95
Simplex (low-carbon ferrochromium)	100	100
	Cents per pound of product	
Ferrochromium-silicon	34.5	34.5
Electrolytic chromium metal	375	375

FOREIGN TRADE

Exports of chromium materials decreased in 1982 compared with those of 1981. Except for chromium chemicals, imports of chromium materials decreased compared with those of 1981. In 1982, the value of imports exceeded that of exports for chromite, chromium ferroalloys, chromium metal, and chromium base pigments. The value of chromium base chemical exports exceeded that of imports. The value of chromium material imports, $139 million, exceeded that of exports by $107 million in 1982.

In 1982, the major recipients of chromite exports were Mexico, 66%; Canada, 20%; and Argentina, 13%. The major recipients of 4,943 tons of exported chromium ferroalloys were Canada, 87%; the Federal Republic of Germany, 7%; and Mexico, 4%. The major recipients of 213 tons of chromium metal (wrought, unwrought, waste and scrap) exports valued at $2.7 million were the Federal Republic of Germany, 27%; Mexico, 21%; Canada, 19%; Japan, 13%; and the United Kingdom, 12%. The major recipients of 2,161 tons of chromium-containing pigments exports valued at $7.4 million were Japan, 23%; Canada, 20%; and Belgium, 17%.

Imports of ferrochromium-silicon, all from Zimbabwe, totaled 6,993 tons, were valued at $3.3 million, and contained 2,725 tons of chromium.

Imports of chromium metal (wrought and unwrought), alloys, waste, and scrap totaled 1,850 tons, and were valued at $10.1 million. The major suppliers of these imports were the United Kingdom, 42%; Japan, 40%; and China, 8%.

Imports of chromium pigments totaled 5,259 tons and were valued at $10 million.

The major suppliers of chromium pigments were Canada, 40%; the Federal Republic of Germany, 15%; the United Kingdom, 14%; and Japan, 8%.

Imports of chromium chemicals totaled 6,790 tons and were valued at $7.9 million. The principal suppliers were Romania, 22%; Japan, 19%; the U.S.S.R., 16%; and the Federal Republic of Germany, 10%.

U.S. import duties for chromium materials as of January 1, 1982, published in the Tariff Schedules of the United States, Annotated (1982), and U.S. import duties as established for January 1, 1987, published in the Federal Register, are shown in table 13.

Table 10.—U.S. exports and reexports of chromite ores and concentrates

(Thousand short tons and thousand dollars)

Year	Exports		Reexports	
	Quantity	Value	Quantity	Value
1978	23	2,767	29	2,574
1979	27	2,514	28	2,860
1980	6	1,447	44	8,544
1981	71	5,893	67	9,575
1982	8	1,574	57	9,172

Table 11.—U.S. imports for consumption of ferrochromium, by country

Country	Low-carbon ferrochromium (less than 3% carbon)			High-carbon ferrochromium (3% or more carbon)		
	Gross weight (short tons)	Chromium content (short tons)	Value (thousands)	Gross weight (short tons)	Chromium content (short tons)	Value (thousands)
1981:						
Belgium	26	19	$31	--	--	--
Brazil	--	--	--	20,673	11,152	$8,601
China	--	--	--	2,767	1,799	1,385
France	2,448	1,695	2,452	--	--	--
Germany, Federal Republic of	4,482	3,134	5,405	341	232	351
Italy	722	528	892	--	--	--
Japan	1,404	944	2,123	--	--	--
Norway	1,246	778	1,042	556	356	539
Philippines	--	--	--	2,315	1,447	1,224
South Africa, Republic of	r14,209	9,026	11,479	246,358	130,483	102,865
Spain	--	--	--	1,383	922	701
Sweden	7,959	5,681	9,047	3,308	1,819	1,428
Turkey	231	165	209	7,984	5,122	3,936
Yugoslavia	--	--	--	47,466	30,642	23,527
Zimbabwe	7,875	5,482	7,402	54,486	35,986	28,971
Total[1]	40,602	27,453	40,082	387,637	219,961	173,529
1982:						
Brazil	--	--	--	17,196	9,219	6,932
Canada	451	311	240	--	--	--
China	18	11	13	5,489	3,602	2,659
Germany, Federal Republic of	3,532	2,473	3,694	218	149	232
Italy	465	346	607	--	--	--
Japan	148	101	266	97	64	81
Norway	84	55	110	--	--	--
Philippines	--	--	--	19	12	11
South Africa, Republic of	8,316	5,205	6,987	47,004	24,628	19,343
Sweden	4,210	3,045	4,954	--	--	--
Turkey	--	--	--	5,934	3,809	2,910
United Kingdom	20	15	22	--	--	--
Yugoslavia	--	--	--	15,583	10,153	8,144
Zimbabwe	5,576	3,855	4,806	26,951	17,721	15,484
Total[1]	22,819	15,417	21,699	118,491	69,357	55,796

rRevised.

[1]Data may not add to totals shown because of independent rounding.

Table 12.—U.S. imports for consumption of chromite, by country

(Thousand short tons and thousand dollars)

Country	Less than 40% Cr_2O_3			More than 40% but less than 46% Cr_2O_3			46% or more Cr_2O_3			Total[2]		
	Gross weight	Cr_2O_3 content	Value	Gross weight	Cr_2O_3 content	Value	Gross weight	Cr_2O_3 content	Value	Gross weight	Cr_2O_3 content	Value
1981:												
Albania	11	4	979	3	1	237	(1)	(1)	5	14	5	1,221
Finland	65	18	3,016	13	6	830	--	--	--	78	24	3,846
Madagascar	--	--	--	8	4	432	10	5	624	18	9	1,056
New Guinea	(1)	(1)	2	--	--	--	--	--	--	(1)	(1)	2
Philippines	134	46	11,236	--	--	--	11	6	507	145	52	11,743
South Africa, Republic of	112	42	4,017	302	135	15,485	68	34	4,274	482	211	23,776
Turkey	30	11	1,408	13	6	1,035	6	3	633	49	20	3,076
U.S.S.R	50	19	2,456	--	--	--	61	29	2,773	111	48	5,229
Total[2]	403	140	23,115	339	151	18,018	156	77	8,815	898	368	49,948
1982:												
Albania	4	2	299	--	--	--	--	--	--	4	2	299
Finland	33	9	1,490	12	5	716	--	--	--	45	14	2,206
Madagascar	--	--	--	29	13	2,002	12	6	681	41	19	2,683
Pakistan	--	--	--	--	--	--	3	2	330	3	2	330
Philippines	66	21	5,375	4	2	444	--	--	--	70	23	5,819
South Africa, Republic of	23	9	1,143	204	91	10,701	50	23	2,822	277	123	14,666
Turkey	16	6	794	8	3	455	8	4	788	32	13	2,037
U.S.S.R	34	13	1,629	--	--	--	--	--	--	34	13	1,629
Total[2]	176	59	10,731	256	115	14,318	74	35	4,621	507	209	29,670

[1]Less than 1/2 unit.
[2]Data may not add to totals shown because of independent rounding.

Table 13.—U.S. import duties for chromium-containing materials

Item	TSUS No.	Most favored nation (MFN) Jan. 1, 1982	Most favored nation (MFN) Jan. 1, 1987	Non-MFN Jan. 1, 1982
Ore:				
Chrome ore and concentrate	601.15	Free	No target duty	Free.
Metal and alloys:				
Low-carbon ferrochromium	606.22	3.9% ad valorem	3.1% ad valorem	30% ad valorem.
High-carbon ferrochromium	606.24	1.9% ad valorem[1]	No target duty	7.5% ad valorem.
Ferrosilicon chromium	606.42	10% ad valorem	10% ad valorem	25% ad valorem.
Chrome metal (wrought, unwrought, waste and scrap)	632.18	4.5% ad valorem	3.7% ad valorem	30% ad valorem.
Chemicals:				
Sodium chromate and dichromate	420.98	2.7% ad valorem	2.4% ad valorem	8.5% ad valorem.
Potassium chromate and dichromate	420.08	1.6% ad valorem	1.5% ad valorem	3.5% ad valorem.
Chromium carbide	422.92	5.3% ad valorem	4.2% ad valorem	25% ad valorem.
Chromic acid	423.0092	do	3.7% ad valorem	Do.
Pigments:				
Chrome green	473.10	4.5% ad valorem	No target duty	25% ad valorem.
Chrome yellow	473.12	do	do	Do.
Chromium oxide green	473.14	do	3.7% ad valorem	Do.
Hydrated chromium oxide green	473.16	do	do	Do.
Molybdenum orange	473.18	do	No target duty	Do.
Strontium chromate	473.19	do	3.7% ad valorem	Do.
Zinc yellow	473.20	do	No target duty	Do.

[1]Total duty of 4.625 cents per pound on material valued at less than 38 cents per pound of chromium through Nov. 15, 1982.

WORLD REVIEW

World chromite production in 1982 decreased to 10.9 million tons from 11.7 million tons in 1981. Mine closings were reported in the Philippines, the Republic of South Africa, and Turkey. Two new chromite mines started operation in 1982, one in New Caledonia and the other in the U.S.S.R. New processing plants were reported in Albania and Madagascar.

Construction of new or expanded ferrochromium production facilities continued in Greece, India, the Philippines, and Turkey. Commerical ferrochromium production in new plants was expected to begin in India and in the Philippines in 1983.

Albania.—Albania has reported third-stage construction of a new chromite concentrator facility at Belqizë. The construction will increase by about 50,000 tons per year of concentrate production capacity. In addition, Albania reported completing a chromite processing plant at Kalimash, located in northwestern Albania near Kukës.

Australia.—The Geological Survey of Tasmania has reported that drilling by the Tasmania Department of Mines has outlined two additional chromite prospects in the Rifle Range area of Tasmania. The indicated ore reserve in South Rifle Range Prospect is about 233,000 tons at a grade of about 15% chromite. The inferred ore reserve in North Rifle Range Prospect is about 200,000 tons at a grade of 7.5% chromite.

Austria.—The Voest-Alpine Group, one of the largest steel production and mining companies in Austria, was concerned with securing raw materials supplies, including chromium. The company partly owns Acoje Mining Co., Manila, Philippines (24%), and Ferrochrome Philippines Inc. (FPI) (64.2%). Acoje is a major Philippine chromite producer. FPI was constructing a new ferrochromium smelter scheduled to start commercial operation in 1983.

Brazil.—In 1981, 90% of the chromite mine production was accounted for by four companies: Ferro-Ligas da Bahina, Serra de Jacobina, Vale do Jacurici, and Cromita do Brasil. The Mines and Power Ministry of Brazil has confirmed the discovery of a new mineral province in northern Brazil, situated between the Jari and Paru Rivers, near Serra do Navio, in Amapá. The province is considered to be rich in chromite among other minerals. Preliminary estimates from Brazil's National Department of Mineral Production (DNPM) indicate that the value of chromite production fell in 1982 by 34% to $19 million.

DNPM's 1982 Anuario Mineral Brasileiro reported measured resources at about 8 million tons of chromite grading 20.2% Cr_2O_3, indicated resources at 2 million tons of chromite, and inferred at about 5 million tons of chromite.

China.—China imposed an export tax of 10% that was to be applied to ferrochromium.

Cyprus.—The Geological Survey Department of Cyprus increased its mineral exploration activities. Chromite deposits known to exist in the Vasa-Layia area were being explored in collaboration with Bureau de Recherches Géologiques et Minières of France.

European Economic Community.—In July, the EEC reached an agreement on duty-free quotas on high-carbon ferrochromium. Agreement was delayed because Italy and Greece did not agree until EEC countries guaranteed to take much of Italy's ferrochromium production. In Italy, Montedison S.p.A.'s capacity was about 20,000 tons per year. Guarantees were obtained for about 18,000 tons. High-carbon ferrochromium entering the EEC in excess of duty-free quotas was charged an 8% duty. By August, duty-free quotas were reached for low-carbon ferrochromium and low-carbon ferrochromium silicon.

In December, Gesellschaft für Elecktrometallurgie mbH, Federal Republic of Germany, filed a complaint with the EEC, alleging that Turkey and Zimbabwe were dumping low-carbon ferrochromium within the EEC.

The EEC set the 1983 duty-free quota for low-carbon ferrochromium at about 3,000 tons. No agreement was reached on high-carbon ferrochromium.

Finland.—Outokumpu Oy, the Finnish state-owned mining company, is one of two vertically integrated companies in the world that mines ore, produces ferroalloys, and produces and markets steel. It also has engineering and exploration departments that conduct business worldwide. Their exploitation of low-grade domestic ore deposits has resulted in the development of expertise in exploration techniques, mining methods, and metallurgical processes. Their innovation and experience have enabled them to offer plant and equipment, consultancy services, licensing agreement, and technological skills on a worldwide basis. They are currently supervising erection of a ferrochromium plant in Greece and have received an order for a ferrochromium plant in India. They have set up a U.S. subsidiary, Outokumpu Inc., to handle sales of ferrochromium and other materials. They were arranging a joint marketing agreement with Turkey, a world supplier of chromite and ferrochromium.

Greece.—Greece continued development of a ferrochromium industry to vertically integrate its currently active chromite mining industry. Both refractory- and metallurgical-grade chromite deposits occur in Greece. Geologic research, started in 1976 to identify chromite resources, was carried out by the Institute of Geological and Mining Research and Project Studies and Mining Development S.A. to verify that chromite resources were adequate for ferrochromium production. Exploration of the Mount Vourinos area resulted in the identification of an estimated 3 million tons of proven reserves and about 3.2 million tons of possible reserves at an average grade of 17% to 20% Cr_2O_3 with some areas having concentrations of as much as 35% Cr_2O_3 at a Cr:Fe ratio of 3:1.

Plans for vertical integration of the chromite industry include expanded mine production, a new beneficiation plant, pelletizing and sintering of concentrates and fines, and preheating of the ferrochromium furnace feed stock. Construction continued on the $70 million ferrochromium plant and trial operation began in 1982. In 1982, the EEC Council of Ministers recommended a $10 million loan toward financing the Greek ferrochromium plant. Greece became fully integrated into the EEC in 1981. The ferrochromium plant is to be operated by Hellenic Ferroalloy S.A., a 96% owned subsidiary of Hellenic Industrial & Mining Co. Hellenic Ferroalloy expected to have about a 45,000-ton-per-year production capacity for high-carbon ferrochromium of 60% chromium content. Until Greek chromite mine and concentrate production is adequate to meet ferrochromium plant demand, Albanian feed material will be used. The Hellenic Ferroalloy plant was designed to permit a potential total capacity of about 90,000 tons per year. Long-term Greek metallurgical industry development plans include a steel plant near the ferrochromium plant. Completion of such a plant would make Greece the third country to possess a completely integrated mine-to-steel product industry. The Republic of South Africa and Finland currently have such an integrated steel industry.

India.—India continued development of its ferrochromium industry, upgrading its chromite mining industry and adding to its current capacity of about 30,000 tons per year of ferrochromium. Construction continued in 1982 on four ferrochromium plants by Indian Metals and Ferroalloys Ltd. (IMFA), Orissa Mining Corp. (OMC), and Ferroalloy Corp. (FACOR). IMFA was constructing two plants. The first, located at Therubali, Koraput district, Orissa State, was expected to start production in February 1983 with an annual capacity of about 45,000 tons per year using Indian and Albanian ore to produce charge ferrochromium. Exports will be through the Port of Visakhapatnum with marketing handled by Elkem AS of Norway. The second, located at Chouduar (20 kilometers from Bhubaneswar), Cutlack district, Orissa State, was to start production in 1985 with an annual capacity of about 50,000 tons per year. This facility will include a captive powerplant fueled with local low-grade lignite resources. Export will be through the Port of Paradip with marketing handled by Elkem.

OMC's ferrochromium plant, located in the Keojbar district, Orissa State, was expected to start production in 1984 with an annual capacity of about 50,000 tons per year. This plant will use Indian low-grade chromite fines as feed.

FACOR's ferrochromium plant, located at Randia, Balasore district, Orissa State, was expected to start production in March 1983 with an annual capacity of about 50,000 tons. The plant will have two captive mines, Kathpal and Boula, and will use low-grade fines to produce 55% chromium content charge ferrochromium. The design permits doubling of capacity. FACOR will export through the Port of Paradip.

Italy.—Montedison resumed ferrochromium production in March 1982, after receiving electricity price concessions from Italian authorities. Montedison received assurance that about 18,000 tons of its production would be taken by EEC countries.

Japan.—The Japanese Ministery of International Trade and Industry proposed a three-level metal-minerals stockpiling program for chromium in the form of ferrochromium, among other materials. The three levels are distinguished by their method of financing; private- industry financed, joint- industry and Government financed; and national- Government financed. In recognition of Japan's strategic and economic dependence on imported industrial materials supplies, from 7 to 13 materials have been identified for stockpile development. A 2-month supply was to be developed over a 5-year period.

Japanese ferroalloy producers are vertically integrated with their steel-producing clients in Japan, a situation that helped them through the 1982 economic slump. In March, the steel producers agreed to purchase ferrochromium equaling the average 1981 production.

Madagascar.—Kraomita Malagasy completed construction of a chromite processing plant. The new plant adds about 150,000 tons of annual capacity of lump chromite (40 to 150 millimeters, 2.5:1 Cr:Fe, 43% to 44% Cr_2O_3) to its current chromite concentrate annual capacity of about 170,000 tons (2.6 to 27:1 Cr:Fe, 50% Cr_2O_3). Madagascar was considering building a ferrochromium plant to vertically upgrade its chromite mining industry. Such a plant would use power from the newly completed 58-megawatt hydroelectric complex at Andekaleka.

New Caledonia.—The Tiebaghi Mine, located at the northwestern tip of New Caledonia, was brought into production in 1982. The mine is expected to have a capacity of about 85,000 tons per year. Output is expected to be about 55,000 to 60,000 tons per year of lump ore graded at 50% to 52% Cr_2O_3 and refractory fines graded at 56% Cr_2O_3, with 2% to 3% silica.

Oman.—The Oman Mining Co. has established a chromite division to exploit chromite resources in the Sohar area. The Oman Ministry of Petroleum and Minerals was prequalifying international firms for a prospection project for chromite, among other minerals, in other parts of northern Oman.

Papua New Guinea.—Development of the Ramu River chromite deposit continued in 1982. Nord Resources Corp., United States, held a 69.5% share of the mining concession in collaboration with Mount Isa Mines holding the remaining share. The mineral deposit was in three layers, the top two contain chromite. The top layer, about 3 meters deep, represented a reserve of 80 to 100 million tons at 8% to 10% chromite, recoverable by gravity separation techniques. The intermediate layer, about 2.7 meters deep, had about 81.5 million tons of ore graded at about 6% chromite. The operation could produce about 500,000 tons per year of chromite concentrate suitable for high-carbon ferrochromium production. Nord Resources was seeking another partner to develop the deposit and applied for renewal of its mining licenses for an additional 2 years.

Philippines.—The Trident Mining and Industrial Corp. closed its chromite mine and mill in Narra Town, Palawan Island, laying off 700 workers. Trident was the third largest chromite producer, and the second largest metallurgical chromite producer in the Philippines.

The Philippines established a fund to aid copper producers ease cash flow problems caused by current low prices and rising costs. The Ministry of Natural Resources proposed the inclusion of chromite as entitled to assistance under the stabilization fund.

Island Industrial and Mining Corp. was considering developing the Bicobian alluvial chromite deposit of about 48 million tons of ore at about 3% Cr_2O_3. The Bicobian deposit is located on Luzon Island in Isabela Province.

FPI, a joint venture of Voest-Alpine AG (80%) and Herdis Group (20%) started operation in 1982. The $70 million smelter was expected to start commercial operation in 1983 with a capacity of about 50,000 tons per year. Construction started in 1980 and was completed in 1982. The plant was located at Tagoloan, Misamis Oriental Province, on Mindanao Island and was capable of processing chromite as either lump or fines.

FPI was the Philippines' second ferrochromium plant. The first, Ferro-Chemicals Inc., started production of ferrochromium in 1976 at Manticao, Misamis Oriental Province, Mindanao Island, with an annual capacity of about 12,000 tons.

Benguet Corp. operates the world's leading refractory chromite mine, the Masinloc Mine, in the Philippines located in Masinloc County, Zambales Province, northwest of Manila. The Masinloc Mine was the Philippines largest chromite producer. A new ore body, discovered in 1981 and identified as 1111, was explored by diamond drilling. As a result, about 500,000 tons of low-silica reserves was identified with the potential for doubling that quantity. Benguet estimated its reserves at the beginning of 1982 to be about 8 million dry tons of run-of-mine ore at about 30% Cr_2O_3.

South Africa, Republic of.—As the world's major supplier of chromite and ferrochromium, South Africa experienced reduced demand for these materials as a result of the worldwide reduction in steel production in 1982. As a result, General Mining Union Corp. Ltd. closed two mines in the Rustenburg area and two mines in Eastern Transvaal; Anglovaal Ltd. closed its Mtuane Mine; and Rand Mines Ltd. closed three sections of its Winterveld Mine.

The chromite deposits of the Bushveld Complex occur in three groups of seams; upper group, middle group, and lower group. The majority of production had been from the lower group with some production coming from the upper group. Lebowa's Mining Corp. and Rustenburg Platinum Holdings Ltd. had established a pilot plant at the Maandagshoek Farm, located in the Lebowa Homeland, to assess methods for mining one of the upper group seams, the UG2. The UG2 is currently being mined for platinum-group metals, but also has production potential for chromite graded at 35% to 40% Cr_2O_3 with a Cr:Fe: ratio of about 1:35.

Middelburg Steel and Alloys, the second largest ferrochromium producer in South Africa and one of two vertically integrated mine-to-steel manufacturers in the world, was developing plasma ferrochromium production technology in cooperation with the South African Council for Mineral Technology (Mintek). Mintek built a 3.2-megavolt-ampere furnace to test and refine the plasma process. Middelburg Steel purchased a 20-megavolt-ampere dc arc pilot furnace, designed and built by Asea in Sweden, for commissioning in 1984. The pilot furnace will be used to develop the plasma process. It was expected to have an initial annual capacity of about 25,000 tons that can be increased to about 50,000 tons. By converting its furnaces from the conventional submerged electric arc type to the plasma type, Middelburg could double its ferrochromium production capacity. The new technique will be able to use both coarse and fine chromite and coke and was expected to have a lower cost per ton of product than orthodox methods of ferrochromium production.

Middelburg Steel and Alloys produced corrosion-resistant 3CR12 steel (an alloy steel of 0.03% carbon, 0.6% nickel, and 12% chromium content) for its home market and was negotiating licensing production to foreign steel producers. The 3CR12 steel was intended to replace coated carbon steel. The use of this steel to replace other alloy steels would greatly increase the world consumption of chromium.

Turkey.—Government-owned Etibank continued the expansion of its high-carbon ferrochromium production plant at Elazig. Turkey currently has two ferrochromium smelters, one at Antalya and the other at

Elazig. The Antalya plant produced only low-carbon ferrochromium with an annual capacity of about 10,000 tons. The Elazig plant produced only high-carbon ferrochromium with an annual capacity of about 50,000 tons. Upon completion of expansion at Elazig, capacity was expected to be increased to about 150,000 tons. The Elazig Ferrochromium Works expansion project will use the Outokumpu Oy process technology and was to be completed in 1985 or 1986.

As a result of reduced demand for chromium, almost all private sector chromite mines in Turkey were closed throughout 1982.

A chemical plant to use about 30,000 tons per year of low-grade chromite concentrate was being built by Cukrosan at Mersin. The plant was due onstream in 1983 or 1984.

U.S.S.R.—Virtually all Soviet chromite production was from deposits in the Ural Mountains, where the minor deposit was in the mid-Ural region and the major deposit in the southern Ural region. Over 90% of production was from the Donskoye mining and concentration complex in Khrom-Tau in western Kazakhstan. The first stage of the Molodezhnyy underground chromite mine at the Donskoye complex started production in 1982. This first stage was projected to reach its designed production capacity of 800,000 tons annually in 1985. Upon completion, the mine was expected to have a capacity of 2 million tons per year. The ore was reported to have 45% to 51% Cr_2O_3 content.

United Arab Emirates.—The United Arab Emirates' (UAE) Ministry of Petroleum and Minerals Resources contracted Hunting Geology and Geophysics to explore for chromite, copper, and industrial minerals in the northern UAE. Geoconsult Co., a company that explored the UAE for minerals, announced the discovery of chromium deposits in the Fujairah region.

Zimbabwe.—As a result of decreased world steel production, demand for ferrochromium was low. Two ferrochromium producers, Zimbabwe Alloys and Rio Tinto (Zimbabwe) Ltd., have appealed to the Zimbabwe Government for financial assistance.

Table 14.—Chromite: World production, by country[1]

(Thousand short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Albania[e 3]	1,090	1,120	1,190	1,260	1,320
Brazil[3]	[r]1,056	[r]983	919	1,021	1,050
Cuba	32	31	32	23	[4]30
Cyprus	17	17	18	11	11
Egypt	1	([5])	--	--	--
Finland[6]	449	[r]480	376	454	440
Greece[7]	41	[r]50	[e]47	[e]47	46
India	293	[r]342	354	370	375
Iran[e]	218	150	90	[r]35	45
Japan	10	13	15	12	[4]12
Madagascar	152	141	198	110	100
New Caledonia	9	[r]13	2	3	25
Pakistan	12	3	3	1	1
Philippines	595	613	547	484	390
South Africa, Republic of	3,466	3,634	3,763	3,164	[4]2,385
Sudan	[r]20	[r]31	28	29	30
Thailand	([5])	([5])	--	--	--
Turkey	[r]420	[r]410	431	466	410
U.S.S.R.[3]	[r e]3,640	[r]3,527	3,748	3,638	3,750
Vietnam[e]	14	15	17	17	17
Yugoslavia	2	([5])	([5])	([5])	--
Zimbabwe	527	597	608	591	470
Total	[r]12,064	[r]12,170	12,386	11,736	10,907

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through June 8, 1983.
[2]In addition to the countries listed, Bulgaria, China, and North Korea may also produce chromite, but output is not reported quantitatively and available general information is inadequate for formulation of reliable estimates of output levels. Figures for all countries represent marketable output unless otherwise noted.
[3]Figures represent crude ore output, not marketable production.
[4]Reported figure.
[5]Less than 1/2 unit.
[6]Production of marketable product (direct-shipping lump ore, plus concentrates and foundry sand).
[7]Exports of direct-shipping ore plus production of concentrates.

TECHNOLOGY

In order to determine the utility of domestic chromite ore in the event of a national emergency, the Bureau of Mines studied low-grade California chromite beneficiation, the extraction of chromite from nickel laterites, and the beneficiation of Montana chromite. Two ores from California were ground and treated using gravity concentration and magnetic separation techniques. The products produced were suitable for metallurgical and/or chemical uses.[2] The Bureau studied chromium recovery from domestic nickel laterites following nickel and cobalt recovery. Preliminary extraction results indicated that over 85% of the chromium can be recovered.[3]

A patent was granted the Bureau on the amine flotation of Montana chromite from acidic pulps. This technique involves the recovery of chromium values from pulverized chromite ore by agitating and aerating an aqueous pulp and recovering a chromite-containing froth as a concentrate.[4]

The Bureau estimated the physical and chemical characteristics of reject waste materials that would be generated from each of five potential manganese nodule processes.[5] These processes were selected because of their economic and technical feasibility.

Bureau research included the development of low-chromium austenitic and ferritic steel substitutes for application in (1) low-temperature, aqueous environments where large tonnages of chromium are used, and (2) high-temperature extreme environments where fewer chromium materials are used.

For low-temperature, mildly corrosive environments, a 9% chromium alloy was studied for special applications.[6] This alloy could substitute for materials now being used that contain 18% or more chromium, alloys that are sometimes overdesigned for the application. For high-temperature turbine environments, metal-matrix composites reinforced with silicon carbide and alumina fibers were being evaluated.[7] The Bureau's high-temperature research complements that of the National Aeronautics and Space Administration that conducts most high-temperature research.[8]

The Bureau, during research on recycling chrome-containing refractory wastes, studied the beneficiation of refractories from argon-oxygen decarburization and electric steelmaking furnaces. The test results indicated that the beneficiated material could be used to produce a refractory product suitable for moderate-temperature applications.[9]

The Bureau investigated the resistance of basic refractories to corrosion by ash slags that result from the burning of coal and lignite in metallurgical operations. Basic refractories are of economic interest because they are from one-third to one-half as expensive as 90% to 99% alumina refractories.[10]

To alleviate the problem of disposal of waste chromium sludges in landfills, a method was studied by the Bureau for efficient in-plant recycling of these waste chromium solutions.[11] Trivalent chromium, produced during surface treatments, is rejuvenated by oxidizing it to the useful hexavalent form in the anode compartment of a diaphragm cell; other metals, which dissolve during the surface-treatment operations, migrate through the membrane of the cell and collect in the cathode compartment. The regenerated chromium solution is then recycled.

Bureau research has resulted in a process for treating and recycling particulate wastes such as electric and argon-oxygen decarburization furnace dusts, mill scale, and grinding swarf.[12] Laboratory research and industrial trials of up to 18 tons have demonstrated that chromium, nickel, molybdenum, and iron recoveries exceeding 90% can be realized. Joslyn Stainless Steel Div. of Joslyn Manufacturing and Supply Co. has adopted this Bureau research technique.[13]

As part of the Bureau program for conserving domestic mineral resources, a survey was made of the methods used for identifying scrap metals.[14] The methods and instruments used to identify scrap metals were described and evaluated.

High-carbon ferrochromium is producible from high-iron chromite that is characteristic of the South African resources. As a result of increased use of friable South African ore to produce ferrochromium, development work has been done by industry to agglomerate chromite.[15] Agglomeration is necessary in order for fines to be used as charge material in most modern high-power electric submergered arc furnaces.

A preconcentrating technique[16] for separating waste rock from ore was introduced. The technique is intended for use before transportation and concentration and after screening. The technique can handle 7 to 40 tons per hour and works best with ores of 0.4% to 0.5% or more metal content.

Chromium, in the form of a black-chrome coating, is used in solar energy collection technology because of its high absorptivity in the solar spectrum and low emissivity in the infrared. Processes that use trivalent instead of hexavalent chromium are being studied.[17] Chromium is also used in industrial-scale solar energy collectors such as the 2.5-megawatt solar energy collector using a liquid sodium process. Chromium is used in both black-chrome coatings and in stainless steel for industrial energy collection.[18]

Copper-chromium oxides are used as catalysts for selective hydrogenation of unsaturated organic compounds. Among those currently being studied is a very efficient polymerizing catalyst, chromcene-silica, a chromium containing catalyst.[19]

An alternative process to agglomerating chromite fines and that offers other advantages is the newly developed plasma reduction process. SKF Steel Ltd. of Sweden[20] and Middelburg Steel and Alloys of the Republic of South Africa[21] are developing in-bath plasma furnace chromite smelter processes. Middelburg Steel and Alloys ordered a 20-megavolt-ampere commercial furnace and has plans to convert its submerged arc furnaces to plasma furnaces in order to double ferrochromium production capacity.

A new method of checking for metal creep in reformer tubes has been developed. Application of this nondestructive test technique could result in material conservation.[22]

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Clays

By Sarkis G. Ampian[1]

Clays in 1 or more of 6 classification categories (kaolin, ball clay, fire clay, bentonite, fuller's earth, or common clay and shale) were produced in 44 States and Puerto Rico during 1982. Clay production was not reported in Alaska, Delaware, Hawaii, the District of Columbia, Rhode Island, Vermont, or Wisconsin. The States leading in output were Georgia, 6.8 million short tons; Texas, 4.2 million tons; Wyoming, 2.6 million tons; California, 1.8 million tons; and North Carolina and South Carolina, 1.6 million tons each. Georgia also led in total value of clay output with $476 million; Wyoming was second with $74 million. Compared with the 1981 figures, clay production increased in six States and value increased in seven States. Total quantity of clays sold or used by domestic producers was 20% lower than in 1981; total value declined 17%. Increases in value per ton were reported for all clays. Unpredictable shortages and costs of fuels continued to cause considerable concern among clay producers and clay products manufacturers. Industrywide, efforts were made both to economize and to obtain standby fuels. Environmental restrictions and associated costs of environmental protection equipment, combined with rising capital costs in general, continued to adversely affect production during 1982.

Production of the specialty clays, ball clay, bentonite, fire clay, kaolin, and common clay and shale decreased; fuller's earth showed increased production. A downturn in construction that lowered demand for clay building materials including brick, lightweight aggregate, vitrified pipe, floor and wall tile, etc., was responsible for the decline in production of common clay and shale. Production of fuller's earth increased 2%, while output of the following decreased: fire clay, 44%; bentonite, 34%; ball clay, 24%; common clay and shale, 18%; and kaolin, 17%. The decreases continued to be largely owing to the overall downturn in the economy that lowered demand across the board.

Kaolin accounted for only 18% of the total clay production in 1982 but accounted for 60% of the value.

Domestic Data Coverage.—Domestic production data for clays are developed by the

Table 1.—Salient clays and clay products statistics in the United States[1]

(Thousand short tons and thousand dollars)

	1978	1979	1980	1981	1982
Domestic clays sold or used by producers:					
Quantity	56,822	54,689	48,790	44,379	35,345
Value	$717,274	$846,089	$898,947	$988,845	$825,064
Exports:[2]					
Quantity	2,665	3,205	3,214	3,151	2,619
Value	$194,914	$243,722	$263,147	$292,914	$267,700
Imports for consumption:[2]					
Quantity	25	51	34	33	24
Value	$2,082	$3,972	$6,688	$7,895	$4,514
Clay refractories shipments:[2] Value	$497,567	$580,257	$557,386	$609,949	$559,655
Clay construction products shipments: Value	$1,158,278	$1,179,058	$1,061,507	$971,824	$923,459

[1]Excludes Puerto Rico.
[2]U.S. Department of Commerce.

Table 2.—Clays sold or used by producers in the United States in 1982, by State[1]

(Short tons)

State	Ball clay	Bentonite	Common clay and shale	Fire clay	Fuller's earth	Kaolin	Total	Total value
Alabama	--	W	1,153,099	89,500	--	80,836	[2]1,323,435	[2]$13,192,542
Arizona	--	27,518	115,460	--	--	--	142,978	997,674
Arkansas	--	--	543,701	--	--	85,197	628,898	6,657,823
California	W	75,649	1,642,558	W	--	25,392	1,762,063	15,642,417
Colorado	--	4,060	194,901	2,429	--	--	201,390	1,123,904
Connecticut	--	--	55,874	--	--	--	55,874	329,459
Florida	--	--	203,031	--	442,253	26,332	671,616	[3]31,339,205
Georgia	--	--	970,441	--	534,184	5,268,358	6,772,983	475,767,539
Idaho	--	100	W	W	--	W	8,074	101,356
Illinois	--	--	444,055	10,464	W	--	[4]454,519	[4]2,305,455
Indiana	--	--	500,923	--	--	--	500,923	1,220,519
Iowa	--	--	436,763	--	--	--	436,763	2,391,983
Kansas	--	15,000	648,862	--	--	--	663,862	3,656,235
Kentucky	W	--	569,596	9,698	--	--	[5]579,294	[5]2,038,783
Louisiana	--	17,174	308,664	--	--	--	325,838	[2]6,215,920
Maine	--	--	37,488	--	--	--	37,488	75,782
Maryland	W	--	404,737	--	--	--	[5]404,737	[5]1,346,287
Massachusetts	--	--	210,364	--	--	--	210,364	1,114,663
Michigan	--	--	1,022,436	--	--	--	1,022,436	4,369,853
Minnesota	--	--	W	--	--	W	W	W
Mississippi	W	231,596	329,857	--	W	--	804,807	21,181,373
Missouri	--	--	851,284	447,668	W	84,298	[4]1,383,250	[4]13,408,601
Montana	--	207,879	9,675	546	--	--	218,100	[6]8,064,312
Nebraska	--	--	133,687	--	--	--	133,687	391,617
Nevada	--	14,500	W	--	15,640	W	102,573	2,639,633
New Hampshire	--	--	W	--	--	--	W	W
New Jersey	--	--	50,560	12,143	--	--	62,703	566,160
New Mexico	--	--	59,944	W	--	--	[6]59,944	[6]112,459
New York	W	--	352,319	--	--	--	[5]352,319	[5]896,647
North Carolina	--	--	1,573,368	--	--	W	[3]1,573,368	[3]5,243,016
North Dakota	--	--	W	--	--	--	W	W
Ohio	--	--	1,299,077	152,089	--	--	1,451,166	6,099,607
Oklahoma	--	--	751,858	--	--	--	751,858	1,907,322
Oregon	--	--	149,399	--	--	--	149,399	212,385
Pennsylvania	--	--	795,043	135,881	--	W	[3]930,924	[3]5,616,057
Puerto Rico	--	--	162,038	--	--	--	162,038	297,911
South Carolina	--	--	901,583	17,408	W	615,746	[4]1,534,737	[4]28,165,837
South Dakota	--	W	128,137	--	--	--	[2]128,137	[2]345,705
Tennessee	420,557	W	223,842	--	W	W	765,753	20,107,083
Texas	W	100,470	3,939,835	38,493	W	W	4,192,656	26,497,224
Utah	--	6,874	175,201	817	W	--	[4]182,892	[4]994,432
Virginia	--	--	419,340	--	2,860	--	422,200	2,237,051
Washington	--	--	244,104	6,836	--	--	250,940	1,829,407
West Virginia	--	--	209,653	W	--	--	[6]209,653	[6]583,478
Wyoming	--	2,407,776	153,269	--	--	--	2,561,045	73,695,852
Undistributed	[7]221,934	[7]136,204	[7]111,995	[7]162,999	[7]687,718	[7]176,044	[8]919,457	[8]34,380,930
Total	642,491	3,244,800	22,488,021	1,086,971	1,682,655	6,362,203	35,507,141	825,361,498

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Includes Puerto Rico.
[2]Excludes bentonite.
[3]Excludes kaolin.
[4]Excludes fuller's earth.
[5]Excludes ball clay.
[6]Excludes fire clay.
[7]Total of States indicated by symbol W.
[8]Incomplete total; difference included with individual State totals.

Table 3.—Number of mines from which producers sold or used clays in the United States in 1982, by State[1]

State	Ball clay	Bentonite	Common clay	Fire clay	Fuller's earth	Kaolin	Total
Alabama	--	1	24	7	--	13	45
Arizona	--	4	6	--	--	--	10
Arkansas	--	--	18	--	--	4	22
California	1	6	54	3	--	12	76
Colorado	--	2	26	8	--	--	36
Connecticut	--	--	2	--	--	--	2
Florida	--	--	4	--	4	1	9
Georgia	--	--	16	--	12	70	98

See footnotes at end of table.

Table 3.—Number of mines from which producers sold or used clays in the United States in 1982, by State[1] —Continued

State	Ball clay	Bentonite	Common clay	Fire clay	Fuller's earth	Kaolin	Total
Idaho	--	1	2	1	--	1	5
Illinois	--	--	11	1	2	--	14
Indiana	--	--	19	--	--	--	19
Iowa	--	--	13	--	--	--	13
Kansas	--	1	20	--	--	--	21
Kentucky	6	--	11	5	--	--	22
Louisiana	--	1	8	--	--	--	9
Maine	--	--	5	--	--	--	5
Maryland	1	--	8	--	--	--	9
Massachusetts	--	--	3	--	--	--	3
Michigan	--	--	8	--	--	--	8
Minnesota	--	--	1	--	--	1	2
Mississippi	1	4	19	--	2	--	26
Missouri	--	--	14	58	2	14	88
Montana	--	11	5	1	--	--	17
Nebraska	--	--	5	--	--	--	5
Nevada	--	6	1	--	1	2	10
New Hampshire	--	--	1	--	--	--	1
New Jersey	--	--	2	2	--	--	4
New Mexico	--	--	4	2	--	--	6
New York	1	--	10	--	--	--	11
North Carolina	--	--	51	--	--	2	53
North Dakota	--	--	2	--	--	--	2
Ohio	--	--	55	17	--	--	72
Oklahoma	--	--	16	--	--	--	16
Oregon	--	--	8	--	--	--	8
Pennsylvania	--	--	41	36	--	1	78
South Carolina	--	--	30	1	1	19	51
South Dakota	--	1	2	--	--	--	3
Tennessee	22	1	14	--	1	--	38
Texas	3	5	83	2	3	1	97
Utah	--	3	12	1	1	1	18
Virginia	--	--	22	--	1	--	23
Washington	--	--	14	6	--	--	20
West Virginia	--	--	6	2	--	--	8
Wyoming	--	234	7	--	--	--	241
Total	35	281	683	153	30	142	1,324

[1]Includes both active and idle operations.

Bureau of Mines from one voluntary survey of U.S. operations. Of the 1,408 operations covered by the survey, 1,324, or 94%, responded, representing 94% of the total clay and shale production sold or used in table 1. Production of the 84 nonrespondents was estimated using reported prior year production levels adjusted by trends in employment and other guidelines.

DOMESTIC PRODUCTION, PRICES, AND FOREIGN TRADE, BY TYPE OF CLAY

KAOLIN

Domestic production of kaolin in 1982 decreased 17%. The average unit value for all grades of kaolin increased 3% to $77.43 per ton. Kaolin was produced in 14 States. Two States, Georgia (83%) and South Carolina (10%), accounted for 93% of total U.S. production. Arkansas ranked third, and Missouri, fourth. Output decreased in all States.

Kaolin is defined as a white, claylike material approximating the mineral kaolinite. It has a specific gravity of 2.6 and a fusion point of 1,785° C. The other kaolin-group minerals, such as halloysite and dickite, are encompassed.

Total domestic consumption of domestically produced kaolin decreased 19%. Kaolin producers reported major end uses for their clay as follows: paper coating, 39%; paper filling, 17%; refractories, 9%; chemicals, 6%; common brick, 5%; and rubber, fiberglass, and catalysts, 4% each. Although demand for kaolin by the paper industry decreased during the year, it was not affected as significantly as were sales for refractories and chemicals. These latter industries were undergoing long-range modifications brought about by changes in technology and imports. Domestic sales for catalysts and fiberglass increased significantly.

All Georgia waterwashed kaolin producers concentrated on modernizations, instead of major expansions, to reduce drying and other energy-related costs during 1982. Production of delaminated Georgia kaolin increased 30% to 613,000 tons. Spray dryers were installed by Georgia Kaolin Co. at its Dry Branch complex, by Freeport Kaolin Co. at Gordon, and by Engelhard Minerals and Chemical Corp. at its McIntyre facility. Spray-dryer and high-intensity magnetic separator installations continued in the Macon-Sandersville, Ga., kaolin belt. Thiele Kaolin Co. took delivery of a separator at its Sandersville plant, and J. M. Huber Corp. accepted similar units for its Wrens, Ga., and Edisto, S.C., plants. J. M. Huber completed construction of a 40,000-ton-per-year calcining facility at its Huber, Ga., plant, and Anglo-American Clays Corp. commissioned its second Herrschoff calciner for producing coating clays at Sandersville. Low-calcined kaolins, under 1,000° C, were finding increasing application as an extender and/or substitute for titania (TiO_2), in paints and paper, and in production of petroleum-cracking catalysts. Katalistics International BV, jointly owned by English China Clays Ltd. (ECC), Catalyst Recovery Co., Baltimore, Md., and EKA, Göteburg, Sweden, completed construction of a new petroleum-cracking catalyst plant in Savannah, Ga. Engelhard completed its third expansion since 1973 of its fluid-cracking-catalyst manufacturing facility in Attapulgus, Ga. J. M. Huber was enlarging its Wilkinson County mining operations by installing a new pipeline and dragline at a cost of about $75 million. General Refractories Co. was offering to sell its kaolin deposits and Stevens Pottery refractory plant in Georgia.

Exports of kaolin, as reported by the U.S. Department of Commerce, decreased 8% in 1982 to 1.30 million tons valued at $147 million. Kaolin, including calcined material, was exported to 68 countries. The major recipients were Japan, 34%; Canada, 15%; the Netherlands, 14%; Italy, 8%; and Mexico, 5%. Kaolin producers reported the end uses for their exports as follows: paper coating, 72%; refractories, 10%; paper filling, 8%; rubber and paint, 3% each; and others, including ceramics, chemical manufacturing, medical, pharmaceutical and cosmetics, pesticides and related products, sanitary ware, graphite anodes, ink, and plastics, 4%.

Kaolin imports decreased 31% to 9,400 tons valued at $0.80 million. The United Kingdom supplied about 94%; Canada about 6%; and three other countries supplied small quantities. The unit price of kaolin imported from the United Kingdom apparently decreased 32%.

Kaolin prices quoted in the trade journals in 1982 remained unchanged from 1981. Chemical Marketing Reporter, December 27, 1982, quoted prices as follows:

Waterwashed, fully calcined, bags, carload lots, f.o.b. Georgia, per ton	$218.00
Paper-grade, uncalcined, bulk, carload lots, f.o.b. Georgia, per ton:	
No. 1 coating	94.00
No. 2 coating	75.00
No. 3 coating	73.00
No. 4 coating	70.00
Filler, general purpose, same basis, per ton	58.00
Delaminated, waterwashed, uncalcined, paint-grade, 1-micrometer average, same basis, per ton	182.00
Dry-ground, air-floated, soft, same basis, per ton	60.00
National Formulary, powder, colloidal, bacteria controlled, 50-pound bags, 5,000-pound lots, per pound	.24

Table 4.—Kaolin sold or used by producers in the United States, by State

State	1981		1982	
	Short tons	Value	Short tons	Value
Alabama	249,395	$12,896,587	80,836	$4,906,151
Arkansas	141,683	7,983,553	85,197	5,659,147
California	32,312	1,353,600	25,392	1,157,344
Florida	32,071	W	26,332	W
Georgia	6,235,867	519,496,664	5,268,358	445,389,265
Missouri	104,488	2,220,370	84,298	1,970,887
South Carolina	724,724	25,928,842	615,746	25,068,174
Other[1]	139,941	8,013,986	176,044	8,459,198
Total	7,660,481	577,893,602	6,362,203	492,610,166

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes Idaho, Minnesota (1982), Nevada (1982), North Carolina, Ohio (1981), Pennsylvania, Tennessee (1982), Texas, and data indicated by symbol W.

Table 5.—Kaolin sold or used by producers in the United States, by kind

Kind	1981		1982	
	Short tons	Value	Short tons	Value
Airfloat	1,311,093	$56,426,719	910,134	$43,909,147
Calcined[1]	1,494,801	147,637,273	915,196	109,675,506
Delaminated	470,998	43,603,922	612,591	56,251,295
Unprocessed	759,795	11,262,648	699,411	11,063,621
Waterwashed	3,623,794	318,963,040	3,224,871	271,710,597
Total	7,660,481	577,893,602	6,362,203	492,610,166

[1]Includes both low-temperature filler and high-temperature refractory grades.

Table 6.—Calcined kaolin sold or used by producers in the United States, by State

State	High temperature		Low temperature	
	Short tons	Value	Short tons	Value
1981				
Georgia	672,648	$60,198,079	403,121	$63,863,012
Other[1]	419,032	23,576,182	--	--
Total	1,091,680	83,774,261	403,121	63,863,012
1982				
Georgia	317,698	29,256,516	410,044	67,904,368
Other[1]	187,454	12,514,622	--	--
Total	505,152	41,771,138	410,044	67,904,368

[1]Includes Alabama, Arkansas, California, Idaho, Pennsylvania, and Texas.

Table 7.—Georgia kaolin sold or used by producers, by kind

Kind	1981		1982	
	Short tons	Value	Short tons	Value
Airfloat	753,930	$29,574,295	467,922	$16,778,096
Calcined[1]	1,075,769	124,061,091	727,742	97,160,884
Delaminated	470,998	43,603,922	612,591	56,251,295
Unprocessed	313,841	3,435,670	277,245	3,856,568
Waterwashed	3,621,329	318,821,686	3,182,858	271,342,422
Total	6,235,867	519,496,664	5,268,358	445,389,265

[1]Includes both low-temperature filler and high-temperature refractory grades.

Table 8.—Georgia kaolin sold or used by producers, by use

(Short tons)

Use	1981 Air-float	1981 Unprocessed[1]	1981 Water-washed[2]	1981 Total	1982 Air-float	1982 Unprocessed[1]	1982 Water-washed[2]	1982 Total
Domestic:								
Adhesives	5,685	--	41,906	47,591	28,086	--	29,965	58,051
Alum (aluminum sulfate) and other chemicals	58,769	229,717	260	288,746	8,708	185,440	697	194,845
Animal feed	3,131	--	209	3,340	--	242	200	442
Asphalt tile and linoleum	--	4,955	--	4,955	3,433	--	--	3,433
Catalysts (oil-refining)	--	--	99,093	99,093	39,272	--	94,515	133,787
China and dinnerware; crockery and earthenware	7,915	2,490	8,444	18,849	15,675	4,574	1	20,250
Electrical porcelain	11,923	--	--	11,923	7,387	7,263	--	14,650
Face brick	--	27,524	--	27,524	--	16,000	29,842	45,842
Fiberglass and mineral wool	14,698	--	12,690	27,388	57,241	11,477	37,729	106,447
Firebrick, block, shapes	464	11,121	--	11,585	140	926	--	1,066
Floor and wall tile, ceramic	W	--	--	W	21,014	--	--	21,014
Flue linings and high-alumina brick, glazes, glass, enamels	64,291	2,934	--	67,225	38,548	--	--	38,548
Foundry sand	571	--	235	806	--	--	501	501
Grogs and crudes, refractory	W	445,789	--	445,789	2,970	213,917	--	216,887
Ink	W	--	W	11,805	W	--	W	13,163
Kiln furniture, mortar, cement	W	W	--	22,422	W	W	--	19,185
Medical, pharmaceutical, cosmetic	W	--	W	980	W	--	W	1,660
Paint	9,239	--	66,886	76,125	28,964	--	68,198	97,162
Paper coating	--	--	2,405,505	2,405,505	--	--	2,026,511	2,026,511
Paper filling	421,275	--	758,503	1,179,778	63,463	--	803,397	866,860
Plastics	7,472	--	44,889	52,361	1,158	--	34,733	35,891
Pottery	5,821	5,500	--	11,321	7,210	1,117	--	8,327
Roofing granules	9,747	--	--	9,747	6,265	7,316	--	13,581
Roofing and structural tile	106	--	--	106	--	--	--	--
Rubber	32,620	--	42,545	75,165	29,123	--	31,196	60,319
Sanitary ware	36,794	--	52	36,846	29,394	18,984	5,646	54,024
Miscellaneous, airfloat:								
Animal oil (1981), common brick (1982), fertilizers, gypsum products, oil and grease absorbents (1981), pesticides and related products, textiles (1981), waterproofing and sealing (1981), other, unknown(1981)	39,625	--	--	39,625	13,473	--	--	13,473

Miscellaneous, unprocessed:								
Drain tile (1981), flower pots (1981), gypsum products (1981), fertilizers, pesticides and related products, other (1981)	--	19,441	--	19,441	--	10,968	--	10,968
Miscellaneous, waterwashed:								
Gypsum products, pesticides and related products, waterproofing and sealing, graphite anodes, textiles, and other	--	--	73,800	73,800	--	--	45,554	45,554
Undistributed	9,035	17,646	11,360	[3]2,834	7,415	13,433	13,160	--
Total	739,181	767,117	3,566,377	5,072,675	408,939	491,657	3,221,845	4,122,441
Exports:								
Paint	87	--	31,310	31,397	--	--	31,256	31,256
Paper coating	--	--	604,296	604,296	26,396	--	833,430	859,826
Paper filling	--	--	77,992	77,992	9,437	--	87,299	96,736
Plastics	--	--	23,895	23,895	--	--	20,572	20,572
Refractories	--	219,372	--	219,372	19,821	103,286	--	123,107
Rubber	55	--	364	419	2,400	--	465	2,865
Undistributed	14,607	--	191,214	205,821	929	--	10,626	11,555
Total	14,749	219,372	929,071	1,163,192	58,983	103,286	983,648	1,145,917
Grand total	753,930	986,489	4,495,448	6,235,867	467,922	594,943	4,205,493	5,268,358

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Includes high-temperature calcined.
[2]Includes low-temperature calcined and delaminated.
[3]Incomplete total; difference included in totals for specific uses.

Table 9.—South Carolina kaolin sold or used by producers, by kind

Kind	1981		1982	
	Short tons	Value	Short tons	Value
Airfloat	514,070	$24,309,941	441,694	$23,996,889
Unprocessed	210,654	1,618,901	174,052	1,071,285
Total	724,724	25,928,842	615,746	25,068,174

Table 10.—South Carolina kaolin sold or used by producers, by kind and use

(Short tons)

Kind and use	1981	1982
Airfloat:		
Adhesives	17,766	12,522
Animal feed and pet waste absorbent	--	2,193
Ceramics[1]	117,941	27,477
Fertilizers	15,444	7,929
Fiberglass	98,427	76,969
Paint	841	410
Paper coating and filling	3,292	2,799
Pesticides and related products	17,075	14,424
Plastics	13,966	11,075
Rubber	122,625	158,819
Other refractories[2]	5,202	4,737
Other uses[3]	50,744	81,708
Exports[4]	50,747	40,632
Total	514,070	441,694
Unprocessed: Face brick; firebrick, block and shapes; miscellaneous	210,654	174,052
Grand total	724,724	615,746

[1]Includes floor and wall tile, pottery, roofing granules, and sanitary ware.
[2]Includes refractory grogs and crudes; refractory mortar and cement.
[3]Includes common brick; catalyst (oil refining); chemical manufacturing; animal oil; medical, pharmaceutical and cosmetic; sewer pipe and roofing tile (1981); and miscellaneous.
[4]Includes ceramics, paper filling, pesticides and related products, rubber, and miscellaneous.

Table 11.—Kaolin sold or used by producers in the United States, by use

(Short tons)

Use	1981 Airfloat	1981 Unprocessed[1]	1981 Water-washed[2]	1981 Total	1982 Airfloat	1982 Unprocessed[1]	1982 Water-washed[2]	1982 Total
Domestic:								
Adhesives	23,451	6,161	41,900	71,512	41,736	--	29,965	71,701
Alum (aluminum sulfate) and other chemicals	77,701	373,388	260	451,349	24,788	288,359	5,477	318,624
Animal feed	3,131	8,690	209	12,030	2,250	242	3,076	5,568
Brick, common and face	1,061	269,092	--	270,153	24	222,672	29,842	252,538
Catalysts (oil- and gas-refining)	29,511	--	99,093	128,604	89,801	--	95,710	185,511
Cement, portland	--	10,105	--	10,105	--	38,417	--	38,417
China and dinnerware	12,191	4,923	8,444	25,558	20,064	4,463	1	24,528
Crockery and other earthenware	W	W	--	1,417	W	W	--	W
Electrical porcelain	20,103	3,650	--	23,753	17,282	10,608	--	27,890
Fertilizers[3]	15,807	13,750	2	29,559	9,350	6,015	1,195	16,560
Fiberglass; mineral wool and other insulation	113,858	9,105	12,690	135,653	147,250	11,477	37,729	196,456
Firebrick, block, shapes	2,388	128,904	--	131,292	140	83,990	2,390	86,520
Floor and wall tile, ceramic glazes, glass, enamel	13,150	9,593	--	22,743	35,641	5,773	--	41,414
Flue linings and high-alumina brick	65,253	2,934	--	68,187	38,548	57,453	--	96,001
Foundry sand	571	--	235	806	--	--	501	501
Grogs and crudes, refractory	4,674	631,053	--	635,727	6,542	213,917	--	220,459
Gypsum products	2,828	9,763	73	12,664	5,095	458	1,309	6,862
Ink	W	--	W	11,805	W	--	W	13,163
Kiln furniture, mortar and cement, refractory	7,576	23,246	--	30,822	6,917	14,548	--	21,465
Linoleum and asphalt tile	--	4,955	--	4,955	--	3,433	--	3,433
Medical, pharmaceutical, cosmetic	W	--	W	986	W	--	W	1,665
Paint	10,080	--	66,886	76,966	29,374	14,390	75,702	119,466
Paper coating	--	--	2,405,505	2,405,505	--	--	2,026,511	2,026,511
Paper filling	426,567	--	758,503	1,185,070	67,215	--	803,397	870,612
Pesticides and related products	40,372	39,009	1,280	80,661	14,699	12,615	2,631	29,945

See footnotes at end of table.

Table 11.—Kaolin sold or used by producers in the United States, by use —Continued

(Short tons)

Use	1981 Airfloat	1981 Unprocessed[1]	1981 Water-washed[2]	1981 Total	1982 Airfloat	1982 Unprocessed[1]	1982 Water-washed[2]	1982 Total
Domestic —Continued								
Plastics	21,438	--	44,889	66,327	12,276	--	35,928	48,204
Pottery	10,149	9,400	--	19,549	10,850	6,896	--	17,746
Roofing granules	9,944	460	--	10,404	9,328	12,182	--	21,510
Roofing tile and structural tile	606	1,000	--	1,606	--	--	--	--
Rubber	155,245	9,866	42,545	207,656	190,404	--	31,196	221,600
Sanitary ware	150,979	4,553	52	155,584	29,854	51,248	5,646	86,748
Waterproofing and sealing	9,212	--	159	9,371	--	--	W	W
Miscellaneous	16,147	20,828	86,117	[4]108,884	26,425	35,026	48,767	[4]95,390
Total	1,243,993	1,594,428	3,568,842	6,407,263	835,853	1,094,182	3,236,973	5,167,008
Exports:								
Ceramics	3,071	--	1,851	4,922	3,273	--	1,975	5,248
Foundry sand; grogs, crudes, other refractories	321	257,047	--	257,368	19,821	104,861	--	124,682
Paint	87	--	31,310	31,397	--	--	31,256	31,256
Paper coating	--	--	604,296	604,296	--	--	859,826	859,826
Paper filling	4,225	--	77,992	82,217	11,933	--	87,299	99,232
Plastics	--	--	23,895	23,895	--	--	20,572	20,572
Rubber	43,058	--	364	43,422	34,517	--	465	34,982
Other	16,338	--	189,363	205,701	4,737	5,520	9,140	19,397
Total	67,100	257,047	929,071	1,253,218	74,281	110,381	1,010,533	1,195,195
Grand total	1,311,093	1,851,475	4,497,913	7,660,481	910,134	1,204,563	4,247,506	6,362,203

W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous."
[1]Includes high-temperature calcined.
[2]Includes low-temperature calcined and delaminated.
[3]Includes soil conditioners and mulches.
[4]Incomplete total; remainder included with totals for specific uses.

BALL CLAY

Reported production of domestic ball clay in 1982 decreased 24% to 642,000 tons valued at $22 million. Tennessee provided 65% of the Nation's output, followed in order by Kentucky, Mississippi, Texas, Maryland, New York,[2] and California. Production in all States decreased compared with 1981 output.

Ball clay is defined as a plastic, white-firing clay used principally for bonding in ceramic ware. The clays are of sedimentary origin and consist mainly of the clay mineral kaolinite and sericite micas.

Increased production capacities, modernization, and/or construction of new plants slowed during 1982. Ball clay producers, however, were cautiously either increasing their production capabilities for water-slurried ball clay for sanitary ware, dinnerware, and tile markets or adopting this capability. At yearend, Louisville Cement Co. offered to buy all the common shares outstanding of the Kentucky-Tennessee Clay Co., the largest domestic ball clay producer with multistate operations, and General Refractories sold its east Texas ball clay deposits, located in Henderson, Tex., to Henderson Brick Co.

The average unit value for ball clay reported by domestic producers increased 5% to $34.59 per ton. Chemical Marketing Reporter, December 27, 1982, listed ball clay prices unchanged from 1981, as follows:

Domestic, air-floated, bags, carload lots, Tennessee, per ton	$18.00-$22.00
Domestic, crushed, moisture-repellent, bulk, carload lots, Tennessee, per ton	8.00- 11.25
Imported, air-floated, bags, carload lots, Atlantic ports, per ton	70.00
Imported, lump, bulk, Great Lakes, per ton	40.50

Ball clay exports in 1982 decreased 32% to 144,000 short tons valued at $5.2 million. Unit value increased 15% to $35.77 per ton. Shipments were made to 29 countries. The major recipients were Mexico, 58%, and Canada, 31%. The large Mexican market was required to use local clays because of lack of foreign capital caused by poor economic conditions and devaluation of the peso.

Ball clay imports, almost entirely from the United Kingdom, decreased 29% to 5,171 tons valued at $368,000 in 1982. The unit value of these imports decreased 39% to $71.17 per ton.

Table 12.—Ball clay sold or used by producers in the United States, by State

State	Airfloat[1]		Unprocessed		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1981						
Tennessee	317,156	$11,751,863	242,312	$6,212,308	559,468	$17,964,171
Other	[2]231,225	[2]8,704,208	[3]54,467	[3]1,175,908	285,692	9,880,116
Total	548,381	20,456,071	296,779	7,388,216	845,160	27,844,287
1982						
Tennessee	238,657	9,111,952	181,900	4,680,024	420,557	13,791,976
Other	[2]189,827	[2]7,635,223	[3]32,107	[3]796,208	221,934	8,431,431
Total	428,484	16,747,175	214,007	5,476,232	642,491	22,223,407

[1]Includes water-slurried.
[2]Includes Kentucky, Maryland, Mississippi, and Texas (1981).
[3]Includes California, Kentucky, Maryland, Mississippi, New York, and Texas.

Table 13.—Ball clay sold or used by producers in the United States, by use

(Short tons)

Use	1981 Air-float[1]	1981 Un-processed	1981 Total	1982 Air-float[1]	1982 Un-processed	1982 Total
Adhesives	3,577	--	3,577	W	--	W
Animal feed	W	--	W	W	W	11,650
Brick, face	--	W	W	--	--	--
China and dinnerware	13,838	23,427	37,265	27,657	735	28,392
Crockery and other earthenware	976	8,259	9,235	W	--	W
Drilling mud	W	--	W	W	--	W
Electrical porcelain	12,614	11,150	23,764	9,790	5,450	15,240
Fiberglass and catalysts (oil-refining)	W	--	W	W	--	W
Firebrick, block, shapes	524	6,171	6,695	W	W	W
Glazes, glass, enamels	W	W	2,567	W	W	2,135
Grogs and crudes, high-alumina; mortar and cement refractories	87,846	9,813	97,659	69,804	6,487	76,291
Kiln furniture	W	W	2,540	2,001	--	2,001
Paper coating and filling	15,533	--	15,533	11,476	--	11,476
Pesticides and related products	W	W	763	--	W	W
Pottery	192,092	26,933	219,025	145,254	11,833	157,087
Rubber	--	W	W	--	W	W
Sanitary ware	68,698	12,130	80,828	44,119	78,249	122,368
Tile:						
Floor and wall	69,467	12,649	82,116	29,718	56,371	86,089
Other	--	W	W	--	--	--
Miscellaneous	52,090	104,979	[2]151,199	34,544	24,628	[2]45,387
Exports	31,126	81,268	112,394	54,121	30,254	84,375
Total	548,381	296,779	845,160	428,484	214,007	642,491

W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous."
[1]Includes water-slurried.
[2]Incomplete total; difference included in totals for specific uses.

FIRE CLAY

Fire clay sold or used by domestic producers in 1982 decreased 44% to 1.09 million tons valued at $18.4 million. Fire clay is defined as detrital material, either plastic or rocklike, containing low percentages of iron oxide, lime, magnesia, and alkalies to enable the material to withstand temperatures of 1,500° C or higher. It is basically kaolinite but usually contains other materials such as diaspore, ball clay, bauxite clay, and shale. Fire clays commonly occur as underclay below coal seams and are generally used for refractories. Some fire clay was previously reported in other end uses in this report.

Industrywide expansions, modernizations, acquisitions, and/or mergers were slowed during 1982. Most plants were closed for part of the year or placed on minimal production schedules. The refractory clay industry appeared to be entering a period of low production, reflecting lower demand by the major consumers—steel, foundry, aluminum, and cement industries.

Fire clay production was reported in 1982 from mines in 17 States. Five States, Missouri, Ohio, Pennsylvania, West Virginia, and Alabama, in order of volume, accounted for 88% of the total domestic output.

Exports of fire clay decreased 38% in 1982 to 180,000 tons valued at $13.6 million. The price of exported fire clay increased 14% to $75.56 per ton, indicating a larger percentage of higher quality material shipped.

Fire clay was exported to 31 countries. Japan received 28%, while Mexico, Belgium, the Federal Republic of Germany, and Canada received 18%, 16%, 13%, and 11%, respectively. No imports of fire clay were reported during 1982.

Unit values for fire clay, reported by producers, ranged from $5.94 to $23.30 per ton. The average unit value increased 5% to $16.97 per ton.

Table 14.—Fire clay sold or used by producers in the United States, by State[1]

State	1981		1982	
	Short tons	Value	Short tons	Value
Alabama	257,879	$5,777,179	89,500	$2,085,278
Colorado	24,742	204,771	2,429	28,056
Illinois	21,553	245,920	10,464	131,323
Kentucky	5,815	67,037	9,698	106,699
Missouri	668,839	13,396,750	447,668	8,832,909
Montana	546	2,730	546	W
New Jersey	10,644	233,539	12,143	212,240
Ohio	360,031	4,641,786	152,089	2,214,063
Pennsylvania	226,109	3,582,448	135,881	2,601,714
Texas	41,941	258,954	38,493	233,728
Other[2]	309,024	2,766,098	188,060	2,002,742
Total	1,927,123	31,177,212	1,086,971	18,448,752

[1]Refractory uses only.
[2]Includes California, Idaho, New Mexico, South Carolina, Utah, Washington, and West Virginia.

BENTONITE

Bentonite production in 1982 decreased 34% to 3.2 million tons valued at $103 million. Domestic consumption decreased in drilling mud, foundry sand, and pelletizing iron ore.

Bentonite was produced in 15 States. Production decreased in all States except California, Idaho, and Nevada, in which the increases were slight.

The high-swelling or sodium bentonites have been produced chiefly in Wyoming, Montana, and California. The calcium or low-swelling bentonites have been produced in the other States.

During 1982, all the major western and southern bentonite producers either canceled or deferred ongoing expansions or modernizations. Most plants were shut down intermittently during the year or were on reduced production schedules. However, the industry remained in a position to meet reasonable demand increases. The industry malaise was caused by the precipitous drop in oil- and gas-well drilling activities at midyear, compounded by the continued depression in the steel and foundry industries. These three industries traditionally had consumed about 90% of domestic output.

Burlington Northern cut its rail rates during midyear for shipping bentonite from Wyoming and Montana to the major oil- and gas-well regions along the gulf coast and in Oklahoma in an attempt to regain business lost to trucking. Rates were cut about 20% to under $50 per ton.

On December 27, 1982, Chemical Marketing Reporter quoted domestic bentonite, 200 mesh, bags, carload lots, f.o.b. mines, from $37 to $40 per ton. The average unit value reported by domestic producers increased 5% to $31.67 per ton. Per-ton values reported in the various producing States ranged from $11.00 to $62.40, but the average value reported by the larger producers was near the Montana average figure of $38.69.

Bentonite exports in 1982 decreased 22% to 668,000 tons valued at $54.7 million. The unit value of exported bentonite increased 9% to $81.91 per ton; this was attributed to a larger percentage of the higher cost drilling muds and foundry sand grades shipped. Domestic bentonite producers were facing increased competition in foreign markets.

Bentonite was exported to 71 countries. The major recipients were Canada, 34%; Japan, 12%; Singapore, 7%; Saudi Arabia and the Netherlands, 6% each. Domestic bentonite producers reported that the end uses of their exports were drilling mud, 64%; foundry sand, 15%; and other, 21%.

Bentonite imports in 1982, consisting largely of chemically activated material, decreased 28% to 7,241 tons valued at $2.8 million, primarily because of reduced shipments from the Federal Republic of Germany. The chemically activated bentonite was imported from five countries, with Canada supplying 58%; the Federal Republic of Germany, 22%; Mexico, 17%; and the United Kingdom and Japan, the remaining 3%.

Table 15.—Bentonite sold or used by producers in the United States, by State

State	Nonswelling		Swelling		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1981						
Arizona	33,220	$655,126	20	$1,200	33,240	$656,326
California	53,073	3,433,167	22,213	1,036,324	75,286	4,469,491
Colorado	2,000	28,000	39,100	391,000	41,100	419,000
Kansas	--	--	27,000	331,830	27,000	331,830
Mississippi	285,446	7,060,084	--	--	285,446	7,060,084
Montana	--	--	586,991	23,077,808	586,991	23,077,808
Nevada	--	--	14,127	706,717	14,127	706,717
Texas	116,046	8,262,576	50	2,500	116,096	8,265,076
Utah	--	--	7,845	89,062	7,845	89,062
Wyoming	--	--	3,584,287	99,745,102	3,584,287	99,745,102
Other	[1]147,648	[1]3,334,000	[2]28,092	[2]1,118,111	175,740	4,452,111
Total	637,433	22,772,953	4,309,725	126,499,654	4,947,158	149,272,607
1982						
Arizona	27,518	529,189	--	--	27,518	529,189
California	54,742	3,725,351	20,907	995,104	75,649	4,720,455
Colorado	4,000	56,000	60	660	4,060	56,660
Kansas	--	--	15,000	300,000	15,000	300,000
Mississippi	231,596	6,063,403	--	--	231,596	6,063,403
Montana	--	--	207,879	8,042,594	207,879	8,042,594
Nevada	--	--	14,500	752,206	14,500	752,206
Texas	49,580	3,496,738	50,890	1,664,709	100,470	5,161,447
Utah	--	--	6,874	96,543	6,874	96,543
Wyoming	--	--	2,407,776	72,992,324	2,407,776	72,992,324
Other	[1]132,799	[1]3,198,914	[2]20,679	[2]852,102	153,478	4,051,016
Total	500,235	17,069,595	2,744,565	85,696,242	3,244,800	102,765,837

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes Alabama, Idaho, and Louisiana (1981).
[2]Includes Idaho, South Dakota, and Tennessee.

Table 16.—Bentonite sold or used by producers in the United States, by use

(Short tons)

Use	1981			1982		
	Non-swelling	Swelling	Total	Non-swelling	Swelling	Total
Domestic:						
Adhesives	W	W	382	--	179	179
Animal feed	57,855	99,258	157,113	66,334	74,148	140,482
Brick, face	--	W	W	--	--	--
Catalysts (oil refining)	7,749	5	7,754	4,311	4	4,315
Cement, portland	--	W	W	--	W	W
Drilling mud	60,554	2,004,088	2,064,642	15,275	1,409,072	1,424,347
Fertilizers	--	4,054	4,054	--	2,749	2,749
Filtering, clarifying, decolorizing:						
Animal oils and mineral oils and greases	102,702	2,610	105,312	120,120	1,936	122,056
Vegetable oils	55,662	--	55,662	27,135	--	27,135
Foundry sand	270,289	521,430	791,719	186,243	328,028	514,271
Glazes, glass, enamels	--	W	W	--	W	W
Medical, pharmaceutical, cosmetic	--	2,818	2,818	--	8,050	8,050
Paint	--	14,412	14,412	--	12,998	12,998
Pelletizing (iron ore)	--	884,976	884,976	--	396,506	396,506
Pesticides and related products	506	2,872	3,378	366	4,731	5,097
Pet waste absorbent	W	--	W	W	--	W
Waterproofing and sealing	1,897	88,882	90,779	17,939	87,527	105,466
Miscellaneous	63,944	71,168	[1]134,730	60,155	65,817	125,972
Total	621,158	3,696,573	4,317,731	497,878	2,391,745	2,889,623
Exports:						
Drilling mud	--	364,342	364,342	--	227,409	227,409
Foundry sand	13,956	203,928	217,884	109	53,441	53,550
Pelletizing (iron ore)	--	37,771	37,771	--	--	--
Other	2,319	7,111	9,430	2,248	71,970	74,218
Total	16,275	613,152	629,427	2,357	352,820	355,177
Grand total	637,433	4,309,725	4,947,158	500,235	2,744,565	3,244,800

W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous."
[1]Incomplete total; difference included with total for each specific use.

FULLER'S EARTH

Production of fuller's earth in 1982 increased 2% to 1.68 million tons valued at $97 million. The average unit value increased 2% to $57.44 per ton.

Fuller's earth production was reported from operations in 11 States. The two top producing States, Georgia (32%) and Florida (26%), accounted for 58% of domestic production. Illinois, Missouri, South Carolina, and Tennessee showed gains in production; the other producing States had production decreases.

Fuller's earth is defined as a nonplastic clay or claylike material, usually high in magnesia, which has adequate decolorizing and purifying properties.

Production from the region that includes Attapulgus, Decatur County, Ga., and Quincy, Gadsden County, Fla., is composed predominantly of the lath-shaped amphibole clay mineral attapulgite. Most of the fuller's earth produced in other areas of the United States contains varieties of montmorillonite.

In 1982, industrywide enlargements, modernizations, acquisitions, and/or mergers were either canceled or deferred until economic conditions improve. Two notable exceptions were activities by the Floridin Co. and Malthan Inc. Floridin completed a $23 million expansion of its attapulgite processing plant in Quincy, Fla., and Malthan, a subsidiary of Gurley Oil Co., Memphis, Tenn., completed an expansion of its Paris, Tenn., operation.

Attapulgite, a fuller's earth-type clay, finds wide application in both the absorbent and thickening areas. Mineral thickeners are used in such diverse markets as paints, joint compound cement, polishes, and plastics. The thixotropic properties of attapulgite clays provide the important thickening and viscosity controls necessary for suspending solids.

Prices for attapulgite reported by producers ranged from $49.50 to $69.89; montmorillonite prices ranged from $10.00 to $62.30.

In 1982, fuller's earth was exported to 42 countries; exports decreased 16% to 93,000 tons. The unit value of exported fuller's earth decreased 2% to $92.68 per ton. The major recipients were Canada, 63%; the Netherlands, 16%; the United Kingdom, 6%; and other countries, 15%.

Imports of fuller's earth were 40 tons valued at $8,000, all from the United Kingdom.

Table 17.—Fuller's earth sold or used by producers in the United States, by State

State	Attapulgite		Montmorillonite		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1981						
Florida	518,031	$34,955,895	--	--	518,031	$34,955,895
Georgia	346,995	19,035,619	237,108	$11,137,782	584,103	30,173,401
Other	[1]51,283	[1]3,108,462	[2]502,437	[2]24,945,910	553,720	28,054,372
Total	916,309	57,099,976	739,545	36,083,692	1,655,854	93,183,668
1982						
Florida	442,253	30,907,739	--	--	442,253	30,907,739
Georgia	294,861	15,763,497	239,323	11,794,188	534,184	27,557,685
Other	[1]119,059	[1]6,645,625	[2]587,159	[2]31,533,356	706,218	38,178,981
Total	856,173	53,316,861	826,482	43,327,544	1,682,655	96,644,405

[1]Includes Nevada and Texas.
[2]Includes Illinois, Mississippi, Missouri (1982), Nevada, South Carolina, Tennessee, Utah, and Virginia.

Table 18.—Fuller's earth sold or used by producers in the United States, by use

(Short tons)

Use	1981 Attapulgite	1981 Montmorillonite	1981 Total	1982 Attapulgite	1982 Montmorillonite	1982 Total
Domestic:						
Adhesives	1,226	--	1,226	661	--	661
Animal feed	5,969	--	5,969	10	--	10
Drilling mud	191,287	2,027	193,314	109,226	--	109,226
Fertilizers	55,442	22,841	78,283	54,268	19,285	73,553
Filtering, clarifying, decolorizing mineral oils and greases	20,647	--	20,647	19,102	--	19,102
Medical, pharmaceutical, cosmetic	74	--	74	112	--	112
Oil and grease absorbents	196,465	246,821	443,286	170,031	232,833	402,864
Paint	5,347	--	5,347	5,396	--	5,396
Paper filling	4,472	--	4,472	--	--	--
Pesticides and related products	117,549	66,669	184,218	92,327	75,210	167,537
Pet waste absorbent	116,657	304,080	420,737	320,179	359,958	680,137
Rubber	252	--	252	--	--	--
Miscellaneous	70,220	36,378	106,598	34,032	81,557	115,589
Total	785,607	678,816	1,464,423	805,344	768,843	1,574,187
Exports:						
Drilling mud	363	--	363	653	--	653
Oil and grease absorbents	37,330	33,112	70,442	41,539	29,783	71,322
Pet waste absorbent	85,666	27,283	112,949	3,297	27,513	30,810
Miscellaneous	7,343	334	7,677	5,340	343	5,683
Total	130,702	60,729	191,431	50,829	57,639	108,468
Grand total	916,309	739,545	1,655,854	856,173	826,482	1,682,655

COMMON CLAY

Domestic production of common clay and shale decreased 18% in 1982 to 22.5 million tons valued at $93 million. Output decreased significantly in all major producing States except Texas, the overall major producing State. Common clay and shale represented 63% of the quantity and 11% of the value of total domestic clays produced in 1982. Domestic clays and shales have been for the most part used by the producers in fabricating or manufacturing products. Less than 10% of the total clay and shale output was sold. The average unit value for all common clay and shale produced in the United States and Puerto Rico increased 3% to $4.12 per short ton. The range in unit value reported for the bulk of the output was from $1.42 to $20.14 per ton.

Common clay is defined as a clay or claylike material that is sufficiently plastic to permit ready molding and that vitrifies below 1,100° C. Shale is consolidated sedimentary rock composed chiefly of clay minerals that has been both laminated and indurated while buried under other sediments. These materials are used in the manufacture of structural clay products such as brick and drain tile, portland cement clinker, and bloated lightweight aggregates.

Increased production capacities, new plants, and acquisitions and/or mergers slowed during 1982. The construction industry, the largest consumer of heavy clay products, such as brick, lightweight aggregate, portland cement, sewer pipe, and tiles, continued in its depressed state. Large inventories resulted in either plant shutdowns during portions of the year or lower production schedules. Davidson Brick Co. contracted with the Lingl Corp., Paris, Tenn., to build a new plant in Perris, Calif., located near Riverside, halfway between Los Angeles and San Diego. The plant, targeted for completion in the spring of 1983, was to produce about 300 tons per day of large hollow block for commercial use. Denver Brick and Pipe Co. moved its plant and offices from Denver, Colo., to its new $4.4 million facility in Castle Rock, located near to and south of Denver. The new plant, when fully operational, was to produce about 35 million brick annually. Pipe production was to be discontinued. A new $5 million lightweight aggregate plant with a rotary-fired kiln was to be built by Camp Lightweight Inc. at Fort Gaines, Ga.

Output continued to be hindered by fluctuating fuel costs and labor shortages. Industry attention in the Northwest and Southeast focused on coal, sawdust, and woodchip firing as a possible escape from the high cost and intermittent shortages of oil and gas.

Table 19.—Common clay and shale sold or used by producers in the United States, by State[1]

State	1981 Short tons	1981 Value	1982 Short tons	1982 Value
Alabama	1,402,897	$6,732,395	1,153,099	$6,201,113
Arizona	114,924	448,910	115,460	468,485
Arkansas	738,235	1,349,393	543,701	998,676
California	2,183,227	13,208,448	1,642,558	9,653,436
Colorado	210,038	1,110,463	194,901	1,039,188
Connecticut	72,854	390,668	55,874	329,459
Florida	180,964	362,620	203,031	431,466
Georgia	1,209,399	4,156,061	970,441	2,820,589
Illinois	300,192	1,294,161	444,055	2,174,132
Indiana	690,593	1,601,914	500,923	1,220,519
Iowa	476,249	2,374,802	436,763	2,391,983
Kansas	887,714	4,424,230	648,862	3,356,235
Kentucky	484,157	2,327,290	569,596	1,931,784
Louisiana	379,921	6,337,687	308,664	6,215,920
Maine	56,650	166,460	37,488	75,782
Maryland	596,811	1,984,202	404,737	1,346,287
Massachusetts	258,853	1,322,424	210,364	1,114,663
Michigan	1,609,562	5,862,484	1,022,436	4,369,853
Minnesota	83,778	1,077,154	W	W
Mississippi	649,145	2,028,457	329,857	1,212,289
Missouri	973,710	2,796,528	851,284	2,604,805
Montana	13,095	30,003	9,675	21,718
Nebraska	135,965	409,278	133,687	391,617
New Hampshire	W	W	W	W
New Jersey	51,786	329,359	50,560	353,920
New Mexico	63,720	118,811	59,944	112,459
New York	597,276	2,310,037	352,319	896,647
North Carolina	2,110,380	6,838,420	1,573,368	5,243,016
Ohio	1,853,302	5,752,626	1,299,077	3,885,544
Oklahoma	838,339	2,063,568	751,858	1,907,322
Oregon	176,359	299,642	149,399	212,385
Pennsylvania	1,020,275	3,914,696	795,043	3,014,343
Puerto Rico	200,049	473,932	162,038	297,911
South Carolina	907,432	2,671,497	901,583	2,793,023
South Dakota	116,250	209,050	128,137	345,705
Tennessee	403,330	939,808	223,842	511,199
Texas	3,901,802	15,359,280	3,939,835	16,066,641
Utah	247,271	1,048,196	175,201	891,352
Virginia	501,829	2,015,834	419,340	2,094,051
Washington	262,652	1,524,212	244,104	1,724,303
West Virginia	219,693	502,231	209,653	583,478
Wyoming	270,909	1,181,084	153,269	703,528
Other[2]	91,899	598,836	111,995	662,105
Total	27,543,486	109,947,151	22,488,021	92,668,931

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes Puerto Rico.
[2]Includes Idaho, Nevada, North Dakota, and data indicated by symbol W.

CONSUMPTION AND USES

The manufacture of heavy clay products (building brick, sewer pipe and drain, roofing, structural, terra cotta, and other tile), portland cement clinker, and lightweight aggregate accounted for 29%, 20%, and 11%, respectively, of total domestic consumption for both 1981 and 1982. In summary, 60% of all clay produced in 1982 was consumed in the manufacture of these clay- and shale-based construction materials.

Heavy Clay Products.—The value reported for shipments of heavy clay products decreased 5% to $923 million. Thousand-unit counts for building or common face brick decreased 15%, shipments of glazed and unglazed ceramic tile and glazed brick decreased 68%, and clay floor and wall tile shipments increased 3%. The tonnage of unglazed structural tile decreased 47%, and vitrified clay sewer pipe and fittings shipped during the year decreased 30%.

Lightweight Aggregates.—Consumption of clay and shale in the manufacture of lightweight aggregate decreased 18% to 4.0 million tons. This was attributed to a downturn in construction. However, uses in the newer markets, such as running tracks, golf courses, and potting plants and other horticultural applications, continued to grow.

The tonnage of raw material mentioned in tables 20 and 23 for lightweight aggregate production refers only to clay and shale and does not include slate and blast furnace slag similarly used.

Refractories.—All types of clay were used in manufacturing refractories. Fire clay, bentonite, and kaolin accounted for 42%, 21%, and 17%, respectively, of the total clays used for this purpose. The remainder, ball clay, fuller's earth, and common clay and shale, were used primarily as bonding agents. Bentonite was used primarily as a bonding agent in proprietary foundry formulations.

The tonnage of clays used for refractories decreased slightly in 1982 and constituted 7% of the total clays produced. A similar downward trend occurred in the late 1970's and in 1980. The 1981 increases were caused primarily by continued expansion in refractory aggregate production and an upsurge in the manufacturing of more conventional brick-type refractories. Refractory aggregates are used mostly in specialty plastics, gunning, ramming, castable mixes, and/or as a substitute for refractory bauxite. The 1982 downturn, involving conventional brick and, for the first time, specialty refractories, was due largely to the poor economy but also signaled major changes in technology and production levels for the consuming steel, foundry, aluminum, and cement industries.

Filler.—All kinds of clay have been used to some extent as fillers in one or more areas of use. Kaolin, fuller's earth, and bentonite have been the principal filler clays. Kaolin was used in the manufacture of a large number of products, such as paper, rubber, paint, and adhesives. Fuller's earth was used primarily in pesticides and fertilizers. Clays in pesticides and fertilizers were used either as carriers, diluents, or prilling agents. Bentonites were used mainly in animal feed.

In 1982, 11% of clay produced was used in filler applications; of this, kaolin accounted for 87%; fuller's earth, 7%; bentonite, 4%; and ball clay, common clay and shale, and fire clay, the remaining 2%. The total amount of kaolin consumed as fillers did not change significantly. Decreases occurred in the use of kaolin for gypsum products (46%), fertilizer (44%), and plastics (27%). The total quantity of fuller's earth used in insecticides and fungicides decreased 63%.

Absorbent Uses.—Absorbent uses for clays accounted for over 1.20 million tons, or 3% of the total 1982 clay production. Demand for absorbents increased 25% over that reported for 1981. Fuller's earth was the principal clay used, and absorbent applications accounted for 89% of its entire output. Bentonite was used to a lesser degree. The tonnage of raw materials indicated in table 20 for pet waste and oil and grease absorbents refers only to clays and does not include the over 105,000 tons of other nonclay minerals similarly used. Demand for clays in pet waste absorbent, representing 56% of the 1982 absorbent use, increased 39% from that reported for 1981. Use in floor absorbents, chiefly to absorb hazardous oily substances, representing the remaining 44% of absorbent demand, decreased 16% from the 1981 figure.

Drilling Mud.—Demand for clays in rotary-drilling muds decreased 32% in 1982 to 1.54 million tons and accounted for 4% of total clay production. The domestic bentonite industry continued its rapid expansion, begun in the latter half of the 1970's, until midyear 1982. Then an oil glut and economic downturn, compounded by uncertainty as to the future of unregulated deep gas, resulted in lower oil- and gas-well drilling activity. Swelling-type bentonite remained the principal clay used in drilling mud mixes, although fuller's earth and nonswelling bentonite are also used to a limited extent. Bentonite and fuller's earth accounted for nearly 100% of the total amount of clay used for this purpose. Small amounts of ball clay and kaolin were used in specialized formulations.

Floor and Wall Tile.—Common clay and shale, ball clay, fire clay, and kaolin, in order of demand, were used in manufacturing floor, wall, and quarry tile. This end-use category accounted for 1% of the total clay production in 1982. Demand for tiles increased 5% to 365,000 tons.

Pelletizing Iron Ore.—Bentonite is used as a binder in forming hard iron ore pellets. Demand decreased 55% in 1982 to 397,000 tons, reflecting a downturn in taconite pellet production because of decreasing steel demand, exacerbated by inroads made by cheaper foreign bentonites into a traditional U.S. clay market. Of the total bentonite produced, about 12% of the swelling variety was consumed for this purpose. U.S. deposits continued to be the major world source for swelling bentonites.

Ceramics.—Total demand for clays in the manufacture of pottery, sanitary ware, china and dinnerware, and related products (excluding clay flower pots) accounted for 3% of the total 1982 clay output. This demand, principally for ball and kaolin clays, increased 6%, to 1.20 million tons.

Table 20.—Clays sold or used by producers in the United States in 1982, including Puerto Rico, by use

(Short tons)

Use	Ball clay	Bentonite	Common clay and shale	Fire clay (refractory only)	Fuller's earth	Kaolin	Undistributed[1]	Total[2]
Adhesives	W	179	--	W	661	71,701	1,647	74,188
Alum (aluminum sulfate) and other chemicals	--	W	--	--	1,653	318,624	W	320,277
Animal feed	11,650	140,482	--	494	10	5,568	--	158,204
Building brick:								
Common	W	W	2,334,822	--	W	8,326	29,278	2,372,426
Face	--	--	7,589,882	25,435	--	244,212	--	7,859,529
Catalysts (oil-refining)	W	4,315	--	--	4,744	185,511	W	194,570
Cement, portland	--	W	7,027,563	W	--	38,417	2,462	7,068,442
China and dinnerware	28,392	--	--	--	--	24,528	--	52,920
Crockery and other earthenware	W	--	W	--	--	W	17,627	17,627
Drilling mud	W	1,424,347	5,530	--	109,226	W	2,087	1,541,190
Electrical porcelain	15,240	--	--	--	--	27,890	--	43,130
Fertilizers	--	2,749	--	--	73,553	16,560	--	92,862
Fiberglass, mineral wool, other insulation	--	W	--	--	--	196,456	W	196,456
Filtering, clarifying, decolorizing:								
Animal oil	--	105,627	--	--	--	W	W	105,627
Mineral oils and greases	--	16,429	--	--	19,102	--	--	35,531
Vegetable oils	--	27,135	--	--	--	--	--	27,135
Firebrick, block, shapes	W	W	28,621	604,510	--	86,520	10,336	729,987
Flower pots	--	--	27,499	W	--	--	W	27,499
Flue linings and high-aluminum (minimum 50% Al_2O_3) refractories	7,688	--	32,255	167,541	--	96,001	--	303,485
Foundry sand	--	514,271	W	24,104	--	501	W	538,876
Grogs and crudes, refractory	W	--	W	115,136	--	220,459	W	335,595
Gypsum products	--	--	--	--	W	6,862	W	6,862
Ink	--	W	--	--	--	13,163	W	13,163
Kiln furniture	2,001	--	--	--	--	1,534	--	3,535
Lightweight aggregate:								
Concrete block	--	--	2,152,047	--	--	W	W	2,152,047
Structural concrete	--	--	1,259,189	--	--	--	--	1,259,189
Highway surfacing	--	--	238,688	--	--	--	--	238,688
Other	--	--	384,403	--	--	--	--	384,403
Linoleum and asphalt tile	--	--	8,000	--	--	3,433	--	11,433
Medical, pharmaceutical, cosmetic	--	8,050	--	--	112	1,665	--	9,827

See footnotes at end of table.

Table 20.—Clays sold or used by producers in the United States in 1982, including Puerto Rico, by use —Continued

(Short tons)

Use	Ball clay	Bentonite	Common clay and shale	Fire clay (refractory only)	Fuller's earth	Kaolin	Undistributed[1]	Total[2]
Mortar and cement, refractory	W	--	294,852	108,220	W	19,931	118,407	541,410
Oil and grease absorbents	--	W	--	--	402,864	W	9,240	412,104
Paint	--	12,998	W	--	5,396	119,466	W	137,860
Paper coating	W	W	--	--	3,087	2,026,511	W	2,029,598
Paper filling	W	W	--	--	--	870,612	W	870,612
Pelletizing (iron ore)	--	396,506	--	--	--	--	--	396,506
Pesticides and related products	W	5,097	W	--	167,537	29,945	W	202,579
Pet waste absorbent	--	W	W	--	680,137	--	W	680,137
Plastics	--	W	W	--	W	48,204	49,351	97,555
Pottery	157,087	--	139,684	W	W	17,746	W	314,517
Roofing granules	W	--	W	--	--	21,510	W	21,510
Rubber	W	W	--	--	--	221,600	W	221,600
Sanitary ware	122,368	--	--	--	--	86,748	--	209,116
Sewer pipe, vitrified	--	--	395,024	--	--	W	W	395,024
Tamping dummies	--	--	4,800	--	--	--	--	4,800
Tile:								
Drain	--	--	51,399	--	--	--	--	51,399
Floor and wall, vinyl, glazes, glass, enamels	88,224	W	78,010	W	--	41,414	178	207,826
Quarry	--	--	153,126	7,097	--	--	--	160,223
Roofing	--	--	23,197	--	--	--	--	23,197
Structural	--	--	12,539	--	--	--	--	12,539
Terra cotta	--	--	3,127	--	--	--	--	3,127
Waterproofing and sealing	--	105,466	--	--	--	W	W	105,466
Miscellaneous[3]	15,988	67,959	48,998	17,265	20,123	76,962	--	247,295
Exports	84,375	355,177	6,760	7,842	108,468	1,195,195	--	1,757,817
Total	533,013	3,186,787	22,300,015	1,077,644	1,596,673	6,343,775	240,613	35,278,520
Total undistributed	109,478	58,013	188,006	9,327	85,982	18,428	228,621	228,621
Grand total	642,491	3,244,800	22,488,021	1,086,971	1,682,655	6,362,203	--	35,507,141

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Total of clays indicated by symbol W; unpublishable data included with "Total undistributed."
[2]Data may show incomplete total; difference included with "Total undistributed."
[3]Includes asphalt emulsion, graphite anodes, and unknown uses.

Table 21.—Shipments of principal structural clay products in the United States

Product	1978	1979	1980	1981	1982
Unglazed common and face brick:					
Quantity ---- million standard brick	8,957	8,020	6,513	5,202	4,407
Value ---- million	$765	$749	$625	$540	$504
Unglazed structural tile:					
Quantity ---- thousand short tons	76	69	102	92	49
Value ---- million	$4	$4	$7	$8	$6
Vitrified clay and sewer pipe fittings:					
Quantity ---- thousand short tons	924	847	654	463	325
Value ---- million	$126	$120	$109	$73	$52
Unglazed, salt-glazed, ceramic-glazed structural facing tile, including glazed brick:					
Quantity ---- million equivalent	58	56	46	35	11
Value ---- million	$11	$11	$11	$10	$8
Clay floor and wall tile, including quarry tile:					
Quantity ---- million square feet	299	314	323	288	296
Value ---- million	$253	$295	$310	$341	$354
Total value[1] ---- do	$1,158	$1,179	$1,062	$972	$923

[1]Data may not add to totals shown because of independent rounding.

Source: Bureau of Census Report Form M32-D (82), Current Industrial Reports—Clay Construction Products.

Table 22.—Common clay and shale used in building brick production in the United States, by State

State	1981		1982	
	Short tons	Value	Short tons	Value
Alabama	641,145	$2,135,878	579,011	$2,478,325
Arizona and New Mexico	139,985	342,327	137,890	353,255
Arkansas	422,690	848,809	250,467	528,911
California	445,498	1,594,921	412,455	1,534,116
Colorado	201,584	1,062,536	193,101	1,036,854
Connecticut, Florida, New Jersey (1981)	125,998	715,313	116,059	703,801
Georgia	1,056,185	3,790,366	829,824	2,407,097
Idaho and Utah	56,520	391,447	84,966	525,959
Illinois	144,200	749,296	358,294	1,742,151
Indiana and Iowa	367,652	936,988	252,095	884,170
Kansas	156,166	346,385	130,412	319,979
Kentucky	182,071	809,379	163,105	697,307
Louisiana	137,921	311,887	66,064	150,920
Maine, Massachusetts, New Hampshire	129,231	737,801	131,789	712,681
Maryland and West Virginia	315,328	1,170,087	205,829	706,038
Michigan and Minnesota	96,590	812,290	83,011	759,726
Mississippi	460,241	1,572,078	257,244	1,012,925
Missouri	87,579	325,494	60,544	222,586
Nebraska and North Dakota	148,077	418,971	134,453	366,774
New York	137,466	182,455	95,462	137,281
North Carolina	1,801,488	5,953,531	1,298,270	4,360,734
Ohio	865,976	2,482,645	563,360	1,769,679
Oklahoma	288,400	766,472	298,495	865,781
Oregon	29,485	40,291	48,385	61,490
Pennsylvania	838,867	3,032,334	663,871	2,330,421
South Carolina	605,265	1,849,449	559,536	1,899,236
Tennessee	217,222	439,964	169,082	329,710
Texas	1,485,188	5,532,686	1,408,155	5,521,876
Virginia	442,299	1,110,668	335,260	803,823
Washington	146,125	602,603	99,799	433,081
Wyoming	24,654	238,479	14,314	125,104
Total	12,197,096	41,303,830	10,000,602	35,781,791

Table 23.—Clay and shale used in lightweight aggregate production in the United States, by State

State	Short tons					Total value
	Concrete block	Structural concrete	Highway surfacing	Other	Total	
1981						
Alabama and Arkansas	579,261	105,158	25,695	--	710,114	$3,191,196
California	238,791	317,661	--	60,438	616,890	5,833,408
Florida, Indiana, Iowa	227,841	49,324	--	5,222	282,387	1,084,707
Kansas, Kentucky, Louisiana	499,906	147,090	62,570	12,736	722,302	9,867,171
Massachusetts, Minnesota, Missouri	191,437	85,083	7,500	7,004	291,024	2,587,258
Mississippi and New York	291,334	171,189	12,275	1,500	476,298	2,263,173
Montana, North Carolina, North Dakota	118,366	72,844	--	1,240	192,450	538,032
Ohio, Oklahoma, Pennsylvania	278,342	70,979	100	--	349,421	838,114
South Dakota, Utah, Virginia	188,797	84,868	--	8,860	282,525	1,631,353
Texas	369,511	445,878	122,716	32,246	970,351	3,078,803
Total	2,983,586	1,550,074	230,856	129,246	4,893,762	30,913,215
1982						
Alabama and Arkansas	456,296	116,001	990	13,483	586,770	2,511,906
California	127,936	225,809	--	28,300	382,045	3,214,765
Florida, Indiana, Iowa	179,513	45,639	--	8,416	233,568	893,275
Kansas, Kentucky, Louisiana	419,417	163,287	52,076	8,844	643,624	9,153,840
Massachusetts, Minnesota, Missouri	208,434	73,647	18,345	--	300,426	1,638,081
Montana and New York	86,899	27,323	--	--	114,222	432,169
North Carolina and North Dakota	116,308	79,426	487	13	196,234	563,761
Ohio, Oklahoma, Pennsylvania	205,939	32,948	50	51,176	290,113	597,480
South Dakota, Utah, Virginia	110,415	42,027	--	14,100	166,542	1,600,724
Texas	244,771	449,201	166,740	260,071	1,120,783	4,075,042
Total	2,155,928	1,255,308	238,688	384,403	4,034,327	24,681,043

Table 24.—Shipments of refractories in the United States, by product

Product	Unit of quantity	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)
CLAY REFRACTORIES					
Superduty fire clay brick and shapes	1,000 9-inch equivalent.	48,727	$51,608	31,399	$37,061
Other fire clay, including semisilica, brick and shapes, glasshouse pots, tank blocks, feeder parts, upper structure parts used only for glass tanks.	do	110,309	73,910	70,311	51,610
High-alumina (50% to 60% Al_2O_3) brick and shapes made of calcined diaspore or bauxite.[1]	do	76,779	150,115	58,711	116,492
Insulating firebrick and shapes	do	46,373	40,398	31,852	30,031
Ladle brick	do	149,582	49,407	78,473	25,110
Sleeves, nozzles, runner brick, tuyeres	do	42,311	35,480	23,373	22,357
Hot-top refractories	Short tons	6,067	1,022	1,198	W
Kiln furniture, radiant heater elements, potter's supplies, other miscellaneous-shaped refractory items.	do	22,350	22,761	20,862	20,327
Refractory bonding mortars	do	65,113	23,569	64,799	25,791
Plastic refractories and ramming mixes, containing up to 87.5% Al_2O_3.[2]	do	170,444	39,442	190,984	70,099
Castable refractories	do	139,643	36,103	210,495	77,543
Gunning mixes	do	96,973	20,648	91,014	27,447
Other clay refractory materials sold in lump or ground form.[3] [4]	do	420,028	65,486	318,365	55,787
Total clay refractories		XX	609,949	XX	559,655
NONCLAY REFRACTORIES					
Silica brick and shapes	1,000 9-inch equivalent.	NA	NA	W	W
Magnesite and magnesite-chrome brick and shapes	do	71,444	273,164	17,824	67,949
Chrome and chrome-magnesite brick and shapes	do	8,558	35,590	28,620	108,214
Shaped refractories containing natural graphite	Short tons	24,995	42,000	19,067	31,903
Zircon and zirconia brick and shapes; other carbon refractories: Forsterite, pyrophyllite, dolomite, dolomite-magnesite molten-cast,[5] other brick and shapes.	1,000 9-inch equivalent.	13,461	83,454	3,321	30,534
Other mullite, kyanite, sillimanite, or andalusite brick and shapes.	do	3,025	15,748	1,884	9,267
Other extra-high (over 60%) alumina brick and fused bauxite, fused alumina, dense-sintered alumina shapes.[6]	do	8,426	44,506	13,000	35,541
Silicon carbide brick, shapes, kiln furniture	do	1,158	32,382	3,296	42,916
Refractory bonding mortar	Short tons	30,849	16,693	19,769	10,324
Hydraulic-setting nonclay refractory castables	do	35,752	24,494	16,840	16,524
Plastic refractories and ramming mixes	do	224,031	108,005	108,978	67,562
Gunning mixes	do	365,863	89,812	254,821	84,691
Dead-burned magnesia or magnesite[3] [7]	do	426,954	118,905	61,446	68,294
Dead-burned dolomite	do	--	--	156,518	9,528
Other nonclay refractory material sold in lump or ground form.[3]	do	557,113	58,717	318,258	39,995
Total nonclay refractories		XX	943,470	XX	623,242
Grand total refractories		XX	1,553,419	XX	1,182,897

NA Not available. W Withheld to avoid disclosing figures for individual companies. XX Not applicable.

[1]Heated short of fusion; volatile materials are thus driven off in the presence of chemical changes, giving more stable material for refractory use.

[2]More or less plastic brick and materials which, after the addition of any water needed, are rammed into place.

[3]Materials for domestic use as finished refractories and all exported material.

[4]Including calcined clay, ground brick, and siliceous and other gunning mixes.

[5]Molten cast refractories are made by fusing refractory oxides and pouring the molten material into molds to form finished shapes.

[6]Completely melted and cooled, then crushed and graded for use in a refractory.

[7]Includes shipments to refractory producers for reprocessing in the manufacture of other refractories.

Source: Bureau of Census Report form MQ 32C (82), Current Industrial Reports—Refractory.

Table 25.—U.S. exports of clays in 1982, by country

(Thousand short tons and thousand dollars)

Country	Ball clay		Bentonite		Fire clay		Fuller's earth		Kaolin		Clays, n.e.c.		Total[1]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Argentina	--	--	1	140	(2)	5	(2)	16	9	1,407	1	332	11	1,900
Australia	(2)	78	53	2,666	5	347	(2)	46	11	1,475	2	322	71	4,934
Belgium-Luxembourg	(2)	4	1	33	28	2,305	4	507	8	1,202	1	374	42	4,425
Brazil	(2)	8	11	2,551	(2)	2	(2)	63	4	1,444	2	886	17	4,954
Canada	45	1,175	226	12,543	20	1,502	59	4,893	197	17,175	53	4,945	600	42,233
Chile	(2)	27	5	730	--	--	(2)	4	1	119	(2)	11	6	891
Colombia	(2)	20	12	966	(2)	80	(2)	41	5	807	(2)	67	17	1,981
Ecuador	(2)	180	3	247	--	--	--	--	1	140	2	2,108	8	2,675
Finland	--	--	1	14	--	--	--	--	15	1,514	(2)	4	16	1,532
France	(2)	53	1	262	(2)	34	(2)	189	27	4,402	2	433	32	5,373
Germany, Federal Republic of	(2)	100	8	900	23	1,804	(2)	30	17	2,606	23	1,958	71	7,398
Hong Kong	--	--	3	234	--	--	--	--	1	176	(2)	50	4	460
Italy	(2)	11	1	136	4	477	(2)	61	110	11,344	3	271	118	12,300
Japan	4	443	79	8,539	50	4,017	(2)	10	444	52,791	68	10,004	645	75,804
Korea, Republic of	(2)	23	2	952	1	207	(2)	3	30	6,111	1	154	34	7,450
Mexico	84	2,398	10	797	32	1,311	(2)	4	64	5,648	28	6,990	218	17,148
Netherlands	--	--	40	2,303	(2)	33	15	1,127	180	15,510	22	2,069	257	21,042
Peru	--	--	3	256	(2)	11	(2)	1	4	460	1	129	8	857
Philippines	2	175	9	1,192	(2)	2	(2)	73	5	634	1	148	17	2,224
Saudi Arabia	--	--	41	4,772	--	--	1	98	--	--	(2)	16	42	4,886
Singapore	--	--	47	2,414	(2)	52	(2)	65	2	397	(2)	109	49	3,037
South Africa, Republic of	(2)	13	2	336	--	--	--	--	19	2,724	1	302	22	3,375
Spain	--	--	3	377	(2)	33	(2)	18	5	686	(2)	245	8	1,359
Sweden	(2)	6	(2)	5	--	--	(2)	6	28	3,196	6	857	34	4,070
Switzerland	--	--	(2)	21	6	430	(2)	4	22	2,482	2	55	28	2,992
Taiwan	(2)	14	6	897	(2)	42	(2)	27	33	4,264	1	55	40	5,299
Thailand	(2)	1	5	385	--	--	--	--	1	153	(2)	39	6	578
United Arab Emirates	--	--	3	758	--	--	1	211	--	--	(2)	60	4	1,029
United Kingdom	2	10	27	2,344	8	613	6	532	10	1,871	7	1,630	60	7,000
Venezuela	1	128	34	2,718	1	131	(2)	84	32	3,611	4	1,486	72	8,158
Other	2	284	29	4,225	2	165	6	506	16	2,640	9	2,516	62	10,336
Total[1]	144	5,151	668	54,713	180	13,603	93	8,619	1,296	146,989	238	38,625	2,619	267,700

[1]Data may not add to totals shown because of independent rounding.
[2]Less than 1/2 unit.

Source: U.S. Department of Commerce.

Table 26.—U.S. imports for consumption of clays in 1982, by kind

Kind	Quantity (short tons)	Value (thousands)
China clay or kaolin, whether or not beneficiated:		
Canada	575	$31
France	3	2
Germany, Federal Republic of	11	1
New Zealand	17	4
Sweden	1	1
United Kingdom	8,820	758
Other[1]	2	1
Total	9,429	798
Fuller's earth, not beneficiated: United Kingdom	40	8
Bentonite:		
Canada	111	45
Germany, Federal Republic of	13	4
Mexico	25	2
Other[1]	6	1
Total	155	52
Common blue and other ball clay, not beneficiated:		
Canada	21	5
United Kingdom	4,204	243
Total	4,225	248
Common blue and other ball clay, wholly or partly beneficiated:		
United Kingdom	945	119
Other[1]	1	1
Total	946	120
Other clay, not beneficiated:		
Canada	24	3
Italy	274	3
United Kingdom	7	1
Other[1]	1	1
Total	306	8
Clay, n.e.c., wholly or partly beneficiated:		
Canada	236	40
Denmark	10	2
France	20	14
Germany, Federal Republic of	178	46
Italy	24	3
Japan	24	41
Mexico	93	8
Spain	28	2
United Kingdom	1,444	378
Other[1]	1	1
Total	2,058	535
Artificially activated clay:		
Canada	4,099	1,043
Germany, Federal Republic of	1,615	1,024
Japan	2	2
Mexico	1,223	433
United Kingdom	146	242
Other[1]	1	1
Total	7,086	2,745
Grand total	24,245	4,514

[1]Includes countries with imports of quantities less than 1 short ton and/or values of less than $1,000.

Source: U.S. Department of Commerce.

WORLD REVIEW

Estimated world production of all grades of bentonite and kaolin decreased 24% and 7%, respectively, in 1982 while production of fuller's earth increased 4%. Bentonite production during the year was 5.72 million tons, and the U.S. output was 57% of the world total. World kaolin production was about 21 million tons, with the United States accounting for 30% of the total. Fuller's earth production during the year was 2.2 million tons, and U.S. output accounted for 76% of the total.

Brazil.—The Jari kaolin-paper-forestry complex was to be purchased by a group being put together by the Government.[3] The group was to include numerous Brazilian companies and banks as well as the Government, which was to assume the largest part of the $200 million obligation. The project was to initially encompass an integrated pulp and paper mill and a kaolin mine and mill complex. In another kaolin event, English China Clays Ltd. do Brazil was nearing completion of a plant near São Paulo to produce kaolin for the South American paper industry.[4]

China.—A deposit with certified reserves of over 1 million tons was reportedly found in the southern part of the Guangxi Zhuang autonomous region.[5] Several clay deposits were also discovered in Jiangsu Province.[6] These included attapulgite in Luhu and Xuyi Counties, kaolin in Suzhou Prefecture, ceramic-grade clay in Yixing Gaochun County, and bentonite in Donghai, Jurong, and Shuyang Counties.

German Democratic Republic.—Nearly 500,000 tons of kaolin were to be produced by three open pit mining operations of the Silicate Raw Material Combine at Kemmlitz in the Leipzig area.[7]

Germany, Federal Republic of.—Watts, Blake, Bearne and Co. (WBB), a large United Kingdom ball clay producer, purchased certain assets from Westerwalder Keramik-Massen-Aufbereitung for the production of prepared body compositions for the ceramics industry.[8] The purchase was made by WBB's West German subsidiary, Fuchs'sche Tongruben KG, for about $11.5 million. Fuchs'sche operated a body plant near Siershahn. In another agreement, Fuchs'sche purchased certain properties from Bertil Fuchs and Peter Fuchs KG, consisting of offices, adjacent land and buildings, and mineral concessions at Wirges.

India.—A number of industrial minerals, including china clay (kaolin) were discovered in the northern State of Haryana.[9] The high quality of the newly found clay, along with that of indigenous quartz sands, was adequate to enable the State to sustain a planned local pottery and porcelain industry.

Indonesia.—Construction of the country's first kaolin plant on Belitung Island, northeast of Sumatra, was scheduled for completion by yearend.[10] The $10 million plant, owned by P.T. Tambang Timah, was to produce about 30,000 tons per year of paper-grade kaolin, when fully operational, to meet domestic demand for paper-quality clay, and to provide a 5,000-ton annual surplus for export to Taiwan and the Republic of Korea.

Indonesia had numerous small-scale kaolin mining operations on the islands of Belitung, Bangka, North Sulawesi, and West Java. Total production from these mines to date has been of ceramic quality for use by local ceramic manufacturers.

Niger.—The $11 million Chanchaga clay brick project, near Minna, came onstream during the year.[11] Production was about 40,000 large and small bricks per day.

Pakistan.—The Punjab Government intended to commission a study for estabishing a fuller's earth activation plant in the Dera Ghazi Khan district.[12] The project was to be onstream by the end of 1984. In another clay project, the Punjab Mineral Development Corp. was reported to have been contracted to supply the Kuwait Government with fire clay refractory products. The refractory plants were to be constructed near the fire clay deposits in Azad Kashmir. The Pakistan Mineral Development Corp. had requested Japanese technical assistance in preparing a feasibility study for a kaolin mining and washing complex near the newly discovered deposits at Nagarparkar in Sind.[13] Previous studies, including physical, mineralogical, and industrial tests, showed that the clay was suitable for ceramics. The deposit was reported to contain over 4 million tons of kaolin scattered in small pockets throughout the area.

Portugal.—ECC, in a joint venture, started constructing a 75,000-ton-per-year kaolin papercoating plant to be operated by Cia. Anglo-Portuguesa de Viana Lda.[14]

Senegal.—The Société Sengalaise des Phosphates de Theis undertook a major development of its attapulgite reserves.[15] The company planned to use its phosphate plant facility, which included rotary kilns, to calcine the clay for the European absorbent markets. The material's low bulk density and high sorptivity reportedly made it equivalent to Florida and Georgia material.

South Africa, Republic of.—Environmentalist groups and local authorities objected to a proposal by Serina Pty. Ltd. to develop kaolin deposits at Chaplin's Estate in Noordhoek Valley in the Cape Peninsula.[16] The company had planned to ship the kaolin over 3 miles to its 20,000-ton-per-year plant at Brakkloof, near Fishhoek, for upgrading to papercoating grades previously not produced domestically.

Spain.—A joint venture was planned by ECC and Caobar S.A. to construct an 80,000-ton-per-year papercoating kaolin plant at Poveda de la Sierra in Guadalajara.[17] The new company, Cía. Española de Caolines, was to process a sandy, crude kaolin having high brightness and low viscosity. In another kaolin project, Caolines de Vimianzo completed a new $15 million kaolin facility, rated at over 100,000 tons per year, in the northeast and planned to develop mines in Galicia and Asturias.

Sweden.—ECC purchased Cedpro Chemical Development and Production AB (CDM), one of ECC's worldwide agents.[18] The action was reportedly taken to serve the Swedish paper, ceramic, paint, rubber, and plastic industries more directly. The takeover gave ECC access to CDM's storage facilities in Falkenberg.

Tanzania.—Large sand-kaolin deposits, estimated at 1 billion tons, were reported to be scattered throughout the more elevated areas of the country. The only other details released stated that the sand and other impurities limited the kaolin's usefulness.

United Kingdom.—Modernization plans were being developed for Laporte Industries Ltd.'s fuller's earth and bentonite production and processing facilities at Redhill and Surrey.[19] The $6 million renovation was to give the company greater flexibility of product mix in order to respond more efficiently to changes in the marketplace. The company's activation plant, transferred to Widnes in 1981, was not involved in the modernization but was expected to benefit from overall increases in efficiency.

ECC acquired Whitfield and Son (Holdings) Ltd., a distributor for the ceramic industry, in order to improve clay supplies and services to the domestic pottery industry.

Redland Brick Co. was attempting to acquire Stourbridge Brick Co. from LCP Holdings for about $10 million.[20] The divestiture of Stourbridge, acquired by LCP in 1968, was part of a trend in the United Kingdom toward larger brick companies.

Yugoslavia.—Preparations were underway to work the sand-kaolin deposits in the Vrsac regions of Vojodina Province, targeted to produce about 70,000 tons per year by 1982 along with quartz, feldspar, and mica.[21] The Bentomak bentonite mine in Kriva Palanka, Macedonia, was scheduled to produce about 80,000 tons of sodium bentonite in 1982.[22] The 80,000-ton production figure represents a 20% increase above the 1981 output.

Table 27.—Kaolin: World production, by country[1]

(Thousand short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Algeria	19	[r]10	[e]20	[e]21	17
Argentina	51	146	101	74	[3]84
Australia	98	160	241	[e]242	254
Austria (marketable)	85	87	92	[e]88	88
Bangladesh[4]	6	8	11	11	[3]6
Belgium[e]	130	130	130	130	130
Brazil (beneficiated)	325	385	452	518	507
Bulgaria	219	223	229	244	248
Burundi[e]	3	2	2	2	2
Chile	53	65	66	63	60
Colombia	863	903	867	893	893
Costa Rica	1	1	1	1	[3]1
Czechoslovakia	[r]550	565	571	570	550
Denmark[e]	25	22	22	22	22
Ecuador	[r]4	[r e]4	4	4	[3]5
Egypt	61	51	45	35	55
Ethiopia (including Eritrea)	35	33	61	10	22
France[5]	292	347	373	365	364
German Democratic Republic (marketable)[e]	200	210	220	220	220
Germany, Federal Republic of (marketable)	574	613	553	551	551
Greece	53	36	47	47	47
Hong Kong	28	3	1	9	([3 6])
Hungary	75	70	57	55	55
India:					
Salable, crude	335	[r]418	391	432	452
Processed	126	[r]128	116	126	132

See footnotes at end of table.

Table 27.—Kaolin: World production, by country[1] —Continued

(Thousand short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Indonesia	41	65	83	89	89
Iran	[e]198	176	165	110	121
Israel	7	25	10	41	39
Italy:					
Crude	[r]77	74	98	82	77
Kaolinitic earth	3	28	30	34	33
Japan	250	240	252	232	[3]218
Kenya	2	[e]2	2	[e]2	2
Korea, Republic of	404	413	302	248	[3]193
Madagascar	3	2	3	3	2
Malaysia	34	36	51	49	[3]49
Mexico	198	85	299	229	[3]205
Mozambique	--	([6])	([6])	([6])	([6])
New Zealand	37	28	51	54	55
Nigeria	1	1	1	1	1
Pakistan	15	17	30	42	44
Paraguay	39	44	55	77	61
Peru	4	[r]7	6	[e]7	7
Poland	73	54	56	47	50
Portugal	81	[e]60	54	58	57
Romania	[r e]394	[r]400	444	[e]452	452
South Africa, Republic of	135	164	119	165	[3]141
Spain (marketable)[7]	[r]602	[r]776	709	780	870
Sri Lanka	6	6	7	5	6
Suriname[8]	3	3	3	[e]3	3
Taiwan	73	94	88	100	[3]96
Tanzania[e]	1	1	1	1	1
Thailand	37	47	22	16	[3]20
Turkey	48	[e]65	[e]55	49	50
U.S.S.R.[e]	2,600	2,800	2,800	2,800	2,900
United Kingdom	4,629	4,899	4,370	4,200	3,750
United States[9]	6,973	7,761	7,879	7,660	6,362
Venezuela	25	24	[e]24	72	72
Vietnam[e]	1	1	1	1	2
Yugoslavia	198	196	217	248	243
Zimbabwe	1	3	5	5	5
Total	[r]21,404	[r]23,217	22,965	22,695	21,041

[e]Estimated. [p]Preliminary. [r]Revised.

[1]Table includes data available through July 6, 1983.

[2]In addition to the countries listed, China and Lebanon also produced kaolin, but information is inadequate to make reliable estimates of output levels. Guatemala and Morocco each produced less than 500 tons in each of the years covered by this table.

[3]Reported figure.

[4]Data for year ending June 30 of that stated.

[5]Includes kaolinitic clay.

[6]Less than 1/2 unit.

[7]Includes crude and washed kaolin and refractory clays not further described.

[8]Data represent exports.

[9]Kaolin sold or used by producers.

Table 28.—Bentonite: World production, by country[1]

(Short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Algeria (bentonitic clay)	39,313	[r][e]40,200	[r][e]40,200	[e]41,900	41,900
Argentina	117,900	173,484	144,826	135,274	[3]137,416
Australia[4]	5,132	7,303	12,112	[r][e]12,130	12,700
Brazil	184,763	234,244	273,322	183,356	220,500
Burma	1,518	1,594	1,485	2,554	1,600
Cyprus[5]	9,370	[r]5,842	25,353	49,600	49,600
Egypt	3,801	[e]3,900	[e]5,700	[e]5,700	5,700
France	[r][e]17,600	[r]17,711	[r][e]17,600	[r][e]17,100	16,500
Greece	450,546	545,837	553,225	343,862	343,900
Guatemala	2,858	[r][e]3,000	[e]2,900	[e]2,750	2,750
Hungary	90,622	79,904	85,633	[e]85,500	86,000
Iran[e]	44,100	22,000	22,000	11,000	12,100
Israel (metabentonite)	7,663	6,930	20,195	13,868	14,300
Italy	259,042	310,851	356,046	305,340	275,600
Japan	[e]440,000	[e]440,000	604,427	564,141	[3]532,948
Mexico	154,682	187,225	194,037	243,009	220,500
Morocco	5,291	1,118	3,620	3,203	[3]4,913
Mozambique	[r][e]3,300	1,825	[e]1,650	[e]1,650	1,650
New Zealand (processed)	[r]10,829	5,461	3,307	2,078	2,200
Pakistan	999	1,588	1,658	1,246	1,100
Peru	20,729	19,677	20,062	33,620	34,200
Philippines	1,730	3,443	5,570	6,092	5,500
Poland[e]	55,000	55,000	55,000	55,000	55,000
Romania	[r][e]178,600	[r]197,900	194,558	[r][e]194,000	193,000
Spain	119,400	133,025	107,701	129,772	132,300
South Africa, Republic of	38,051	51,141	54,912	48,912	[3]33,981
Tanzania	22	88	44	[e]55	55
Turkey	9,127	[e]15,400	[r][e]22,000	33,827	34,200
United States	4,468,000	4,422,075	4,184,619	4,947,000	[3]3,244,800
Total	[r]6,739,988	[r]6,987,766	7,013,762	7,473,539	5,716,913

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through June 21, 1983.
[2]In addition to the countries listed, Austria, Canada, China, the Federal Republic of Germany, and the U.S.S.R. are believed to produce bentonite, but output is not reported and available information is inadequate to make reliable estimates of output levels.
[3]Reported figure.
[4]Includes bentonitic clays.
[5]Includes bleaching earths.

Table 29.—Fuller's earth: World production, by country[1]

(Short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Algeria	5,343	[e]5,500	5,512	5,622	5,500
Argentina	3,838	6,002	5,205	5,783	[3]5,973
Australia	[r]75	55	55	55	55
Italy	[e]4,382	[e]1,190	4,740	6,057	6,000
Mexico	44,770	53,815	62,675	72,067	71,700
Morocco (smectite)	8,819	14,976	19,213	21,771	22,000
Pakistan	19,842	44,457	26,966	22,661	23,100
Senegal (attapulgite)	7,639	14,330	4,385	55,116	109,100
South Africa, Republic of	284	1,013	794	478	[3]343
Spain (attapulgite)	43,244	68,809	52,933	52,059	53,000
United Kingdom	240,304	242,508	231,485	225,974	220,500
United States	1,529,617	1,568,247	1,533,802	1,655,854	1,682,655
Total	[r]1,908,157	2,020,902	1,947,765	2,123,497	2,199,926

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Excludes centrally planned economy countries, some of which presumably produce fuller's earth, but for which no information is available. Table includes data available through July 6, 1983.
[2]In addition to the market economy countries listed, France, Iran, Japan, and Turkey have reportedly produced fuller's earth in the past and may continue to do so, but output is not reported and available information is inadequate to make reliable estimates of output levels.
[3]Reported figure.

TECHNOLOGY

The Bureau of Mines published the results of research on acid-extracting alumina from calcined Georgia kaolin at its facilities in Boulder City and Reno, Nev., and Albany, Oreg. One Boulder City study detailed the calcination of this kaolin in a direct-fired rotary kiln at 750° C and 775° C prior to alumina recovery.[23] The effects of different methods of preparing the kaolin feed materials on the particle size, moisture content, and hydrochloric acid (HCl)-soluble alumina fraction of the calcined products were evaluated. By optimizing kiln parameters, alumina solubilities of 99% were obtained after calcining at either of the two temperatures. Appendices to the report revealed detailed thermodynamic equilibria calculations for the kiln operation. Other Boulder City investigations and the Albany research studied other aspects of kaolin feed preparation for alumina recovery. The Boulder City study described development of a "misted" raw kaolin feed to eliminate difficulties encountered in filtering the solids from the acid leachate slurry.[24] The fines in the slurry had the tendency to plug the filter cloth. The novel misted feed was prepared by dampening the raw 20-mesh clay with a fine water mist while tumbling on a rotating pelletizing disk. This technique resulted in denser and more symmetrical pellets that were better able to resist abrasion during leaching, which had contributed to the unfilterable fines. The Reno laboratory study evaluated in more detail the effects of misted clay feed on the efficiency and kinetics of recovering alumina by HCl leaching of calcined kaolin.[25] The misting process increased solids settling and filtration rates by two orders of magnitude. Rapid uninterrupted leaching occurred during the first 85% to 90% of the alumina extraction step. A constant extraction rate of about 10% per minute was obtained during this initial phase.

The Reno facility reported on a laboratory investigation of sulfurous acid leaching of calcined kaolin for preparing alumina.[26] Results from closed-circuit tests showed that overall extraction was a disappointing 67%. The process consists of leaching calcined kaolin with a 30-weight-percent SO_2 solution at 60° C and 160 pounds per square inch gauge (psig) for 17 hours, filtering the leachate slurry, precipitating monobasic aluminum sulfite from the filtrate at 110° C and 60 psig, and decomposing the sulfite precipitate at 150° C and 55 psig to produce crude alumina. Purification of the crude alumina was accomplished using a modified Bayer process.

A detailed two-part work on the international production[27] and markets[28] of bentonite, including fuller's earth, was published. The production part covered the major worldwide bentonite and fuller's earth producers, including output, production flowsheets, specifications, and future production goals. Presented were the principal nomenclature of bentonite in general, and the specific Japanese nomenclature in particular. The other part reported worldwide marketing conditions and the current downturn in demand, principally in the United States and the United Kingdom. The decreases in bentonite consumption in the steel, oil-well-drilling, and foundry industries were analyzed in great technical depth. Emphasis was placed on the physical and chemical rationale for substitutions and on efficiencies currently practiced by these three main bentonite-consuming industries.

A similar comprehensive report detailed the international production, processing, and markets for ball and plastic clays.[29] The work broadly examined physical and chemical properties, mining, and production flowsheets of the world's major ball clay producers. West German, French, British, and U.S. producers were treated in detail.

Another article reviewed current world production, trade, and markets for kaolin, tracing the progress of the major worldwide kaolin producers in the mining, processing, and marketing of high-quality kaolin clays.[30] An interesting facet of the work showed that all of the companies had overcome the effects of the low growth rate of the paper markets by developing more profitable higher quality kaolins for these markets. Kaolin markets in the United States were reviewed citing Bureau of Mines statistics.[31] Production of waterwashed, calcined, and delaminated kaolins was detailed, as well as their sophisticated use in the paint, plastics, rubber, and adhesives industries.

The role of laboratory testing support of the prospecting and exploration of kaolin clays was described.[32] Test methods used for evaluating the crude kaolin ore samples for the paper and ceramic industries were outlined. Core samples are usually tested for brightness, viscosity, and plus 325-mesh residue with and without magnetic separation.

The geology, mineralogy, physical properties, and uses or potential uses of kaolin and bentonite in Australia and New Zealand were described at the first International SME-AIME Meeting.[33] Residual, hydrothermal, and sedimentary kaolins, including clays associated with coal measures, were all being used domestically. A large sedimentary kaolin deposit in the Cape York Peninsula in Australia, currently being evaluated for export to the Pacific basin markets, has the potential for displacing U.S. clays traditionally serving this area. The stratigraphy (including sections), geological structures, and economic geology of the Aiken County, S.C., mining district were published.[34] Included was a section on the preparation of kaolin clays for market, as well as occurrences, origin, and exploration and evaluation schemes for a few of the economic deposits. Described are mining and beneficiation schemes developed to process the different types of kaolin found.

The effects of impurities usually found in refractory-grade kaolins, such as titania (TiO_2), iron oxide (Fe_2O_3), lime (CaO), soda (Na_2O), and potassia (K_2O), on the crystallite size and morphology of mullite formed at 1,650° C and 1,750° C in Al_2O_3-SiO_2 mixtures equivalent to kaolins were studied.[35] Additions of CaO and Fe_2O_3 increased the size of the acicular mullite crystals to simulate those found in commercially prepared kaolin-made mullites. These mullites, commonly known as refractory grogs or calcines, are used widely in refractory bricks and specialty products. This study should allow refractory manufacturers to better control mullite morphology and crystallite size so as to optimize the density of high-performance refractories.

Commercial-size composite refractories having a porosity gradient in the transverse direction were fabricated using a superduty fireclay composition with coal as the burnout medium.[36] This novel-type brick compared favorably in mechanical and thermal properties with standard bricks made with the same raw materials. These new firebricks should prove effective in minimizing thermal losses without a costly insulating brick or fiber backup.

Research on the thermal expansion of aluminosilicate bricks[37] and thermal conductivity of fire clay and high-alumina refractory bricks,[38] used in torpedo ladles, blast furnaces, and hot blast stoves, showed that the primary factor controlling these two physical properties was the corundum (α-Al_2O_3) content and not just the total alumina content as previously believed. Other factors that influenced these properties were porosity, glass content, and purity. Generally, the thermal expansion and conductivity correlated linearly with the corundum content and were reversible until the onset of transition, such as softening and cracking, which degraded the bricks' performance.

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[1]Physical scientist, Division of Industrial Minerals.

[2]Albany slip clay is included with ball clay solely for statistical convenience.

[3]Industrial Minerals (London). World of Minerals: Brazil—Ludwig To Sell Jari. No. 173, February 1982, p. 9.

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[18]European Chemical News. ECN Newsdesk: English China Clays Buys Swedish Distributor. V. 38, No. 1023, Mar. 15, 1982, p. 8.

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[20]Work cited in footnote 10.

[21]Work cited in footnote 6.

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[28]———. Bentonite—In the Pit of Recession. Ind. Min., No. 182, November 1982, pp. 67-79.

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[30]———. Kaolin Review—Low Growth Markets Put Emphasis on Quality. Ind. Min., No. 176, May 1982, pp. 17-26.

[31]Clark, D. A. A Review of Kaolin Markets in the USA. Ind. Min., No. 176, May 1982, pp. 27-39.

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Cobalt

By William S. Kirk[1]

Domestic consumption of cobalt decreased significantly in 1982, reflecting general recessionary economic conditions. Reported consumption declined to 9.5 million pounds, the lowest consumption since 1960. Similarly, calculated apparent consumption fell from 12.5 million pounds in 1981 to 11.2 million pounds in 1982. Most end-use areas showed declines in consumption.

The producer price was lowered to $12.50 per pound in February and remained there through yearend. Free market prices, however, fell considerably during the year and were at or below $5 per pound for most of the last quarter. The very soft market conditions caused a large buildup of producer inventories throughout the world. Zairean cobalt metal production was drastically cut, and Zaire again failed to recapture its share of the U.S. market in 1982.

There was no domestic mine production of cobalt in 1982. There was, however, one refiner that produced byproduct cobalt from imported nickel-copper matte. That production, obtained from the company's annual report, appears in table 2.

Table 1.—Salient cobalt statistics

(Thousand pounds of contained cobalt unless otherwise specified)

	1978	1979	1980	1981	1982
United States:					
Consumption	19,994	17,402	15,321	11,680	9,468
Imports for consumption	19,029	19,998	16,302	15,594	12,870
Stocks, Dec. 31: Consumer	4,387	3,390	2,540	1,411	1,327
Price: Metal, per pound	$6.40-$20.00	$20.00-$25.00	$25.00	$17.26-$25.00	$12.50-$17.26
World: Production[1]	[r]59,136	[r]65,768	68,286	[p]66,744	[e]55,300

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Based on estimated recovered cobalt.

Legislation and Government Programs.—In December 1982, Congress extended the Defense Production Act (DPA) through March 1983 without change. First passed in 1950, the DPA provides, among other things, an existing legislative basis for the development of alternative cobalt supply policies.

The importance of the stockpile quality was addressed in the President's National Materials and Minerals Program Plan and Report to the Congress released in April 1982. That report, prepared by the Cabinet Council on Natural Resources and the Environment under the direction of the Secretary of the Interior, committed the Government to assessing the stockpile. With this impetus, a contract was awarded by the Federal Emergency Management Agency to the American Society for Metals to assess the quality and form of cobalt in the stockpile and develop a statistical plan for any needed testing procedures.

DOMESTIC PRODUCTION

Noranda Mining Inc. received approval from the U.S. Forest Service to reopen the Blackbird Mine in central Idaho. Later in 1982, however, Noranda decided to close the mine. The decision to close was reportedly based on high interest rates, low cobalt prices and consumption, and congressional opposition to a price support bill. The mine was placed on a care and maintenance status.

The Madison Mine, near Fredericktown, Mo., was also placed on a care and maintenance status in 1982. Anschutz Mining Corp., owner and operator, continued its geological investigations at the site during the year and continued to pump water from the mine.

The Hall Chemical Co. of Wickliffe, Ohio, announced plans, in March 1982, for the construction of a catalysts reclamation facility to be located near Mobile, Ala. The plant was to be designed to recover cobalt, nickel, molybdenum, tungsten, sulfur, vanadium, and alumina from hydrotreating and hydroforming catalysts used in the processing of high-sulfur and vanadium-bearing crude oil. With expected growth in supply of the spent catalyst feedstock, additional units were to be installed. The plant was to have the capacity to produce about 1.5 million pounds of cobalt per year.

GTE Products Corp.'s Chemical and Metallurgical Div. was planning an expansion at its Towanda, Pa., metal powder plant. The expansion was to have tripled the plant's capacity to reclaim tungsten carbide. The plant's capacity to produce extrafine cobalt powder would be dependent on the type of feedstock used. The powder was to be recycled to the tungsten carbide industry.

CONSUMPTION AND USES

Reported domestic consumption of cobalt decreased in 1982 for the fourth consecutive year. The decline was largely the result of general recessionary economic conditions. Despite substantial price declines during the year, conservation and substitution efforts continued. The U.S. National Aeronautics and Space Administration published material presented at a government-industry-university information exchange workshop at its Lewis Research Center in October 1982.[2] The workshop was held as part of the Conservation of Strategic Aerospace Materials (COSAM) Program. COSAM was set up as a long-range program in support of the aerospace industry and aimed at reducing the need for strategic materials (cobalt, columbium, tantalum, and chromium) used in gas turbine engines.

Apparent industrial demand, calculated from net imports, secondary production, and changes in industry and Government stocks, decreased to 11.2 million pounds, about 11% less than that of 1981.

Table 2.—Cobalt products[1] produced and shipped by refiners and processors in the United States

(Thousand pounds)

	1981				1982			
	Production		Shipments		Production		Shipments	
	Gross weight	Cobalt content	Gross weight	Cobalt content	Gross weight	Cobalt content	Gross weight	Cobalt content
Metal	893	893	NA	NA	1,016	1,016	NA	NA
Hydrate (hydroxide)	NA	416	NA	413	NA	336	NA	341
Salts[2] (inorganic compounds)	NA	958	NA	891	NA	609	NA	600
Driers (organic compounds)	NA	1,035	NA	1,117	NA	902	NA	931
Total	893	3,302	NA	2,421	1,016	2,863	NA	1,872

NA Not available.
[1]Figures on oxide withheld to avoid disclosing company proprietary data.
[2]Various salts combined to avoid disclosing company proprietary data.

Table 3.—U.S. consumption of cobalt, by end use

(Thousand pounds of contained cobalt)

End use	Quantity 1981	Quantity 1982
Steel:		
Stainless and heat-resisting	35	51
Full-alloy	141	114
High-strength, low-alloy	W	W
Tool	170	161
Superalloys	4,195	3,319
Alloys (excludes alloy steels and superalloys):		
Cutting and wear-resistant materials[1]	1,076	638
Welding materials (structural and hard-facing)	488	446
Magnetic alloys	1,687	1,544
Nonferrous alloys	131	145
Other alloys	123	56
Mill products made from metal powder	W	W
Chemical and ceramic uses:		
Pigments	329	382
Catalysts	1,279	789
Ground coat frit	441	477
Glass decolorizer	40	32
Drier in paints or related usage	1,378	1,114
Feed or nutritive additive	58	52
Miscellaneous and unspecified	109	148
Total	11,680	9,468

W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous and unspecified."
[1]Cemented and sintered carbides and cast carbide dies or parts.

Table 4.—U.S. consumption of cobalt, by form

(Thousand pounds of contained cobalt)

Form	1978	1979	1980	1981	1982
Metal	12,823	12,006	10,825	7,450	6,055
Oxide	467	704	441	557	732
Purchased scrap	1,036	1,170	1,183	972	871
Chemical compounds (organic and inorganic) other than oxide	[1]5,399	3,254	2,475	2,421	1,643
Other	269	268	397	280	167
Total	19,994	17,402	15,321	11,680	9,468

[1]Salts and driers.

PRICES

The posted producer price of cobalt cathodes at the beginning of 1982 was $17.26 per pound. The price fell to $12.50 per pound in February and remained at that level through yearend. The price cut was forced by lagging cobalt demand and a buildup of producer inventories.

The spot price for cobalt cathodes began the year at the $12 to $13 per pound range and dropped steadily, reaching $5 per pound about mid-October. The price remained at or below this level through yearend. Zaire, although officially maintaining a producer price of $12.50 per pound throughout most of 1982, was discounting heavily in an effort to regain the share of the U.S. market that it had lost in 1981.

Table 5.—Yearend published prices of cobalt materials for 1982[1]

Material	Price per pound
Cobalt:	
Powder	$12.30
Fine powder	16.36
Cobalt oxide:	
Ceramic-grade (70% cobalt)	8.74
Ceramic-grade (72% cobalt)	8.99
Metallurgical-grade (76% cobalt)	9.29

[1]Metals Week, v. 53, No. 52, Dec. 27, 1982, p. 5.

FOREIGN TRADE

Exports of unwrought cobalt metal and waste and scrap totaled 844,000 pounds, gross weight, with an estimated 596,000 pounds cobalt content valued at $7.7 million. These exports were shipped to 36 countries with the following countries (in descending order) receiving the largest quantities: Belgium-Luxembourg, the Netherlands, Japan, France, the Federal Republic of Germany, and Canada. Exports of wrought cobalt metal totaled 579,000 pounds, gross weight, valued at $8.2 million. Of the 42 countries to which wrought cobalt was shipped, the major recipients, in descending order were Ireland, France, the United Kingdom, Canada, and Sweden.

Total imports in 1982 were 12.9 million pounds (contained weight). The major sources of cobalt imports in descending order were Zaire, Canada, Zambia, Japan, Norway, Finland, and Belgium-Luxembourg. Material originating in southern Africa, that is, imports from Zaire, Zambia, Belgium-Luxembourg (Zairean origin), and Botswana, represented 55% of total cobalt imports during the year, compared with 47% for that area in 1981.

Table 6.—U.S. imports for consumption of cobalt, by class

(Thousand pounds and thousand dollars)

Class	1980	1981	1982
Metal:[1]			
Gross weight	14,992	13,906	11,610
Cobalt content[e]	14,992	13,906	11,610
Value	$358,583	$238,820	$137,652
Oxide:			
Gross weight	414	444	362
Cobalt content[e]	306	329	268
Value	$7,630	$5,375	$2,560
Salts and compounds:			
Gross weight	655	1,249	1,340
Cobalt content[e]	197	375	404
Value	$3,572	$4,969	$2,650
Other forms:[2]	807	984	588
Value	$12,105	$11,650	$4,552
Total content	16,302	15,594	12,870

[e]Estimated.
[1]Includes unwrought metal and waste and scrap.
[2]Contained cobalt in nickel-copper and nickel matte.

Table 7.—U.S. import duties for cobalt

Item	TSUS No.	Most favored nation (MFN) Jan. 1, 1982	Most favored nation (MFN) Jan. 1, 1987	Non-MFN Jan. 1, 1982
Ore and concentrate	601.18	Free	Free	Free.
Unwrought metal, waste and scrap	632.20	do	do	Do.
Alloys, unwrought	632.86	9% ad valorem	9% ad valorem	45% ad valorem.
Chemical compounds:				
Oxide	418.60	1.2 cents per pound.	1.2 cents per pound.	20 cents per pound.
Sulfate	418.62	1.4% ad valorem	1.4% ad valorem	6.5% ad valorem.
Other	418.68	5.3% ad valorem	4.2% ad valorem	30% ad valorem.

Table 8.—U.S. imports for consumption of cobalt, by country

(Thousand pounds and thousand dollars)

Country	Metal[1]				Oxide				Other forms[2]				Total content[3 4]	
	1981		1982		1981		1982		1981		1982			
	Gross weight	Value	Gross weight	Value	Gross weight	Value	Gross weight	Value	Cobalt content	Value	Cobalt content	Value	1981	1982
Australia	([5])	9	6	23	31	381	2	19	60	[6]713	162	[6]1,263	83	169
Belgium-Luxembourg	818	17,199	369	4,345	115	1,628	225	1,397	36	629	77	660	939	613
Botswana	--	--	--	--	--	--	--	--	633	[6]7,495	364	[6]2,817	633	364
Canada	1,712	26,703	1,391	13,382	143	1,971	107	881	28	332	12	141	1,846	1,483
Finland	1,206	24,099	798	10,423	--	--	--	--	--	--	--	--	1,206	798
France	367	5,112	324	3,131	--	--	--	--	([5])	1	12	71	367	336
Germany, Federal Republic of	175	2,765	194	2,154	1	16	4	43	38	972	58	885	213	255
Japan	1,624	30,729	1,020	8,734	--	--	--	--	([5])	([5])	4	37	1,624	1,024
Netherlands	59	654	27	653	--	--	([5])	6	5	49	--	--	64	28
New Caledonia	--	--	--	--	--	--	--	--	87	[6]1,030	--	--	87	--
Norway	1,631	28,796	852	9,053	--	--	--	--	--	--	--	--	1,631	852
South Africa, Republic of	15	240	--	--	--	--	--	--	449	[6]4,966	266	[6]1,127	464	266
United Kingdom	488	6,528	238	1,947	150	1,362	--	--	([5])	9	33	162	599	271
Zaire	4,176	66,726	4,971	68,704	--	--	--	--	--	--	--	--	4,176	4,971
Zambia	1,513	27,138	1,164	11,323	--	--	--	--	--	--	([5])	([5])	1,513	1,164
Other	121	2,123	254	3,780	4	18	24	214	25	423	4	39	149	276
Total[4]	13,906	238,820	11,610	137,652	444	5,375	362	2,560	1,361	16,619	992	7,202	15,594	12,870

[1]Includes unwrought metal and waste and scrap.

[2]Contained cobalt in nickel-copper and nickel matte from Australia, Botswana, New Caledonia, and the Republic of South Africa. Salts and compounds were imported from the remaining countries.

[3]Estimated contained cobalt.

[4]Data may not add to totals shown because of independent rounding.

[5]Less than 1/2 unit.

[6]Based on weighted average cobalt metal price of $19.73 per pound for 1981 and $12.50 to $17.26 per pound for 1982, multiplied by 0.6 (estimated factor for matte) for imports from Australia, Botswana, New Caledonia, and the Republic of South Africa.

WORLD REVIEW

Albania.—A contract was awarded to a West German firm for the construction of a nickel and cobalt refinery. The plant was being built by Salzgitter Industriebau GmbH; technology, laboratory services, design engineering, training, and startup assistance were being provided by Inco Tech Ltd., a subsidiary of Inco Ltd. Cobalt oxide was to be produced from domestically produced feedstock.

Australia.—The Greenvale laterite mine in Queensland, owned jointly by Metals Exploration Ltd. and Queensland Nickel Pty. Ltd. converted the power source for its boilers and dryers from oil to coal. The conversion was implemented to help reduce escalating power costs and offset lower prices for cobalt and nickel; the mine owners reported significant losses for the first half of 1982.

Burundi.—Exploration for cobalt and other metals under a United Nations Development Program continued in the Musongati, Nyabikere, and Waga areas. The Musongati lateritic deposits were reported to contain 73 million short tons of ore grading 0.1% cobalt and 1.6% nickel. The Energy and Mines Ministry announced a $7 million project funded by the International Bank for Reconstruction and Development (World Bank) and Finland to carry out further detailed studies.

Canada.—Construction on the Inco electrolytic cobalt plant at Port Colborne, Ontario, neared completion at yearend. The plant was expected to become fully operational in early 1983, with a production capacity of 2 million pounds per year. Inco operations at Port Colborne and Sudbury, Ontario, were shut down on June 1 by a strike called by locals of the United Steelworkers of America. The strike came after negotiators failed to agree to a new contract to replace the 3-year agreement that expired May 31. Although the strike ended July 2, the facilities remained closed through yearend and were not scheduled to reopen until April 1983.

Falconbridge Ltd. and Geddes Resources Ltd., of Toronto, were evaluating a copper-cobalt deposit in northwestern British Columbia. Although the deposit was in the early stages of evaluation, reports said it could become one of the largest of its kind in the world. The inferred tonnage for the overall deposit was reported at more than 330 million tons with grades of 1.52% copper and 0.08% cobalt. Plans called for a tunnel to be driven into the ore body so that comprehensive drilling and bulk sampling could be done at selected points.

Cuba.—A 20-ton-per-day pilot plant for research studies into the processing of nickel-cobalt laterite ores was being constructed at Punta Gorda and was expected to be completed by mid-1983. Research at the plant was expected to focus on the study of process treatment conditions for new laterite deposits; the testing and evaluation of alternative processes; the development of process control systems; and the testing of new equipment. The original conceptual design and specifications were completed in 1979 and were based on the Nicaro process. The Nicaro process involved reduction roasting; nickel leaching with ammonia-ammonium carbonate; cobalt recovery; and nickel precipitation by distillations.

Finland.—Outokumpu Oy, the Government-owned mining company, was planning to start selling a full range of cobalt salts beginning in early 1983. This action was reportedly intended to increase the total value of the company's products but would not increase the total quantity of cobalt sold. The salts were to be produced at a new plant that was being built at Kokkola, where the firm refined cobalt metal.

Outokumpu Metals U.S.A. Inc. opened an office in the United States to sell cobalt and other metals. The company, based in Detroit, Mich., was a subsidiary of Outokumpu U.S.A. Inc., which was the holding company for all the U.S. operations of Outokumpu Oy. The new company was offering cobalt in the form of briquets, coarse powder, and extra-fine powders.

France.—Métaux Spéciaux S.A. a subsidiary of Société Francoise d'Electrometallurgie, which in turn was a subsidiary of Péchiney Ugine Kuhlmann stopped production of cobalt metal because of falling prices and the loss of concentrates. The refinery had been built to take Moroccan concentrates and reportedly would have had difficulty processing concentrates from other mines. The plant had been operating well below capacity and was the only source of cobalt metal in France. Métaux Spéciaux continued to produce other cobalt products such as oxide and chloride.

India.—The Government reportedly licensed Hindustan Copper Ltd. to produce cobalt and was expected to commission a plant in 2 to 3 years. The plant was to be designed to produce about 130,000 pounds of cobalt per year. The operation, which was to be located near the Ghatshila copper mine in Bihar, was to recover metal from slags containing 0.5% to 0.6% cobalt.

Ivory Coast.—Significant nickel-cobalt laterite deposits have been found at Siplou near the town of Man in the west-central part of the country. Falconbridge explored an area containing an estimated 200-million-ton deposit, grading 1.6% nickel. Recoverable cobalt occurred beneath the nickel oxides.

Japan.—The Japan Rare Metals Stockpiling Association began buying nearly $30 million worth of cobalt and other metals as part of a new stockpile program. The first purchase was the equivalent of 10 days of Japanese consumption. The program plans called for buying the equivalent of 12 days of consumption of cobalt, nickel, chromium, tungsten, and molybdenum in subsequent years until the stockpile inventory objectives of a supply equivalent to 2 months of consumption was reached. The stockpiling authority was to be the Federation of Mining and Metals under the control of the Ministry of International Trade and Industry. The Japan Rare Metals Stockpiling Association, a private group coordinating with the Government, made the initial purchases. The stockpile inventory objective for cobalt was set at 100,000 pounds.

Nippon Mining Co. Ltd. planned to commission a new cobalt and nickel scrap processing plant in an effort to reduce dependence on the Greenvale Mine in Australia. Nippon separated cobalt and nickel from mixed sulfides from Greenvale in 1982. Nippon is reported to have developed the technology to produce cobalt and nickel ingots of high purity from cobalt-nickel scrap. The scrap materials included stellites, and plans called for the importation of more than 45 tons per month from the United States and elsewhere. The plant was to produce 10 tons per month of both cobalt-and-nickel.

Sumitomo Metal Mining Co. Ltd. planned, in early 1982, to increase cobalt production by 15 to 20 tons per month to about 100 tons per month. Later in the year, however, Sumitomo cut cobalt production to 50 tons per month. The cutback was reportedly due to poor demand and a shortage of raw materials from the Philippines.

Morocco.—The Bou Azzer Mine, the only mine in the world operated primarily for its cobalt content, ceased operations on December 31. According to reports, the closing was due to depletion of reserves. Elsewhere in the Bou Azzer region, however, other cobalt deposits were being sought. According to a report on a U.S. Government mission to Morocco, the potential for undiscovered cobalt deposits in the region seemed very high. The mission, which included representatives from the U.S. Bureau of Mines and the U.S. Geological Survey, was sponsored by the Trade and Development Program of the International Development Cooperation Agency. The objective of the mission was to evaluate the possibility of locating additional sources of cobalt in Morocco that might encourage joint ventures between Morocco and the United States private sector.

Papua New Guinea.—Prefeasibility studies of the cobalt-nickel-chromium deposits along the Ramu River indicated significant cobalt resources. The project was 69.5% owned by two U.S. companies, Nord Resources Corp. and Highlands Energy Corp. The second layer of the three-layer laterite deposit had reserves of 81 million tons of ore grading 0.16% cobalt; the third layer had estimated reserves of 35 million tons of ore grading 0.06% cobalt. Bechtel Corp. conducted a feasibility study on the project and estimated capital costs at about $1.1 billion to produce 6 million pounds of cobalt, 25,000 tons of nickel, and 500,000 tons of chromite annually.

Peru.—Empresa Minera de Hierro del Perú, a Peruvian Government iron mining concern, was investigating the possibility of recovering and marketing high-grade cobalt concentrate from pyrite being mined and discarded at their Marcona iron mine. The Marcona Mine, located about 10 miles from the Port of Jan Nicolas in southern Peru, has produced iron ore for nearly 30 years. The concentrate reportedly could be compatible with the process used at the AMAX Nickel, Inc., refinery in Braithwaite, La. According to reports, there appeared to be 200 million pounds of recoverable cobalt in the ore at the Marcona Mine.

Philippines.—Marinduque Mining and Industrial Corp. closed their nickel-cobalt concentrating plant during the first 3 months of 1982. The company's equipment that had used oil as a power source was converted to coal.

Table 9.—Cobalt: World production, by country[1]

(Short tons)

Country	Mine output, metal content[2]					Metal[3]				
	1978	1979	1980	1981[p]	1982[e]	1978	1979	1980	1981[p]	1982[e]
Australia[4]	1,283	[r]1,745	2,177	[r] [e]2,200	2,400	--	--	--	--	--
Botswana	288	324	249	280	280	--	--	--	--	--
Canada[5]	1,360	1,808	1,767	2,293	1,650	572	[r]667	763	1,003	865
Cuba	[r]1,613	[r]1,356	1,778	1,890	1,650	--	--	--	--	--
Finland	1,336	1,174	1,141	1,140	1,100	1,016	1,281	1,269	1,355	[6]1,609
France	--	--	--	--	--	998	850	745	493	550
Germany, Federal Republic of	--	--	--	--	--	386	424	[e]440	[e]440	440
Japan	--	--	--	--	--	2,055	2,924	3,160	2,669	[6]2,141
Morocco	1,250	1,059	924	870	770	--	--	--	--	--
New Caledonia[e 7]	170	230	200	155	550	--	--	--	--	--
Norway	--	--	--	--	--	575	1,051	1,405	1,592	[6]1,092
Philippines	[r]1,314	1,510	1,467	1,099	550	--	--	--	--	--
U.S.S.R.[e]	2,150	2,200	2,370	2,480	2,590	3,910	3,970	[r]4,130	[r]4,240	4,350
United Kingdom[e 8]	--	--	--	--	--	720	375	[e]800	[e]800	800
United States	--	--	--	--	--	322	464	500	447	508
Zaire	[e]14,660	[e]16,530	17,090	[e]17,090	12,460	[r]14,435	[r]15,464	[e]15,909	[e]12,262	6,600
Zambia	4,124	4,718	4,850	3,765	3,580	2,274	3,501	3,649	2,833	[6]2,696
Zimbabwe	[e]20	[e]230	[e]130	[r] [e]110	70	19	225	127	103	55
Total	[r]29,568	[r]32,884	34,143	33,372	27,650	[r]27,282	[r]31,196	32,897	28,237	21,706

[e]Estimated. [p]Preliminary. [r]Revised.

[1]Table includes data available through June 8, 1983.

[2]Figures presented represent recovered cobalt content. In addition to the countries listed, Bulgaria, Cyprus, the German Democratic Republic, Greece, Indonesia, Poland, the Republic of South Africa, Spain, and Uganda are known to produce ores that contain cobalt. Information is inadequate for reliable estimates of output levels. Other copper- and/or nickel-producing nations may also produce ores containing cobalt as a byproduct component, but recovery is small or nil.

[3]Figures represent elemental cobalt recovered unless otherwise specified. In addition to the countries listed, Czechoslovakia presumably recovers cobalt from Cuba; Belgium has imported small quantities of partly processed materials containing cobalt, but available information is inadequate for reliable estimates of cobalt recovery from these materials.

[4]Data series on mine output represents an estimate of actual recovery. Australia does not report any production of metallic cobalt, but produces intermediate metallurgical products (cobalt oxide and nickel-cobalt sulfide) with cobalt content as follows, in short tons: 1979—1,745; 1980—not available; 1981—not available; and 1982—not available.

[5]Actual output is not reported. Data for mine output are total cobalt content of all products derived from ores of Canadian origin, including cobalt oxide shipped to the United Kingdom for further processing, and nickel-copper-cobalt matte shipped to Norway for further processing. Data presented for metal output represent the output within Canada of metallic cobalt from ores of both Canadian and non-Canadian origin.

[6]Reported figure.

[7]Series reflects estimated actual recovery from ores and intermediate metallurgical products exported from New Caledonia to Japan, France, and the United States. The estimated content of total ores mined is as follows, in short tons: 1978—1,982; 1979—2,446; 1980—2,468; 1981—2,200; and 1982—2,100.

[8]Estimated recovery of elemental cobalt in refined cobalt oxides and salts from intermediate metallurgical products originating in Canada.

Note: Footnote 4 on Australia is taken from Australia Mineral Industry Annual Review—1979 (p. 95, table 1). Footnote 7 on New Caledonia is taken from New Caledonia table "Content by analysis."

Uganda.—The feasibility of reopening the Kilembe Mine, concentrator, and cobalt smelter was to be investigated by Seltrust Engineering Ltd., in a 6-month study financed by the European Economic Community (EEC). The study was to begin in June and would provide the basis for any action by the Government to reopen the facilities.

United Kingdom.—Inco Europe Ltd. ceased production of cobalt salts at its Clydach, Wales, refinery. The portion of the facility producing salts was permanently closed because it was no longer an economical operation.

Zaire.—Zaire failed to recapture its share of the U.S. cobalt market again in 1982, despite heavy discounting. Zaire supplied 38% of U.S. cobalt imports in 1980. Taking into account the fact that 2.87 million pounds of cobalt imported from Zaire in 1982 was destined for the National Defense Stockpile, Zaire's share of U.S. cobalt imports was only 16%. Zaire sold cobalt at a much lower price than the $12.50 per pound that it had posted for 11 months of the year.

Zaire's state-owned Générale des Carrières et des Mines (GÉCAMINES) mining company was to receive a loan from the EEC to rehabilitate some of its mining facilities. The EEC loan stipulated that foreign earnings from cobalt and copper sales were to be used for investment in mineral production and not diverted into other projects. Zaire was also to receive a loan from the World Bank for the rehabilitation of electrical generating stations and power transmission lines within the Shaba region to minimize power failures at the mining complexes.

GÉCAMINES increased its hold over

Zaire's cobalt and copper exports, according to reports, and was to be responsible for the exported metals until they reached the customer. This was to be accomplished by keeping title to the metals rather than passing it to Société Zairoise de Commercialization des Minerais, the Zairean metal marketing agency, at the African port of shipment as was done previously.

Zambia.—Zambia's two major cobalt and copper producers, Roan Consolidated Mines Ltd. and Nchanga Consolidated Copper Mines Ltd., were merged into one company. The new company was called Zambia Consolidated Copper Mines Ltd. (ZCCM), with controlling interest held by the Zambian Government.

A new vacuum refining furnace was installed at the Chambishi Mine to improve the quality of Zambian cobalt. As the Chambishi Mine itself did not produce any cobalt, the new furnace processed cobalt recovered from concentrates supplied by the Chibuluma and Launshya Mines and then processed in Chambishi's roast-leach-electrowinning plant. ZCCM completed the construction of a roast-leach-electrowinning plant at Rokana. The production capacity of the new refinery was 2,500 tons per year, which brought total Zambian production capacity to 5,000 tons per year.

Zimbabwe.—The Government of Zimbabwe established the Minerals Marketing Corp. (MMC), which took control of mineral sales from that country. A government official emphasized that formation of MMC did not mean that nationalization of the mining industry was near. MMC was given the power to fix the maximum quantity of any mineral that any person or company may own or have under its control, and to be able to order the reduction of stocks.

TECHNOLOGY

The Bureau of Mines estimated the physical and chemical characteristics of reject waste materials that would be generated by processing cobalt-bearing manganese nodules.[3] The results indicated that the reject waste material generated by the five outlined processes may have only minor environmental implications. According to the study, leachate of two ammoniacal leach processes, a sulfuric acid leach process, and a smelting leach process should be well below maximum limits for classification as a hazardous waste.

The Bureau of Mines also conducted research on the mineralization and elemental characteristics of cobalt-bearing Pacific manganese nodules.[4] The weighted mean cobalt content of nearly 5,000 samples was determined to be 0.26%.

Bureau of Mines research was carried out on the magnetic properties of alloys containing lanthanum, cobalt, copper, and magnesium.[5] The work involved finding suitable substitutes for cobalt and samarium.

The use of Caro's acid in the separation of cobalt and nickel was reported to have overcome many of the problems associated with conventional separation methods.[6] Near quantitative removal of cobalt was possible from solutions that had wide ranges of both cobalt to nickel ratios and overall metal concentrations.

Results of the German MIDPAC-81 expedition to the Line Islands and Mid-Pacific Mountains seamount provinces showed that manganese oxide crusts in relatively shallow water consistently contained close to 1.0% cobalt and 0.5% nickel along with 25% manganese.[7] Photographic and other evidence suggested that the crusts covered nearly the entire exposed surface of the seamounts studied.

The cobalt content of rock, soil, and stream silt was determined for samples from the Omar copper prospect, located near the Omar River in the Baird Mountains, northwestern Alaska.[8]

The Bureau of Mines evaluated a method for selectively extracting nickel and cobalt from low-grade domestic laterites.[9]

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Columbium and Tantalum

By Larry D. Cunningham[1]

The United States continued to be dependent on foreign supplies of columbium and tantalum raw materials. Imports of columbium and tantalum mineral concentrates declined substantially, reflecting decreased demand in their respective markets. Canada was again the major source for both columbium and tantalum mineral concentrates. Tantalum materials purchased for the National Defense Stockpile in 1981 were delivered by midyear 1982. However, the inventories of columbium concentrates and tantalum minerals were increased only slightly. Thus, the inventory of all columbium and tantalum stockpile materials remained considerably below their respective goals.

Domestic production and value of ferrocolumbium continued downward. Reported consumption of columbium as ferrocolumbium and nickel columbium decreased substantially. All major segments experienced significant declines, reflecting slumps in the steelmaking industry and orders for new commercial aircraft. Demand for tantalum products remained down. Reported shipments of tantalum carbide were down by 40% from those of 1981, which was attributed in part to substitutes and weak automobile and metalworking industries.

Prices for ferrocolumbium and nickel columbium experienced modest decreases at midyear. Tantalite concentrates and related product prices continued to drop. Net trade for both columbium and tantalum remained at a deficit.

A major producer of tantalum, Tantalum Mining Corp. of Canada Ltd. (Tanco), announced that operations at its Bernic Lake Mine would be suspended at yearend for an indefinite period.

Table 1.—Salient columbium statistics

(Thousand pounds of columbium content unless otherwise specified)

	1978	1979	1980	1981	1982
United States:					
Mine production of columbium-tantalum concentrates	--	--	(1)	(1)	(1)
Releases from Government excesses	2 1	--	--	--	--
Consumption of raw materials	2,673	2,402	3,122	1,983	e 1,900
Production of ferrocolumbium	1,566	969	2,028	1,145	W
Consumption of primary products: Ferrocolumbium and nickel columbium	5,694	6,337	6,503	6,244	3,679
Exports: Columbium metal, compounds, and alloys (gross weight)e	95	100	120	150	100
Imports for consumption:					
Mineral concentrate	1,982	1,690	2,320	1,050	580
Columbium metal and columbium-bearing alloys	(3)	e 4	73	(3)	e 8
Ferrocolumbium e	4,159	5,515	5,918	6,068	3,128
Tin slags 4	436	1,133	1,417	839	NA
World: Production of columbium-tantalum concentrates	21,311	r 31,710	33,359	p 32,664	e 31,561

e Estimated. p Preliminary. r Revised. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1] A small unreported quantity was produced.
[2] Net change in inventory report.
[3] Less than 1/2 unit.
[4] Receipts reported by consumers; includes synthetic concentrates and other miscellaneous materials, after deduction of reshipments.

Table 2.—Salient tantalum statistics

(Thousand pounds of tantalum content unless otherwise specified)

	1978	1979	1980	1981	1982
United States:					
Mine production of columbium-tantalum concentrates	--	--	(1)	(1)	(1)
Releases from Government excesses	[2]1	--	--	--	--
Consumption of raw materials	1,571	1,740	1,863	1,269	[e]800
Production of primary metal	974	NA	NA	NA	NA
Consumption of primary products: Tantalum metal	978	NA	NA	NA	NA
Exports:					
Tantalum ore and concentrate (gross weight)	64	[3]329	[3]468	[3]99	[3]235
Tantalum metal, compounds, and alloys (gross weight)	686	426	524	205	382
Tantalum and tantalum alloy powder (gross weight)	211	296	251	97	115
Imports for consumption:					
Mineral concentrate	596	630	860	650	440
Tantalum metal and tantalum-bearing alloys	137	144	140	[4]32	[4]69
Tin slags[5]	676	1,140	1,327	930	NA
World: Production of columbium-tantalum concentrates	[r]797	[r]1,049	1,165	[p]819	[e]738

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.
[1]A small unreported quantity was produced.
[2]Net change in inventory report.
[3]Includes reexports.
[4]Exclusive of waste and scrap.
[5]Receipts reported by consumers; includes synthetic concentrates and other miscellaneous materials, after deduction of reshipments.

Table 3.—Columbium and tantalum materials in Government inventories as of December 31, 1982

(Thousand pounds of columbium or tantalum content)

Material	Stockpile goals	National Defense Stockpile inventory		Total
		Stockpile grade	Nonstockpile grade	
Columbium:				
Concentrates	5,600	937	869	[1]1,806
Carbide powder	100	21	--	21
Ferrocolumbium	--	598	333	[1]931
Metal	--	45	--	[1]45
Total	(2)	1,601	1,202	2,803
Tantalum:				
Minerals	8,400	1,432	1,152	[3]2,584
Carbide powder	--	29	--	[3]29
Metal	--	201	(4)	[3]201
Total	(2)	1,662	1,152	2,814

[1]All surplus ferrocolumbium and columbium metal were used to offset columbium concentrates shortfall. Total offset was 1,148,000 pounds.
[2]Overall goals, on a recoverable basis, total 4,850,000 pounds for the columbium metal group and 7,160,000 pounds for the tantalum metal group.
[3]All surplus tantalum carbide powder and tantalum metal were used to offset tantalum minerals shortfall. Total offset was 271,000 pounds.
[4]100 pounds.

Domestic Data Coverage.—Domestic data for ferrocolumbium production are developed by the Bureau of Mines from the annual voluntary survey for ferroalloys. Of the five domestic operations to which a survey was sent, 100% responded, representing 100% of total production. Ferrocolumbium production data in table 1 are withheld for 1982 to avoid disclosing company proprietary data.

Legislation and Government Programs.—The National Defense Stockpile goals for columbium and tantalum materials did not change during 1982, and there were no sales of stockpile excess materials. Tantalum minerals contracted for in 1981 from the Norore Corp. of New York City were delivered in June 1982. Yearend stockpile inventories reported by the General Services Administration for contained columbium in concentrates and contained tantalum in minerals increased by 26,000 pounds and 33,000 pounds, respectively. However, inventories of all columbium and tantalum materials continued to be considerably below their respective goals. As of yearend 1982, under the offset concept, 53% of the goal for columbium concentrates and 34% of the goal for tantalum minerals were met. National Stockpile Purchase Specification P-113-R1, effective May 6, 1968, was reviewed for updating purposes.

The National Materials Advisory Board panel on tantalum and columbium supply and demand outlook recommended that the national stockpile goals for columbium be reviewed because it seemed low and that columbium should be stockpiled primarily as ferrocolumbium with smaller amounts as pure columbium oxide in proportion to its relative use. For tantalum, the panel recommended that the stockpile goals also be reviewed in light of current and anticipated consumption rates and that tantalum should be stockpiled as mineral concentrates, either directly from mine operations or as upgraded tin slag, to avoid obsolescence or degradation of intermediate products.[2]

DOMESTIC PRODUCTION

Small quantities of columbium- and tantalum-bearing concentrates were again produced from mine operations in South Dakota. During the summer, there was an increase in exploration activity for columbium and tantalum in Wyoming. Metallurgical work continued on a large titanium deposit, reported to contain significant quantities of columbium, in southwestern Colorado.

Domestic production of ferrocolumbium, expressed as contained columbium, was down by more than 15% from that of 1981. Value of ferrocolumbium production decreased to an estimated $8.6 million. The regular grade was again favored over the high-purity grade of ferrocolumbium in the production mix.

Tantalum content of raw materials consumed by processors in the production of tantalum compounds and metals was estimated to be about 800,000 pounds, 32% lower than that of 1981 and reflecting a continued overall weak domestic tantalum market. Consumption of purchased metal scrap was about 90,000 pounds, down by 5% from the 95,000 pounds consumed in 1981.

Lien Metals, Inc., a subsidiary of Pete Lien and Sons, Inc., operated a tantalum processing plant in Rapid City, S. Dak. A new process for extracting tantalum oxide from tantalite ores was being developed. Production startup of tantalum oxide and tantalum metal powder was planned for early 1983. Initial combined production was expected to be approximately 100,000 pounds per year.

Table 4.—Major domestic columbium and tantalum processing and producing companies in 1982

Company	Plant location	Products[1] Metal[2] Cb	Metal[2] Ta	Carbide Cb	Carbide Ta	Oxide and/or salts Cb	Oxide and/or salts Ta	FeCb and/or NiCb
Cabot Corp.:								
KBI Div	Boyertown, Pa	X	X	--	--	X	X	--
Do	Revere, Pa	--	--	--	--	--	--	X
Kennametal, Inc	Latrobe, Pa	--	X	X	X	--	X	--
Avon Products, Inc.: Mallinckrodt, Inc.	St. Louis, Mo	--	--	--	--	X	X	--
Metallurg, Inc.: Shieldalloy Corp	Newfield, N.J	--	X	X	X	--	--	X
NRC Inc.[3]	Newton, Mass	--	X	--	--	X	--	--
The Pesses Co	Newton Falls, Ohio	--	--	--	--	--	--	X
H. K. Porter Co., Inc.:								
Fansteel, Inc	Muskogee, Okla	X	X	X	X	X	X	--
Do	North Chicago, Ill	--	X	--	--	--	--	--
Reading Alloys, Inc	Robesonia, Pa	--	--	--	--	--	--	X
Teledyne Inc.: Teledyne Wah Chang Albany Div.	Albany, Oreg	X	X	X	--	X	--	X

[1]Cb, columbium; Ta, tantalum; FeCb, ferrocolumbium; NiCb, nickel columbium.
[2]Includes miscellaneous alloys.
[3]Jointly owned by South American Consolidated Enterprises S.A. and H. C. Starck Berlin.

Mallinckrodt, Inc., was merged into Avon Products, Inc., as a wholly owned subsidiary on March 8, 1982. Avon reported that under terms of the merger, approximately 12.9 million shares of Avon's capital stock were issued in exchange for approximately 51% of the outstanding common stock of Mallinckrodt. The remaining 49% of the common stock of Mallinckrodt had been acquired prior to the merger, pursuant to a cash tender offer and a private purchase.[3]

Shieldalloy Corp. completed the modernization of its manufacturing facilities at Newfield, N.J. The facilities were designed with compartmentalized manufacturing modules for the production of high-purity refractory metals such as columbium and tantalum.

A major plant expansion by NRC Inc., Newton, Mass., included the installation of a new variable 800- to 1,400-kilowatt electron beam furnace and new rolling mill. The new expansion allows NRC to produce columbium mill products in addition to its production of tantalum mill products and powders. Marketing of columbium mill products was planned for early 1983.

CONSUMPTION, USES, AND STOCKS

Overall reported consumption of columbium as ferrocolumbium and nickel columbium decreased 41% to the lowest total since 1976. Consumption of columbium by the steelmaking industry decreased 43%, a reversal of the upward trend of recent years. The decline can be linked to an overall decrease of 40% in raw steel production, a modest 6% drop in columbium usage per ton of steel produced, and a falloff in U.S. steel pipe production. Consumption in carbon and high-strength, low-alloy (HSLA) steels experienced sizable declines of more than 40%. Columbium demand in stainless and heat-resisting steel declined for the third consecutive year, decreasing 24% in 1982 compared with demand in 1981.

Demand for columbium in superalloys continued downward, declining 28% in 1982. Consumption as nickel columbium declined by 20% to less than 275,000 pounds, reflecting the continued slump in orders for new commercial aircraft.

Potential new commercial applications for columbium include HSLA plate steel for off-highway equipment, Inconel alloy 718 usage in navigational systems, intermetallic alloys for jet engine nozzles, tubular products for low-temperature usage, and superconducting magnets for which the largest market thus far has been federally funded research programs.

Tantalum consumption was down for the third consecutive year, as reflected in the 11% decrease in overall shipments reported by the Tantalum Producers Association. In 1982, shipments declined nearly 50% from the peak-year shipments of 1979. Tantalum for cemented carbide, which had experienced a moderate growth in 1981, was down by 40% in 1982. Industry sources attributed the decline in part to substitutes, design efficiencies, and a slump in the automobile and metalworking industries.

The Electronic Industries Association reported tantalum capacitor factory sales were down by 6% in 1982. Continued weak demand, powder technology gains, and the substitution of competing materials contributed to the decline.

An application that could increase future tantalum consumption is the Pratt and Whitney Aircraft single-crystal alloy, PWA 1480, containing 12% tantalum and planned for use in aircraft turbine engine blades. The KBI Div. of Cabot Corp. also developed a new alloy, KBI 40, containing 60% tantalum and 40% columbium. In many corrosive environments, the alloy reportedly outperforms columbium and is comparable to tantalum.

Data on aggregate stocks of columbium and tantalum raw materials reported by processors for 1982 were incomplete at the time this chapter was prepared. Aggregate stocks of columbium and tantalum raw materials reported by processors for yearend 1981 contained 4,274,000 pounds of columbium, down from yearend 1980, and 3,452,000 pounds of tantalum, up slightly from yearend 1980.

Table 5.—Reported shipments of columbium and tantalum materials

(Pounds of metal content)

Material	1981	1982
Columbium products:		
Compounds including alloys	632,160	562,680
Metal including worked products	260,500	355,400
Other	20,500	29,700
Total	913,160	947,780
Tantalum products:		
Oxides and salts	50,700	36,500
Alloy additive	--	31,700
Carbide	137,160	82,170
Powder and anodes	520,200	451,100
Ingot (unworked consolidated metal)	7,100	16,700
Mill products	196,700	168,020
Scrap	72,700	94,500
Other	--	--
Total	984,560	880,690

Source: Tantalum Producers Association.

Table 6.—Consumption, by end use, and industry stocks of ferrocolumbium and nickel columbium in the United States

(Pounds of contained columbium)[1]

	1981	1982
END USE		
Steel:		
Carbon	2,322,045	1,138,323
Stainless and heat-resisting	596,022	450,305
Full alloy	([2])	([2])
High-strength, low-alloy	2,387,206	1,411,992
Electric	([3])	--
Tool	([3])	([3])
Unspecified	2,176	7,453
Total	5,307,449	3,008,073
Superalloys	900,665	648,522
Alloys (excluding alloy steels and superalloys)	29,465	17,315
Miscellaneous and unspecified	6,358	5,077
Total consumption	6,243,937	3,678,987
STOCKS		
Dec. 31:		
Consumer	W	W
Producer[4]	W	W
Total stocks	1,868,000	[e]711,000

[e]Estimated. W Withheld to avoid disclosing company proprietary data.
[1]Includes columbium and tantalum in ferrotantalum-columbium, if any.
[2]Small; included with high-strength, low-alloy steel.
[3]Withheld to avoid disclosing company proprietary data; included with "Steel: Unspecified."
[4]Ferrocolumbium only.

PRICES

The price of pyrochlore concentrates produced in Canada by Niobec Inc., was quoted throughout 1982, as in 1981, at $3.25 per pound of contained pentoxide, f.o.b. Canada, for concentrates with a nominal content of 57% to 62% Cb_2O_5. As in 1981, no price was available for Brazilian pyrochlore concentrates because they are no longer being exported. The spot price of regular-grade ferrocolumbium containing 63% to 68% columbium stayed at $6.22 to $6.35 until midyear, then fell to $6.00 per pound of contained columbium, f.o.b. shipping point.

Prices declined at midyear for high-purity ferrocolumbium and nickel columbium. The declines were related to Brazil's entering the high-purity ferrocolumbium and nickel columbium markets coupled with weak columbium demand in high-temperature alloy applications. The price for high-purity ferrocolumbium, quoted at $23.50 to $23.56 per pound of contained columbium in January, remained in effect until July when the price was lowered to $21. At about the same time, nickel columbium experienced about a 10% decrease in price. Columbium metal price quotes remained virtually unchanged throughout 1982. The average spot market price for columbite concentrates continued unchanged, at $8 to $10 per pound of combined columbium and tantalum pentoxides, until December, when the price was lowered to $5 to $8. Columbium oxide, both foreign and domestic, was reported to be selling at yearend for less than $7 per pound of oxide.

Tantalum price trends continued downward, attributed mostly to weak ore prices and declining demand. The spot market price for tantalite, on the basis of 60% combined tantalum and columbium pentoxides, c.i.f. U.S. ports, started the year at $35 to $40, fell to $32 to $38 in late July, and continued to drop in the fourth quarter to finish the year at $20 to $25. The Canadian, Tanco, contract price for tantalite began the year at $85 per pound of contained pentoxide but by midyear had dropped to $45, remaining unchanged to yearend. A contract price for tantalite from Australia (Greenbushes Tin NL) was not available, the price having been suspended in late 1981. Published price quotations for tantalum mill products and powders continued to decline; prices were about $150 per pound at yearend.

FOREIGN TRADE

Net trade continued at a deficit for both columbium and tantalum. Imports of raw materials and intermediates such as ferrocolumbium were almost double the value of exports of upgraded forms of columbium and tantalum. Trade volume was up for all export items with total value down by 10%. For imports, trade volume and value were again down appreciably for nearly all items.

Exports and reexports of tantalum ores and concentrates increased to 235,000 pounds valued at $1.6 million in 1982 from 99,000 pounds valued at $1.7 million in 1981. The Federal Republic of Germany was again the principal recipient with over 70% of total shipments. The difference in total value reflects significant declines in unit values of ores and concentrates between 1981 and 1982.

Imports for consumption from Brazil included more than 4.8 million pounds of ferrocolumbium with a value of $17.2 million, compared with more than 9 million pounds valued at $32.6 million in 1981. Imports of columbium oxide from Brazil declined to 84,000 pounds valued at $468,000, substantially lower than the 1981 totals of 159,000 pounds and $1.3 million. Estimated data for both ferrocolumbium and columbium oxide were based on entries in nonspecific classes.

Imports for consumption of columbium mineral concentrates decreased in 1982 by 52%, with average unit value for overall imports decreasing by more than 40%. Imports were estimated to contain 375,000 pounds of columbium and 205,000 pounds of tantalum and to have an average grade of approximately 59% Cb_2O_5 and 4% Ta_2O_5.

Imports for consumption of tantalum mineral concentrates were down 34% with average unit value decreasing by 58%, reflecting a continued decline in demand and weak ore prices. Canada was again the principal supplier, providing almost 30% of the total quantity and over 40% of the total value. Imports were estimated to contain 413,000 pounds of tantalum and 25,000 pounds of columbium. Average contents of Ta_2O_5 and Cb_2O_5 were 39% and 23%, respectively.

Imports for consumption of columbium-tantalum synthetic concentrates totaled 2.7 million pounds valued at $24.9 million, compared with 3.7 million pounds valued at $76.9 million in 1981; these figures are not included in tables 1 and 2. Imports for consumption from China in 1982 included over 5,000 pounds of potassium tantalum fluoride at a value of almost $22,000, both down substantially from the 1981 totals.

Table 7.—U.S. foreign trade in columbium and tantalum metal and alloys, by class

(Thousand pounds, gross weight, and thousand dollars)

Class	1981 Quantity	1981 Value	1982 Quantity	1982 Value	Principal destinations and sources, 1982
EXPORTS[1]					
Tantalum:					
Powder	97	19,999	115	16,231	Federal Republic of Germany 32, $4,599; Japan 28, $4,286; France 23, $3,589; United Kingdom 13, $2,039.
Unwrought and waste and scrap	164	12,454	330	11,231	Federal Republic of Germany 261, $5,785; Belgium-Luxembourg 35, $3,233; Japan 17, $1,113.
Wrought	41	6,341	52	7,267	Japan 17, $2,030; United Kingdom 10, $1,788; France 10, $1,419; Federal Republic of Germany 8, $1,198.
Total	XX	38,794	XX	34,729	Federal Republic of Germany $11,600; Japan $7,400; France $5,400; United Kingdom $4,000.[2]
IMPORTS FOR CONSUMPTION					
Columbium:					
Ferrocolumbium[e]	9,335	32,570	4,812	17,174	All from Brazil.
Unwrought metal and waste and scrap	1	18	1	15	Federal Republic of Germany 1, $13; United Kingdom ([3]), $2.
Unwrought alloys	--	--	13	140	All from Brazil.
Wrought	--	--	--	--	
Tantalum:					
Waste and scrap	116	5,954	97	3,614	Federal Republic of Germany 34, $1,399; France 21, $436; Mexico 18, $383.
Unwrought metal	31	4,166	67	6,858	Federal Republic of Germany 37, $4,259; Netherlands 18, $1,552; Belgium-Luxembourg 12, $1,047.
Unwrought alloys	([3])	40	1	62	Federal Republic of Germany [2]1, $27; Canada ([3]), $35.
Wrought	([3])	94	2	87	Federal Republic of Germany 1, $66; Japan ([3]), $7; Netherlands ([3]), $7.
Total	XX	42,842	XX	27,950	Brazil $17,300; Federal Republic of Germany $5,800; Belgium-Luxembourg $1,600; Netherlands $1,600.[2]

[e]Estimated. XX Not applicable.
[1]For columbium, data on exports of metal and alloys in unwrought and wrought form, including waste and scrap, are not available; included in basket category.
[2]Rounded.
[3]Less than 1/2 unit.

Table 8.—U.S. imports for consumption of columbium-mineral concentrates, by country

(Thousand pounds and thousand dollars)

Country	1981 Gross weight	1981 Value	1982 Gross weight	1982 Value
Brazil	91	597	31	148
Canada	926	2,141	642	1,601
Malaysia	78	608	--	--
Nigeria	752	6,340	231	950
Thailand	34	417	--	--
Zaire	--	--	7	66
Total[1]	1,882	10,102	910	2,765

[1]Data may not add to totals shown because of independent rounding.

Table 9.—U.S. imports for consumption of tantalum-mineral concentrates, by country

(Thousand pounds and thousand dollars)

Country	1981		1982	
	Gross weight	Value	Gross weight	Value
Australia	268	9,688	161	2,243
Brazil	540	15,348	260	3,111
Canada	628	20,146	373	7,215
Cayman Islands[1]	2	70	--	--
China	20	744	14	174
Germany, Federal Republic of[1]	4	176	--	--
Malaysia	--	--	12	146
Mozambique	--	--	32	580
Nigeria	--	--	12	146
Portugal	--	--	11	131
Rwanda	62	1,204	--	--
Singapore[1]	7	196	--	--
South Africa, Republic of	4	189	19	199
Spain	92	2,215	7	80
Thailand	157	2,446	328	1,276
Zaire	127	3,500	63	861
Zimbabwe	42	1,805	6	124
Total[2]	1,952	57,726	1,297	16,286

[1]Presumably country of transshipment rather than original source.
[2]Data may not add to totals shown because of independent rounding.

WORLD REVIEW

The supply and consumption of columbium (niobium) on a worldwide and country-by-country basis was reported in a German language publication entitled "Niob."[4] Major columbium producers were Brazil, Canada, and the U.S.S.R., with principal consuming countries being the United States, Japan, the Federal Republic of Germany, and Italy. Between 85% and 90% of columbium was estimated to be consumed by the steelmaking industry in the form of ferrocolumbium as an alloying element.

World production of columbium and tantalum minerals is detailed in table 10. The table does not include columbium or tantalum recovered from contemporary or old tin slags or in struverite. Tantalum contained in tin slags produced in 1978, 1979, 1980, and 1981 was, in thousand pounds, 790, 987, 1,133, and 1,006, respectively, according to data of the Tantalum Producers International Study Center (TIC). No data were available for the U.S.S.R. for either minerals or slag. Exclusive of the U.S.S.R., the TIC data were believed to represent 90% to 95% of the recoverable tantalum contained in tin slags produced in 1978-81.

Regarding the shipments of old tin slags, the only data available were from Thailand. Shipments of old tin slags from Thailand in 1981 and 1982 were 109 and 36 short tons, respectively. The totals were substantial decreases from the 10,387 short tons in 1980, reflecting a decline in tantalum demand and weak prices. Estimated Ta_2O_5 content of these slags was 5%. In 1981, reported old slag shipments were made to Singapore (60%), Belgium (30%), and the Netherlands (10%). All shipments in 1982 were reported going to Singapore. Data were not available as to further disposition of any of these shipments.

Australia.—Tin-tantalite mine operations at Greenbushes was reported to have produced a record quantity of Ta_2O_5, more than 240,000 pounds, contained in all products, resulting from increased production, higher grades of ore being mined, and the treatment of tailings. For the fiscal year ending June 30, 1982, production of tantalite concentrates was 206 tons compared with 163 tons in fiscal year 1981, and 826,000 cubic meters of ore was treated in fiscal year 1982 compared with 1.5 million in fiscal year 1981. Additionally, 391,000 cubic meters of tailings were produced in fiscal year 1982 as was 134 tons of tantalum "glass" slag. Approximately 15,000 pounds of Ta_2O_5 was separated in Greenbushes' pilot solvent extraction plant. The plant was closed in September 1981, then recommissioned in May 1982 with production since averaging about 3,300 pounds of Ta_2O_5 per month from leached cassiterite and stibio-tantalite ores.

Greenbushes continued negotiations with a number of major companies on establishing a joint venture to develop its underground mine and ore deposits. Pilot plant production tests from underground ore showed gravity-circuit recoveries in excess of 75% for tin and 70% for tantalum, with overall recoveries expected to be increased to at least 85% with the inclusion of a flotation circuit.

Greenbushes' tin smelter was reported to be operating at 75% of design capacity for the year with production 50% above that of 1981. The new tailings retreatment plant was closed down in January and placed on a standby basis owing to a declining tantalum market. In February, the main ore treatment plant was reduced to one shift per day treating only nearby high-grade ore. A new demountable treatment plant was commissioned during the year to treat high-grade alluvial ore remote from the main treatment plant.

Brazil.—Cia. Brasileira de Metalurgia e Mineração (CBMM) introduced its first production of high-purity ferrocolumbium and nickel columbium into the U.S. market at prices slightly below those of U.S. producers in July 1982. The lower prices were quickly matched by U.S. producers and remained unchanged through yearend 1982. CBMM also conducted experimental work on the production of 99.99%-pure metal from columbium oxide of 99% purity.

Brazil's production and exports of ferrocolumbium both declined by more than 20%. In 1982, production and exports were 12,700 tons and 12,200 tons, respectively, compared with the 1981 totals of 16,100 tons for production and 16,000 tons for exports.

Canada.—As reported by Teck Corp. for fiscal years ending September 30, production of columbium oxide at the Niobec Inc. mine at St. Honoré, Quebec, was up about 16% to 6,899,189 pounds in 1982 from 5,960,776 pounds in 1981. Ore milled continued to increase, 809,242 tons in 1982 compared with 762,838 tons in 1981, as the mill operated on the average of 2,325 tons per day in 1982, up from 2,188 tons per day in 1981. Recovery improved 68% in 1982 compared with 67% in 1981 along with an increase in Cb_2O_5 grade of ore; 0.63% in 1982 compared with 0.58% in 1981. Ore reserves were virtually unchanged, content basis, at the end of the fiscal year 1982; 12,990,000 tons at 0.66% Cb_2O_5 compared with 13,000,000 tons at 0.67% Cb_2O_5 in 1981. The construction of a facility to produce Cb_2O_5 from its columbium concentrate was being considered by Niobec.

Tanco suspended mining and milling operations at its Bernic Lake Mine, Manitoba, for approximately 1 month during the summer. Later in the year, Tanco announced that operations at the mine would be suspended at yearend for an indefinite period, attributing the suspension to a weak tantalum market and high tantalum inventories. In 1982, 142,000 tons of ore at a Ta_2O_5 grade of 0.125% and 38,000 tons of tailings at a Ta_2O_5 grade of 0.065% were milled, compared with 152,000 tons of ore at a Ta_2O_5 grade of 0.122% and 55,000 tons of tailings at a Ta_2O_5 grade of 0.059% milled in 1981. Total production of Ta_2O_5 in concentrates declined to about 275,000 pounds in 1982 compared with 279,000 pounds in 1981. Overall recovery in 1982 was down slightly to about 67%. Reported mine reserves at yearend decreased about 11%, from 2.7 to 2.4 million pounds of contained tantalum, and tantalum contained in stored tailings dropped to 747,000 from 790,000 pounds.

Placer Development Ltd. relinquished its option on the columbium-tantalum-rare-earths property of Highwood Resources Ltd. in the Northwest Territories owing to uneconomic ore recovery. Highwood Resources, with a 70% interest in the property, indicated plans for further exploration and testing.

Japan.—Production of ferrocolumbium in 1982 was reported to be about 1,260 short tons, up from approximately 1,140 tons in 1981.[5] Reported ferrocolumbium imports were over 2,560 tons in 1982 compared with about 1,750 tons in 1981, with the bulk of 1982 imports coming from Brazil.[6]

Namibia.—Exploration for tantalite continued in 1982. The Southern Mining & Development Co., Ltd., a subsidiary of Utah International, Inc., examined a deposit that reportedly has the potential output of approximately 40,000 pounds per year of tantalite.

Nigeria.—Production of columbite reported by the group of Amalgamated Tin Mines of Nigeria (Holdings) Ltd. (ATMN), Bisichi-Jantar Nigeria Ltd., Gold & Base Metal Mines of Nigeria Ltd., and Vestis Tin Mines Ltd. dropped substantially with a combined output of 182 tons in 1982 compared with 401 tons in 1981. Bisichi-Jantar and ATMN accounted for all of the output, divided almost evenly.

In midyear 1982, Dove Holdings Ltd. purchased a controlling interest in Amalgamated Tin Mines of Nigeria (Holdings) P.L.C. Amalgamated Holdings principal activity at that time was represented by its 40% interest in ATMN.

Thailand.—In 1982, tantalum-bearing tin slags were again second only to tin in value

Table 10.—Columbium and tantalum: World production of mineral concentrates, by country[1]

(Thousand pounds)

Country[2]	Gross weight[3]					Columbium content[4]					Tantalum content[4]				
	1978	1979	1980	1981[p]	1982[e]	1978	1979	1980	1981[p]	1982[e]	1978	1979	1980	1981[p]	1982[e]
Argentina: Columbite	([5])	4	--	--	--	([5] [6])	3	--	--	--	([5] [6])	([5] [6])	--	--	--
Australia: Columbite-tantalite	306	379	351	657	660	61	76	70	118	120	101	125	116	230	230
Brazil:															
Columbite-tantalite	448	825	1,186	659	606	83	153	213	138	130	141	260	380	178	170
Pyrochlore	39,463	63,733	67,682	65,887	62,500	16,574	26,729	28,426	27,673	26,200	--	--	--	--	--
Canada:															
Pyrochlore	[e]9,087	[e]9,229	[e]8,256	[e]9,040	10,400	[6]3,811	[r] [6]3,872	[6]3,796	[6]4,224	4,817	--	--	--	--	--
Tantalite	[e]624	[r] [e]625	[e]620	[e]640	590	17	[r]17	17	19	18	[r] [6]286	[r] [6]287	[6]208	[6]188	170
Malaysia: Columbite-tantalite	51	88	73	51	22	13	22	18	8	3	4	7	8	4	2
Mozambique:															
Columbite[e]	5	5	NA	NA	NA	1	1	NA	NA	NA	2	2	NA	NA	NA
Microlite	88	[e]70	NA	NA	NA	4	3	NA	NA	NA	48	40	NA	NA	NA
Tantalite[e]	80	70	NA	NA	NA	13	10	NA	NA	NA	30	25	NA	NA	NA
Nigeria:															
Columbite	1,468	1,250	1,221	831	400	646	550	537	363	180	88	75	73	48	24
Tantalite	2	2	2	2	2	([5])	([5])	([5])	([5])	([5])	1	1	1	1	1
Portugal: Tantalite	18	8	9	20	22	4	2	2	5	5	4	2	2	5	6
Rwanda: Columbite-tantalite	107	104	132	126	137	33	35	42	38	40	19	20	24	28	30
Spain: Tantalite	98	76	112	129	130	NA	NA	NA	NA	NA	[6]23	[6]19	[6]28	[6]33	33
Thailand: Columbite-tantalite	141	897	785	106	86	32	209	171	18	15	23	152	259	23	20
Uganda: Columbite-tantalite[e]	5	5	--	--	--	1	1	--	--	--	1	1	--	--	--
United States: Columbite-tantalite	--	--	([7])	([7])	([7])	--	--	([7])	([7])	([7])	--	--	([7])	([7])	([7])
Zaire: Columbite-tantalite[e]	40	71	203	165	70	11	20	57	45	19	9	15	43	46	20
Zimbabwe: Columbite-tantalite	70	65	90	100	90	7	7	10	15	14	17	18	23	35	32
Total	[r]52,101	[r]77,506	80,722	78,413	75,715	21,311	[r]31,710	33,359	32,664	31,561	[r]797	[r]1,049	1,165	819	738

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.
[1]Excludes columbium- and tantalum-bearing tin ores and slags. Table includes data available through June 30, 1983.
[2]In addition to the countries listed, China, Namibia, the U.S.S.R., and Zambia also produce, or are believed to produce, columbium and tantalum mineral concentrates, but available information is inadequate to make reliable estimates of output levels.
[3]Data on gross weight generally have been presented as reported in official sources of the respective countries, divided into concentrates of columbite, tantalite, pyrochlore, and microlite where information is available to do so and reported in groups such as columbite and tantalite where it is not.
[4]Unless otherwise specified, data presented for metal content are U.S. Bureau of Mines estimates.
[5]Less than 1/2 unit.
[6]Reported in official country sources.
[7]A small unreported quantity was produced.

of exports of metals and minerals. Production of struverite declined to 11 tons in 1982, down from over 330 tons in 1980. Plans were approved for a Government-sponsored tin stockpile to compensate for the country's seasonal production difficulties. The International Tin Council's export control program is calculated on a quarterly basis, whereas much of Thailand's tin production occurs during a 7-month period.

The Thailand Tantalum Industry Co. Ltd.'s, (TTIC) proposed plan to set up a tantalum extraction plant at Phuket, Thailand, was slowed. However, the TTIC was reported to have signed a $1.5 million contract with a local engineering consulting firm, Chachaval de Weger International Co., for design, construction supervision, and management of the project. The Thai Pioneer Enterprise Co. Ltd. (TPE) tin smelter was closed in May 1982 owing in part to an inadequate supply of tin concentrates, low tin prices, and weak demand. The merger of TPE with a consortium of large Thai miners was being weighed. Such a merger could force Thai Present Smelter Co. Ltd. to indefinitely postpone the opening of its tin smelter. Some of the planned participants for the Thai Present project were considering backing TPE instead.

Zimbabwe.—Zimbabwe's state-owned Mineral Marketing Corp. (MMC) was reported to have commenced business. The corporation expects to handle most sales as an agent and will charge producers a commission of under 1% to cover costs. Tantalum was the first mineral to be taken over by MMC, which will ultimately take over all mineral export marketing from private companies. Only sales of gold were reported exempt from the corporation's supervision.

TECHNOLOGY

A new modified 9Cr-1Mo steel was developed by the Oak Ridge National Laboratory that is a potential alternative to austenitic stainless steels in elevated temperatures.[7] The modified 9Cr-1Mo steel contains small additions of columbium and vanadium. Advantages when compared to the standard version of 9Cr-1Mo and to Type 304 stainless steels include improved long-term creep properties, lower thermal expansion, higher thermal conductivity, and better resistance to stress-corrosion cracking.

The evolution of HSLA steels was the subject of a review that traced the historical development of the steels from their beginning in the 1920's to the present highly sophisticated controlled microalloyed steels, containing small amounts of columbium.[8] Recent developments in the area of high-strength sheet steels for automobile application were discussed.

The effects of processing parameters on the recrystallization kinetics and yield strength of steels were described in an investigation on rapid annealing of cold-rolled rephosphorized steels containing Si, Cb, and V.[9] For an annealing time of 1 minute, the recrystallization-finish temperature was raised by increasing the Si, Cb, or V content, with Cb and V exhibiting the most potent effect. Increasing annealing temperature or time resulted in a decrease in the yield strength of the Cb and V steels owing to a drop in precipitation strengthening.

[1]Physical scientist, Division of Ferrous Metals.

[2]National Materials Advisory Board. Tantalum and Columbium Supply and Demand Outlook. Natl. Acad. Sci., NMAB-391, 1982, 173 pp.

[3]Avon Products, Inc. 1982 Annual Report. 44 pp.

[4]Krausz, U., H. Schmidt, C. Kippenberger, P. Eggert, J. Priem, and E. Wettig. Untersuchungen Über Angebot und Nachfrage Mineralischer Rohstoffe. XVI. Niob. (Investigation of Supply and Demand of Mineral Raw Materials. XVI. Columbium.) Bundesanstalt für Geowissenschaften und Rohstoffe and Deutsches Institut für Wirtschaftsforschung, Hannover and Berlin, 1982, 208 pp.

[5]Japan Metal Journal. V. 13, No. 21, May 23, 1983, p. 9.

[6]———. V. 13, No. 9, Feb. 28, 1983, p. 7.

[7]Irving, R. R. What's This Steel They're Raving About Down in Tennessee? Technology Features. Iron Age, v. 225, June 25, 1982, pp. 46-47, 50.

[8]Porter, L. F., and P. E. Repas. The Evolution of HSLA Steels. J. of Met., v. 34, No. 4, April 1982, pp. 14-21.

[9]Pradhan, R. R. Rapid Annealing of Cold-Rolled Rephosphorized Steels Containing Si, Cb, and V. Paper in Metallurgy of Continuous-Annealing Sheet Steel, ed. by B. L. Branfitt and P. L. Mangonon (Proc. AIME Annual Meeting, Dallas, Tex., Feb. 15, 1982). TMS-AIME 1982, pp. 203-227.

Copper

By J. L. W. Jolly[1] and D. L. Edelstein[1]

In 1982, world copper consumption continued a downward trend that began in 1979. According to the World Bureau of Metal Statistics, refined copper consumption in the market economy countries declined to 6.7 million tons[2] in 1982 from the high point of 7.3 million tons reached in 1979.[3] World refined copper inventories increased in 1982. Inventories of refined copper held by the New York Commodity Exchange Inc. (COMEX), the London Metal Exchange (LME), and by world refined-copper producers were estimated at 1.1 million tons at yearend 1982,[4] compared with 700,000 tons held at yearend 1981.

Table 1.—Salient copper statistics

	1978	1979	1980	1981	1982
United States:					
Ore produced ---- thousand metric tons--	239,247	277,532	221,597	r277,674	182,407
Average yield of copper -----percent--	0.51	0.47	r0.47	0.51	0.55
Primary (new) copper produced:					
From domestic ores, as reported by:					
Mines ---------- metric tons--	1,357,586	1,443,556	1,181,116	1,538,160	1,139,563
Value ---------- thousands--	$1,990,323	$2,960,675	$2,666,931	$2,886,440	$1,866,895
Smelters ---------- metric tons--	1,269,981	1,313,224	994,479	1,294,962	940,547
Percent of world total -------	16	16	13	16	12
Refineries -------- metric tons--	1,327,373	1,411,518	1,121,897	1,430,210	1,064,816
From foreign ores, matte, etc., as reported by refineries ------------do----	121,684	103,858	88,957	113,807	162,245
Total new refined, domestic and foreign ----------do----	1,449,057	1,515,376	1,210,854	1,544,017	1,227,061
Secondary copper recovered from old scrap only -----------------do----	501,650	604,301	613,458	598,122	517,726
Exports: Refined --------------do----	91,923	73,677	14,489	24,397	30,558
Imports for consumption:					
Unmanufactured -----------do----	531,678	281,584	547,006	429,601	505,986
Refined ----------------do----	402,673	203,855	426,948	330,625	258,439
Stocks, Dec. 31: Producers:					
Refined (primary producers) ---do----	153,000	64,000	49,000	151,000	268,000
Blister and materials in solution -do----	263,000	275,000	272,000	277,000	233,000
Total ----------------do----	416,000	339,000	321,000	428,000	501,000
Consumption:					
Refined copper ------------do----	2,189,301	2,158,442	1,862,096	2,025,169	1,658,142
Apparent consumption, primary copper ---------------do----	1,819,000	1,735,000	1,638,000	1,748,000	1,338,000
Apparent consumption, primary and old copper (old scrap only) ------do----	2,321,000	2,339,000	2,251,000	2,346,000	1,854,000
Price: Weighted average, wirebar, cents per pound -----------------------	66.51	93.33	102.42	85.12	74.31
World:					
Production:					
Mine------- thousand metric tons--	r7,604	r7,675	7,663	p8,175	e7,963
Smelter ----------------do----	r7,946	r8,001	7,915	p8,297	e8,153
Price: London, high-grade, average cents per pound -----------------------	61.88	90.07	99.25	[1]79.35	67.17

eEstimated. pPreliminary. rRevised.
[1]Based on January-November monthly averages. (See table 33.)

Inventories rose partly as a result of continued high levels of production at both mine and copper refineries in several countries outside of the United States despite decreased demand. Significant mine production increases were registered by Australia, Chile, Iran, Morocco, Peru, Poland, and the U.S.S.R., which together produced 300,000 tons more than that in 1981. Chile, alone, increased copper mine production by about 160,000 tons of contained copper and became the top world producer of mine copper.

In constant dollars, U.S. producer prices for copper in 1982 were at the lowest point since the 1940's. Lower prices received for byproducts, such as molybdenum and cobalt, compounded the problems of copper producers. Faced with low prices, high interest rates, and reduced access to capital for expansion or modernization of facilities, copper mining firms closed some properties, some of which were placed on the market for sale. As the year progressed, U.S. smelters were becoming increasingly reliant on foreign concentrates and scrap for feed as domestic mines shut down in economy moves.

Domestic Data Coverage.—Domestic production data for copper are developed by the Bureau of Mines from seven separate, voluntary surveys of U.S. operations. Typical of these surveys is the mine production survey. Of the 113 operations to which a survey request was sent, 55% responded, representing an estimated 93% of the total production shown in tables 1 through 9. Production for the remaining 52 companies was estimated using data reported in other surveys.

Legislation and Government Programs.—Public Law 97-276, signed into law on October 2, 1982, as an amendment to the supplemental appropriations bill for 1982, provided $120 million for the purchase of materials for the National Defense Stockpile, of which $85 million was to be available for purchase of copper mined and smelted in the United States after September 30, 1982. No purchases were made during the year. At yearend 1982, the stockpile held 26,352 tons of copper, including 6,124 tons in brass transferred from the U.S. Department of Defense, far short of the 907,000-metric-ton goal set in 1980 by the Federal Emergency Management Agency.

Negotiations on the Law of the Sea treaty were brought to a close on April 30, 1982, with 130 nations voting to approve the treaty; 4 nations, including the United States, voting against the approval; and 17 nations abstaining, including the Soviet Union. H.R. 6120 was passed as an amendment to section 310 of the Deep Seabed Hard Mineral Resources Act, Public Law 96-283 of June 28, 1980, allotting a further $1.5 million for 1983 and $2.2 million for fiscal year ending September 30, 1984, to carry out the U.S. program. Through the end of 1982, 4 mining companies submitted exploration license applications to the Office of Ocean Minerals and Energy of the U.S. Department of Commerce for 10 mining sites.

Transportation prices were the basis for a National Association of Recycling Industries (NARI) suit against Consolidated Rail Corp. (Conrail) and the Interstate Commerce Commission (ICC) after the Government agency approved the rail carrier's special rate structure on nonferrous recyclable metals. In 1981, Conrail set a new rate basis for recyclable metals that abandoned the traditional commodity rate structure in favor of a single tariff adjusted for maximum weight, mileage, and type of movement. The carrier also created a rate differential between traffic moving within Conrail and that which moved on an interline basis. The ICC permitted this new rate structure to become effective August 1, 1982, and gave its final approval. NARI took the matter to the Court of Appeals contending that Conrail had no legal basis for charging a special rate structure on recyclable materials alone and that Conrail sought to subvert the original order to lower rates on these materials not to exceed a revenue-to-cost ratio of 146%. This rate cap was established on January 1, 1981, by ICC, in accordance with the Rail Deregulation Law.[5]

DOMESTIC PRODUCTION

Mine Production.—Domestic mine production reflected the general economic malaise of 1982 and was at the lowest level since the 1960's. The United States slipped from first to second place in ranking among world mine-copper producers. From March 1981 to January 1983, 28 domestic mines closed or cut back production. Most of these occurred during 1982, as shown in the following tabulation:

Operator	Mine and location	Date closed
Anaconda Minerals Co	Carr Fork, Utah	November 1981.
	Berkeley main pit, Montana	January 1983.
Anamax Mining Co	Twin Buttes, Arizona	Do.
ASARCO Incorporated	Silver Bell, Arizona	December 1981.
Cities Service Co	Copper Cities, Arizona	June 1982.
	Pinto Valley, Arizona	Do.
	Boyd Mine, Tennessee	September 1981.
	Cherokee, Tennessee	January 1982, open-pit only.
Copper Range Co	White Pine, Michigan	October 1982.
Cyprus Pima Mining Co	Pima, Arizona	June 1982; processed stockpiled ore to October 1982.
Duval Corp	Esperanza, Arizona	December 1981.
	Mineral Park, Arizona	Do.
	Sierrita, Arizona	December 1981 to April 1982.
Hecla Mining Co	Victoria, Nevada	February 1981.
Inspiration Consolidated Copper Co	Christmas, Arizona	January 1982.
Kennecott Minerals Co	Chino, New Mexico	April-July 1982.
	Ray, Arizona	May 1982.
Magma Copper Co. (Newmont Mining Corp.).	San Manuel, Arizona	December 1982, 2 weeks.
	Superior, Arizona	August 1982.
Phelps Dodge Corp	New Cornelia, Arizona	April 1982 to February 1983.
	Metcalf, Arizona	January 1981 to October 1982.
	Morenci, Arizona	April-October 1982.
	Tyrone, New Mexico	April 1982 to May 1983.
Quintana Minerals Corp	Copper Flat, New Mexico	July 1982.
Ranchers Exploration and Development Corp.	Bluebird, Arizona	October 1982.
Sharon Steel Corp	Continental underground and open pit, New Mexico.	January and May 1982.
Silver King Mines Inc	Copper Cliff Mine, Idaho	December 1981.

By yearend, the Morenci, Metcalf, and Chino Mines had reopened, but total U.S. mine capacity utilization was still at about 65%. Of the top 25 mines in 1981, 14 were closed at yearend 1982, and about 42% of the total copper industry work force had been laid off (approximately 17,800 workers out of an estimated total work force of 42,300 employed on January 1, 1982).

As shown in table 2, U.S. mine production had not attained a rate consistently above 80% of capacity since 1974. The rest of the world, on the other hand, had maintained a level generally above 80%, except for the years 1979 and 1980, when production was as low as 79% of rated capacity.

Table 2.—Copper mine production, capacity, and capacity utilization

Year	United States			Rest of world		
	Production (thousand metric tons)	Capacity (thousand metric tons)	Percent of utilization	Production (thousand metric tons)	Capacity (thousand metric tons)	Percent of utilization
1970	1,560	1,680	93	4,462	4,820	93
1971	1,381	1,720	80	4,687	5,070	92
1972	1,510	1,720	88	5,132	5,480	94
1973	1,559	1,810	86	5,558	6,070	92
1974	1,449	1,810	80	5,852	6,740	87
1975	1,282	1,810	71	5,727	6,480	88
1976	1,457	1,810	80	6,068	6,780	89
1977	1,364	1,810	75	6,375	7,400	86
1978	1,358	1,810	75	6,256	7,530	83
1979	1,444	1,840	78	6,231	7,890	79
1980	1,181	1,835	64	6,482	8,215	79
1981	1,538	1,730	89	6,637	7,790	85
1982	1,140	1,750	65	6,824	7,990	85

Principal copper mining States in 1982 were Arizona, 68%; Utah, 17%; and Montana, 5%. Copper was also mined in New Mexico, Michigan, Tennessee, Missouri, Nevada, Idaho, Colorado, California, and Washington. Kennecott Minerals Co.'s Bingham Canyon, Utah, property remained in first place among U.S. producing mines, followed in second place by the Twin Buttes, Arizona, mine of Anamax Mining Co., and in third place by the Morenci, Arizona, mine of Phelps Dodge Corp. Of the 33 operating mines where copper was the principal metal mined, the top 5 producers accounted for about 50% of the total production. Five of the thirty-three mines were processing from stockpiled ore for much of the year. In 1982, domestic copper was mined from ore that had an average grade of 0.65%, which was 30% lower than the world average grade.

The average copper yield for ores, except those leached in dumps or in place, was 0.55% or about 11 pounds of copper per ton of ore. Copper recovered by leaching of ore tailings, dumps, or of in-place ore continued to form about 9% of the total recoverable copper mined in the United States; it has been in this range since the early 1970's, when it dropped from over 10% of the total mine production.

The Anaconda Copper Co., a subsidiary of Atlantic Richfield Co. (ARCO), changed its name to Anaconda Minerals Co. to reflect a broadened range of activities since its acquisition by the oil company on January 12, 1977. ARCO's Anaconda Minerals continued to lose money in 1982, losing approximately $332 million. Early in the year, the company announced its intent to sell the Weed Heights property in Nevada. The final day for the few remaining activities at the mine was to be March 31, 1983. Although the open pit copper mine, which at one time employed 600 people, officially ceased production on June 30, 1978, some minor activities, including a zeolite operation, had continued to function. Later in the year, Anaconda Minerals and AMAX Inc. agreed to terms for the sale of the Anamax Mining properties near Tucson, Ariz., following the signing of a letter of intent in 1981. ARCO was under a Federal Trade Commission ruling, handed down in 1979, to divest itself of Anamax Mining by October 1984. Properties affected by the sale were the Twin Buttes copper mine and the Helvetia copper-molybdenum-silver prospect, both in Arizona. The Eisenhower property, jointly owned by Anamax Mining and ASARCO Incorporated, would not be affected; Asarco mines the property and delivers a share of the product to Anamax Mining. In addition to the mines, Anamax Mining operates a 27,000-ton-per-year electrowinning plant. Plummeting molybdenum prices during 1982 had made mining at Twin Buttes particularly unprofitable; Twin Buttes mining costs were estimated to be $1.10 per pound after byproduct credits. The mine is profitable only if byproduct prices are high.[6]

In January, Anaconda Minerals reported its mining costs for 1981 to be an average of $1.30 per pound at Butte, Mont. This was after deduction for byproduct credits, without which the actual costs would be $1.63 per pound of copper extracted. Molybdenum, gold, and silver added about 33 cents of revenue per pound of copper.[7] In February 1982, dried concentrates were shipped from the Weed concentrator at Butte for the first time to the loading facility in North Vancouver, British Columbia, Canada, directly from Butte, rather than from the defunct concentrator at Anaconda, Mont. A new $10 million loading facility also was completed at Vancouver, Wash., for concentrate shipments to Japan. In 1981, Anaconda Minerals signed an agreement with the Port of Vancouver, Wash., to ship 400,000 tons of copper concentrates per year to Japan, starting in July 1982. A new drying process at the Weed concentrator allowed a 50% savings over the old drying method used at Anaconda. The company had spent $30 million on the project, which had included a molybdenum ore processing plant, a lime-slaking facility, and a concentrate drying plant. The new drying process used pressure filtration. Even so, by yearend, Anaconda Minerals announced its intent to close the East Berkeley pit in June 1983. In April 1982, all development work was suspended at the company's Carr Fork Mine at Tooele, Utah, and 650 workers were laid off. The mine had been closed in 1981 for development and engineering work that had continued since then; a new mining method was tested in May 1982 with some success.

Copper production from Asarco's mines was at about the same level as that in 1981. The loss of production from the Silver Bell Mine, Arizona, which closed in December 1981 and remained closed through 1982, was about equal to the gain from the first full year of operation of the new Troy Mine in Montana. The Troy Mine had a capacity of 18,000 tons per year of copper in addition to its silver output. Production from Asarco's four other open pit copper mines in Arizona was about the same as that in 1981. Asarco emphasized cost reduction in 1982 that included shutdown of the molybdenum recovery plant in July and a combination of attrition and a series of worker layoffs at the Mission, Eisenhower, and San Xavier Mines in Arizona; employment was reduced by about 24%. Production was maintained through mining plan alterations. The company reported 1982 labor costs to represent about 40% of the total production costs of one of Asarco's Arizona copper mines and a large percentage of other producers' overall costs. Interest costs for money borrowed during 1982 were $57.5 million compared with $47 million for 1981 and were also a factor affecting the cost of producing copper. Increased interest costs were the result of borrowing that was necessitated in part to comply with environmental requirements.[8]

Two of Duval Corp.'s copper-molybdenum mines, Mineral Park and Esperanza, remained closed throughout 1982. The Sierrita Mine near Tucson, Ariz., reopened on April 1 at a reduced rate, but by November 1982, cost-cutting measures by the company, a subsidiary of Pennzoil Co., had resulted in a 10% increase in production to 42,000 tons per day of ore (about 35% of capacity) despite the reduced work force. The Sierrita and Esperanza copper complex employed about 2,500 employees before the operations were shut down temporarily in December 1981. The work force at Sierrita was less than one-half of the normal number when the mine reopened. An innovative, movable ore-crushing system was started at Sierrita by the yearend. The system can be moved to various sites within the pit as mining progresses. Savings were estimated to be as much as 15% of the mining costs at Sierrita, using the movable three-crusher system. Pennzoil's mining operations accounted for 4% of its consolidated operating income in 1982, compared with 14% in 1981 and 35% in 1980. Operating losses in the metals division were $60.9 million, an increase of $17.9 million over that of 1981. Contributing to the increased losses were $24.4 million in mine shutdown costs and nonrecurring employee severance payments.[9]

After 2 years of development work at the Cities Service Co.'s Miami East Mine, the underground haulage ramp was connected early in 1982 between the 2900-foot and 3,300-foot levels of the mine. A new technique involving several Dosco mining machines was to be used to recover the ore in the Arizona ore body. In this technique, the ore is removed along 13- by 13-foot cuts, and the stopes are back filled with a mixture of tailings and cement. As the fill hardens, the adjoining stope is mined with no support pillars of ore being left behind. Scheduled to be onstream by mid-July, the startup was deferred. Both the Pinto Valley and Copper Cities Mines were closed in June 1982. Pinto Valley had normally provided 70% of the toll feed at the Inspiration Consolidated Copper Co.'s Miami smelter, and as a result, the smelter also closed in August 1982. Plans for selling Cities Service's Miami operations were halted in May 1982 because an acceptable offer did not seem forthcoming. In December, Newmont Mining Corp. had reached agreement with Cities Service to buy its Miami operations for approximately $75 million plus a profit-sharing scheme, not to exceed $30 million, involving any remaining inventories. This sale followed reports of an impending acquisition of Cities Service by Occidental Petroleum Corp.[10] Included in the sale were the open pit Pinto Valley Mine, the new Miami East underground mine, and two electrowinning plants at Pinto Valley and Miami. Miami concentrates were to be processed at Newmont Mining's Magma Copper Co. smelter at San Manuel, Arizona, after the tolling contract with Inspiration Consolidated expires in 1984. In September, Cities Service also sold its Copperhill, Tenn., operations to the Tennessee Chemical Co. The complex included mining, metallurgical, and chemical manufacturing activities. The Boyd Mine had been closed for nearly 1 year, and the open pit at Cherokee had stopped producing in January 1982.

Kennecott Minerals' copper mine production for 1982 was reduced to 260,000 tons from 338,000 tons in 1981. The company, a subsidiary of Standard Oil Co. of Ohio, had an operating loss of about $189 million in 1982. Cost cutting took place in all operations during the year and included mine closures and personnel layoffs. Approximately 1,670 Arizona employees, 910 Utah employees, and 540 New Mexico employees were affected by the Kennecott mine and smelter closures. In April and May 1982, mining at the Chino, New Mexico, and Ray, Arizona, mines was suspended. Limited mining resumed in July at Chino. The Utah Copper Div. maintained full production during the year at the Bingham Canyon Mine despite work-force cuts. The modernization of the Chino concentrator was completed with a new capacity of 34,000 tons of ore per day; the concentrates were transported by a slurry pipeline to the smelter. The second phase of the Chino smelter modernization to increase capacity to 100,000 tons per year and to comply with the Federal Environmental Protection Agency (EPA) emission standards began in 1982 and was expected to be completed by 1985.[11] Chino Mines Co., formed in 1981, was two-thirds owned by Kennecott Minerals and one-third owned by Mitsubishi Corp. of Japan, which paid $116 million for its share of equity. During the year, Kennecott Minerals received approval from the State of Minnesota to acquire the AMAX copper and nickel exploration project near Babbitt, Minn.

Magma Copper cut back staff, the length of the work week, and mine production at both the Superior and San Manuel, Arizona, mines in 1982. Six planned, 1-week shutdowns were carried out at San Manuel, in addition to a more extensive 2-week shutdown in December and January. Development work was halted starting in June at San Manuel, and approximately 2,390 employees out of a total of 6,120 normally employed by Magma Copper had been laid off by November 1982. Magma Copper closed its Superior Div. on August 15, 1982, for an indefinite period.

Through the first quarter of 1982, operating rates at Phelps Dodge's copper mines were curtailed to 80% of capacity, and on April 17, 1982, all of the company's open pit mines were shut down. By yearend, only the Morenci and Metcalf pits and concentrators at Morenci, Arizona, had been reopened. Mining at Metcalf had been suspended since January 1981. As a result, Phelps Dodge copper mine production was only 136,000 tons in 1982, compared with 286,400 tons in 1981 and 242,000 tons in 1980. The company had a net loss of $74.3 million, compared with 1981 earnings of $69.3 million, the first loss since the depression years of 1932 and 1933. By yearend, production costs had been reduced by measures such as salary cuts of up to 10% for salaried employees at both mine and smelter operations and a considerably trimmed staff when operations restarted. The company announced yearend production costs had been trimmed, substantially below 79 cents per pound.[12] This compared with earlier estimates of an average cost of about 85 cents after byproduct credits. Other cost-reduction measures included use of prestripped ore at Metcalf; basic improvements in maintenance procedures, inventory control, haulage systems, and energy conservation; increasing low-cost leach production; and computerized mining plans. The program of installing new, larger flotation cells at the Morenci concentrator continued, with completion of the program delayed to 1983. A similar program was completed at Ajo in 1982. The larger cells serve to lower production costs. Among cost-cutting measures being evaluated was a solvent extraction plant at Tyrone. Copper ore reserves at the company's four open pit mines and at its underground deposit near Safford, Ariz., were estimated at 9 million tons of recoverable copper. Development work at Safford was temporarily halted. At the current stage of development, an estimated 40 months would be needed to bring the mine online with a capacity of 27,000 tons of ore per day.

Smelter Production.—Of the 15 primary domestic copper smelters located in 8 States, 7 were closed at yearend, and production had dropped at 6 of the remaining 8. Smelter production was cut back beginning in December 1981 and was decreased to a rate of 63,000 tons per month by June 1982, compared with the monthly average of 115,000 tons for 1981. Production of copper from domestic ores decreased by 27% in 1982, while copper production from foreign primary materials increased by 61%.

By January 1, 1988, smelters must comply with the control standards for sulfur dioxide emissions as set forth in the 1977 amendments to the Clean Air Act of 1970. Compliance will add substantially to the cost of producing copper and may force the closing of some of the older smelters. Anaconda Copper Co. closed its Montana smelter in 1980 for this reason and turned to shipping concentrates to Japan for smelting. Phelps Dodge's smelters at Douglas and Ajo, Ariz., Kennecott Minerals' smelter at McGill, Nev., and Asarco's smelter at Tacoma, Wash., will face this decision. In addition, Inspiration Consolidated's smelter at Inspiration, Arizona, although modernized, was still unable to meet the emission standards.

In 1981, Phelps Dodge negotiated a consent decree with EPA, setting timetables to bring the Morenci smelter into compliance with emission standards by January 1, 1985, and to bring the Ajo smelter into compliance by December 31, 1985. The initial construction phase at Morenci was substantially completed during 1982, including the first of two oxygen plants and modifications to one of the reverberatory furnaces. The use of oxygen with natural gas as a smelting technique began in October. At yearend, about $60.8 million had been spent in modifications at the Morenci smelter. The company indicated that the costs of building a sulfuric acid plant and related facilities needed to bring the Douglas smelter into compliance could not be justified economically. Phelps Dodge applied for a second Nonferrous Smelter Order (NSO), which under the Federal Clean Air Act would continue to relieve the company from construction of new facilities until the end of 1987. The first NSO expired in 1982.[13] Phelps Dodge suspended operations at its Ajo, Douglas, and Morenci smelters in Arizona in April 1982, coinciding with the mine closures. The Douglas smelter resumed operation on a reduced basis in mid-July, but was shut down again in early November because of a lack of material for smelting. The Morenci smelter resumed production in mid-October. The Hidalgo, N. Mex., smelter operated throughout 1982 except for brief repair shutdowns. Amoco Minerals Co.'s Cyprus-Bagdad Mine was a major source of concentrates smelted at Hidalgo during the year.

Smelters closed during 1982 also included the Chino Mines Co. plant at Hurley, N. Mex., which was closed from May 1982 to October 1982; the Inspiration Consolidated smelter, which was closed from August 1982 to January 1983; and the Copper Range Co. White Pine, Michigan, smelter, which was closed on June 21, 1982, and remained closed at yearend. The Newmont Mining San Manuel smelter and refinery operated at 20% below their normal annual capacities of about 136,000 tons for the first 6 months of 1982; in August, their operating rates were cut back to 58%.

Demolition of the larger of Asarco's two reverberatory furnaces at Hayden, Ariz., commenced in November to make room for a new oxygen furnace. More efficient and more amenable to environmental control than the present roaster and reverberatory furnaces, the new oxygen flash smelting furnace was to cost about $132.6 million. Smelting operations were to be curtailed to about 65% of capacity for 11 months until the startup of the new furnace, which was scheduled for October 1983. Construction was about 40% complete at yearend. According to agreements made with EPA, the new facilities at Hayden were scheduled to be in full operation by April 1984. The smaller furnace was shut down for 1 month during 1982 because of a shortage of concentrate usually acquired from Duval. Previously committed air quality improvement projects at Asarco's smelters in El Paso, Tex., and Tacoma, Wash., were also pursued. The Tacoma plant completed construction and evaluation of a secondary exhaust hood on one of its converter furnaces, and two more hoods were planned for the remaining converter furnaces. At the El Paso plant, plans were completed for the 1983 expansion of the electrostatic precipitator, which removes dust particles from the converter furnace gases.[14]

Refinery Production.—Ten of the twelve domestic electrolytic and fire-refining primary plants were in operation at yearend 1982. In addition, eight of the nine electrowinning plants were in operation; the electrowinning plant of Duval at Sierrita, Arizona, closed down in March 1982. Production from primary materials at refining plants did not drop as soon, or the decline last as long, as mine and smelter production; the decline started in May, and production dropped to a low point of 91,505 tons per month by August, compared with the January production of 106,187 tons and a 1982 yearend rate of 103,000 tons per month. Total refinery output from primary materials fell by 21% in 1982. Refinery output from secondary materials increased by 1% as a result of the increased use of scrap during the final 6 months of 1982. The use of foreign material also increased by yearend 1982; in January 1982, refinery production from foreign materials was 8,863 tons per month, but by July, the monthly rate had increased to 13,820 tons produced. During December 1982, 18,056 tons of refined copper was produced from foreign materials.

End-of-year refined copper stocks held by refineries, wire-rod mills, brass mills, other processors, the National Defense Stockpile, and COMEX rose to approximately 687,000 tons in 1982, compared with 469,000 tons in 1981 according to Bureau of Mines reported figures. Refined stocks held outside the United States by copper producers, merchants, consumers, and LME were estimated to be 901,300 tons at yearend 1982, compared with 635,600 tons at yearend 1981. This was the highest inventory recorded since 1978.[15]

Phelps Dodge reported byproduct copper, silver, and gold production to be down for 1982 because of reduced output of copper from the company's mines and smelters. Both company refineries at El Paso, Tex., and Laurel Hill, N.Y., also produced copper sulfate and recovered small amounts of selenium, tellurium, platinum, and palladium in refinery slimes. Construction of an electrolytic purification plant at the El Paso refinery was completed in 1982 at a cost of $2.6 million. A small amount of nickel sulfate was being produced as a byproduct at this plant. Construction of a precious metals recovery plant was expected to be completed in 1983 at a total cost of about $7.0 million.[16]

At Asarco's Amarillo, Tex., refinery, the installation of equipment for acid cleaning of continuous-cast copper rod was started. The new equipment was expected to be in operation by mid-1983 and to enhance the surface characteristics of the high-quality rod produced at Amarillo.[17] About 50 workers were laid off when the refinery reduced operations in June 1982 to 25% of its operating rate of 300,000 tons per year because of closings and curtailments at mines of its toll customers, who in 1981 accounted for about 35% of the refinery's production.

Duval began installing some uniquely designed low-energy electrolytic cells at its electrowinning (CLEAR) facility at Sierrita, which promised to save energy, cut maintenance costs, and improve purity of the finished products. Savings from this installation could average as much as 9 cents per pound of copper when the CLEAR facility goes back into operation, probably in late 1983 or early 1984. The CLEAR facility utilized hydrometallurgical technology (ferric chloride leaching and electrolysis of ferrous and cuprous chlorides) to convert copper sulfide concentrate into high-grade copper.[18] The method has proven economically competitive with conventional smelting.

Copper Range closed its White Pine, Michigan, mine, smelter, and refinery on October 1, 1982, after cutting back production in mid-March; the work schedule was down to a 3-day week by June. Meanwhile, work continued on the construction of the new $80 million electrolytic refinery that was to start production in January 1983. The new refinery, with a potential annual capacity of 55,000 tons per year, was to operate using scrap metal until the mine and smelter reopened.

Copper Sulfate.—Copper sulfate was produced from secondary metal, electrolytic refinery solutions, and blister copper by seven companies. Production decreased by 10% in 1982, while imports, which accounted for less than 5% of domestic supply, increased by 23%. Van Waters & Rogers Inc. stopped producing copper sulfate when its Wallace, Idaho, plant closed in June.

Table 3.—Copper sulfate producers in 1982

Company	Plant location
Chevron Chemical Co	Richmond, Calif.
Cities Service Co	Copperhill, Tenn.
CP Chemicals Inc	Sewaren, N.J.
Madison Industries Inc	Old Bridge, N.J.
Phelps Dodge Corp	Laurel Hill, N.Y., and El Paso, Tex.
Van Waters & Rogers Inc	Wallace, Idaho.

Byproduct Sulfuric Acid.—Because of smelter shutdowns and curtailments, sulfuric acid production was down during 1982. At the Phelps Dodge Ajo, Hidalgo, and Morenci smelters, only 579,200 tons of sulfuric acid was produced during 1982, compared with 901,000 tons in 1981. The company reported sales of about 598,000 tons of acid during the year at prices that averaged substantially less than their costs of production.

CONSUMPTION AND USES

Domestic consumption of refined copper declined by 18% to a total of 1.7 million tons in 1982. Of this amount, 74% was consumed by 18 wire-rod mills and 24% by 45 brass mills. Use of copper and copper-alloy mill products was estimated to be 29% electrical and electronic products (including 13.4% telecommunications), 31% building construction, 18% industrial machinery and equipment, 9% transportation (including 4.4% nonelectrical automotive), and 13% consumer and general products.[19]

During the year, discussions concerning changes in copper consumption revolved around two key issues—changes resulting from miniaturization and substitution in key consumer markets. Examples of miniaturization were thinner gauges, narrower widths, and smaller quantities required by the electronics and automotive industries. Examples of substitution were given as polyvinyl chloride competing with copper in plumbing pipe and tubing, aluminum for automotive radiators and electrical cable, and optical fibers in telephone lines. Although the subject of much speculation, the copper telephone trunkline replacement by optical fiber material was not expected to affect more than 5% of the amount of copper currently used in the telecommunications industry. Economic maturization in the industrial countries was also seen as a factor in the decrease of future copper consumption, requiring less copper than in a country's early development stages in such areas as electrical generation and transmission and telecommunications. The industry has seen some markets disappear over the years, such as markets for gutters, downspouts, brass hardware, and so forth, but the loss was generally replaced with new markets. This was no longer considered likely. The areas holding small promise were the infant solar energy field, shipbuilding (with some smaller vessels experimenting with copper-sheathed hulls), and the potential for electrical cars.[20]

PRICES

The average U.S. producers' delivered price for electrolytic copper cathode was 72.8 cents per pound in 1982, compared with 84.2 cents per pound in 1981. A low point of 69.5 cents per pound was recorded in September 1982. The LME cash price for copper cathode averaged 65.6 cents per pound in 1982 and 79 cents per pound in 1981. The monthly low LME copper cathode price was in November, when it was 62.2 cents per pound. On a constant-dollar basis, the U.S. producers' price was the lowest since the 1940's. Compounding copper producers' problems was the collapse of prices received by U.S. producers for byproducts, especially molybdenum and cobalt, where huge stocks had been amassed. Gold and silver values generally fared a little better.

TRADE

The United States continued to be a net importer of refined copper in 1982, continuing a trend that began in the early 1970's. Net imports of blister copper also increased, but were lower than that of the 1960's and early 1970's. Imports of copper ores and concentrates also increased, but the United States was still a net exporter of concentrates, reflecting the double-edged problem facing domestic smelters of a loss of domestic concentrates and the difficulty of competing effectively with nations such as Japan for foreign ores and concentrates.

In a petition to the Commerce Department, domestic wire-rod producers charged that imports of Venezuelan copper wire rod were being sold in the United States at 40% below fair market value and that wire-rod imports from Venezuela jumped fivefold from 4,047 tons in 1980 to 23,082 tons in 1981.[21] The U.S. Department of Labor granted additional benefits to the 3,925 unemployed copper workers at Kennecott Minerals' Utah Copper Div., Ray Mines Div., Arizona, and Chino, New Mexico, mine. The workers were certified under the provisions of the Trade Act of 1974 after an investigation showed that the cheaper price of imported copper led to the layoffs. The United Steelworkers of America also had filed petitions for other copper workers, some of which were still pending at yearend.

In another case of trade litigation under the General Agreement on Tariffs and Trade (GATT), the European Communities (EC) accused Japan of unfair trade practices, contending that they had manipulated the copper concentrate market in their favor by placing a tariff on refined copper but not on concentrates and by limiting copper cathode imports. These actions, the EC claimed, allowed Japanese copper smelters to out bid their U.S. and European competitors for feed. Japan reportedly imported about 70% of all internationally traded copper concentrates, most of which originated from mines around the Pacific Ocean rim, including the United States.

There have been no meetings of the United Nations Conference on Trade and Development (UNCTAD) Intergrated Programme on Commodities on copper since February 1980. Since then, according to the Secretariat, "there were insufficient indications of the prospects of holding a productive meeting to explain the lack of followup meetings." At the end of 1982, 90 countries had signed the agreement setting up the Common Fund for Commodities, and 40 of them had ratified it. Ninety ratifications were needed to secure the two-thirds of the projected capital needed for the Common Fund to come into operation. The Common Fund had been a major feature of international discussions since 1976. At the conclusion of the Paris Conference of International Cooperation in June 1977, the United States and other major industrial countries agreed to establish a common fund to be negotiated in UNCTAD. Agreements were completed in June 1980 that governed the establishment and operation of the fund. Membership in the fund would be held by governments and intergovernmental organizations, such as the European Economic Community (EEC). The fund was to be comprised of two accounts: The first would facilitate financing of international buffer stocks or internationally coordinated national stocks of international commodity agreements, and the second would finance nonprice stabilization measures for commodities, such as research and development and marketing with benefits accruing to both producers and consumers. The deadline for ratification was extended to September 1983. The sixth conference of UNCTAD was to be held in Belgrade, Yugoslavia, in June 1983.[22]

WORLD REVIEW

The depressed world copper market of 1982 was difficult for most producers and for North American producers in particular. The world's copper mines were operating at about 82% of a rated capacity of 9.7 million tons of ore during 1982, with the United States operating at 65% of capacity and the rest of the world at 85% of capacity (table 2). Operating rates for Canada were similar to those of the United States; Canadian production in 1982 decreased by 12% compared with that of 1981. Meanwhile, Mexican copper mine production increased by nearly 4%. More than 60% of the 63 copper-producing nations in the world either increased or maintained 1981 levels of production in 1982. Significant increases were recorded for Australia, Brazil, Chile, Mongolia, Morocco, Namibia, Peru, Poland, and the U.S.S.R. Iran was also reported as having started significant production from its Sar Chesmeh complex.[23] By yearend, however, Argentina, Brazil, Mexico, Zaire, and Zambia were having problems in maintaining higher levels of production while contending with external debt problems that compelled them to adopt austerity measures.

The Intergovernmental Council of Copper Exporting Countries (CIPEC) voted to move the organization's headquarters from Paris, France, to Lusaka, Zambia. The eight CIPEC members, Australia, Chile, Indonesia, Papua New Guinea, Peru, Yugoslavia, Zaire, and Zambia, accounted for 41% of total world production in 1982, compared with 38% in 1981. In its Quarterly Review for April-June 1982, CIPEC continued to support its steadfast policy of maintaining production in spite of falling prices. By yearend, CIPEC conceded that world consumption had fallen off through much of the world and that depressed prices had caused widespread cutbacks in production in some nations, but its support for high production was unchanged. Based on estimates that 25% of total copper resources, including estimates of undiscovered resources, was in Chile and Peru, CIPEC speculated that both Chile and Peru could expect to increase their share of world copper production over the next two decades and achieve a mine output equal to 30% of world output.[24] The two countries accounted for 20% of world production in 1982.

Canada.—A number of mines were temporarily closed during 1982, and other mines were closed indefinitely owing to depletion of reserves. By December, mines were reported to be operating at only 65% of the 1981 level, or at the rate of 450,000 tons per year. Copper prices were lower than the production costs reported for most producers. In 1982, copper was produced as a principal product at about three dozen mines and as an important coproduct at about one dozen mines. Copper was produced in 7 of the 10 Provinces and in the two Territories. British Columbia was the leading producer with 44% of the national total, followed by Ontario with 29%, Quebec with 15%, and Manitoba with 8% of the total produced. The remaining 4% was produced in the Yukon, New Brunswick, Newfoundland, Saskatchewan, and the Northwest Territories.

By yearend 1982, Noranda Mines Ltd., which previously had accounted for about 15% of Canadian copper production, had curtailed copper mine output by about 70%. Following interim cutbacks and temporary closures, mining ceased at Noranda Mines' Gaspe Div. in December. While mine output was not scheduled to resume for at least 6 months, the Gaspe copper smelter remained open. In October, the Bell copper mine was closed for an indefinite period, and startup of the Goldstream Mine in British Columbia was delayed. A 17-week strike at Noranda Mines' Canadian Copper Refiners unit in Quebec resulted in temporary suspension of refined copper shipments.

Other copper mine curtailments included Corporation Falconbridge Copper's closure of the Lake Dufault operation in June; shutdown of Inco Ltd.'s Sudbury operation, initially because of a 1-month strike in June; an employee reduction followed by a 15-week closure at Inco's Fox and Ruttan Mines; an 8-week production suspension and deferral of all possible capital expenditures at the Manitoba-Saskatchewan mining operations of Hudson Bay Mining and Smelting Co. Ltd.; and a strike at the Afton Mine of Teck Corp. and Metallgesellschaft Canada Ltd. from November 1981 through March 1982, followed by indefinite closure in June.

In March, Teck was reported to have begun full-scale operation at its new Highmont Mine in British Columbia, which had an annual rated capacity of 18,000 tons of copper. Bethlehem Copper Corp. was developing the Lake Zone copper ore body, with a projected 18,000 tons per day of copper ore to be milled at the existing Bethlehem concentrator beginning in 1983. Kidd Creek Mines Ltd.'s new Mitsubishi-type copper smelter-refinery, which was placed into commercial operation in 1981, was experiencing difficulties and was reportedly operating at 60% to 65% of capacity. The facility was the first commercial continuous smelting operation in North America, moving directly from concentrate to blister to cathode.

Chile.—The Government-owned Corporación Nacional del Cobre de Chile (CODELCO-Chile), which had copper ore reserves estimated to be 121 million tons, produced 83% of the Chilean copper from its four large mines, Chuquicamata, El Teniente, El Salvador, and Andina. Despite declining world copper prices, CODELCO-Chile was reportedly able to obtain a modest profit in 1982 from copper sales. Devaluation of the peso by 18% in June and other major changes in exchange-rate policy designed to deal with rising unemployment and declining output contributed to lowering the costs of mining operations and improving the outlook for expanded investment in mining projects. In December, CODELCO-Chile signed a $305 million private loan, the largest single foreign loan ever issued to Chile, from a syndicate of 25 foreign banks, including 14 in the United States.

Average ore grade at the four CODELCO-Chile mines was 1.68% copper in 1980 and was projected to fall to 1.13% copper by 1990. To compensate for tonnage losses due to declining ore grades, CODELCO-Chile was undertaking several major expansion projects at its four copper mine divisions. As part of a project to increase concentrating capacity at the El Teniente Mine by a reported 25% to 75,000 tons of ore per day, a 30,000-ton-per-day primary crusher was brought onstream during 1982. The unit was designed to allow treatment of hard primary ore; previous production had come from nearly depleted, soft, secondary rock. At the Chuquicamata Mine, expansion of the concentrator from 70,000 tons per day to 96,000 tons per day was completed during 1982, and a licensing agreement was signed to allow construction of a 300,000-ton-per-year smelter using the Outokumpu flash smelting method.

The Andina Mine was the only one of the four major CODELCO-Chile mines showing a production decline in 1982. However, the newly discovered Sur-Sur deposit near the Andina Mine, with estimated reserves of 50 million tons of ore, was scheduled for startup in 1985. The deposit was reportedly capped with 4.0% copper ore, directly underlain by a 2.5% copper ore.

Minera Utah de Chile S.A. and Getty Mining (Chile) Inc. were jointly engaged in developmental drilling of the La Escondida deposit. La Escondida ore, which was discovered in 1981, was described as a high-grade porphyry copper deposit that assayed from 1.2% to 2.3% copper.

Mexico.—Most of the increased copper mine production was from the La Caridad Mine operated by Mexicana de Cobre S.A. Although smelter and refinery expansion projects were underway, capacity was not sufficient to process mine production. Consequently, over one-half of production was in the form of concentrates, and Mexico remained a net importer of refined copper. Although there were 45 mining companies producing copper ores, only 3 companies, Mexicana de Cobre, Cía. Minera de Cananea, and Industria Minera México S.A. (IMMSA), accounted for more than 90% of production. Mexicana de Cobre, a joint Government and private sector venture, initiated development of the La Caridad mining-metallurgical project 13 years ago. In 1982, the concentrator was reported to be operating near capacity. Startup of the La Caridad smelter, initially scheduled for early 1983, was reportedly delayed until early 1985. Work on the smelter was said to be only one-third completed, and construction of the 18,000-ton-per-year refinery was expected to begin in 1983. During 1983, concentrate was shipped by rail to the Port of Guaymas for export.

Cananea, the largest known copper deposit in Mexico, with estimated reserves of 1.7 billion tons of ore grading 0.7% copper, was acquired by The Anaconda Company in the 1930's. In 1971, 51% of Anaconda's stock in Cía. Minera de Cananea was sold to Mexican investors. In 1981, the Mexican Government, through Nacional Financiera, which is a Government development bank, acquired Anaconda's remaining stock in Cananea. In July 1982, the International Finance Corp. (IFC), an affiliate of the International Bank for Reconstruction and Development (World Bank), approved a $400 million loan to help finance expansion of the Cananea Mine and smelter complex, which is located 30 miles from Douglas, Ariz. Private banks were to underwrite $370 million of the total. However, because of Mexico's financial difficulties, IFC later deferred the loan.

Peru.—In 1982, copper accounted for 14%

by value of Peru's total exports, or 35% of mineral exports. Southern Peru Copper Corp. (SPCC), which operated the Toquepala and Cuajone Mines, was the largest copper producer. These two mines accounted for 65% of copper mine production. SPCC (which was jointly owned by the U.S. corporations Asarco, Newmont Mining, Phelps Dodge, and Cerro Corp.) and the state-owned Empresa Minera del Perú (MINERO PERÚ) and Empresa Minera del Centro del Perú (CENTROMIN PERÚ) accounted for 81% of copper mine production in 1982.

SPCC's Toquepala Mine and Ilo smelter lost about 20 days to labor strikes in 1982. This was an improvement over 1981 when both mines and the Ilo smelter were paralyzed by labor problems for almost 2 months. SPCC unit production costs reportedly rose by 29% in 1982, principally because of high fuel costs. SPCC delayed decisions to expand capacities at the Ilo smelter and Toquepala and Cuajone Mines pending improved copper conditions.

MINERO PERÚ slightly increased production from the Cerro Verde I copper oxide mine to 33,532 tons of copper cathodes, and at its electrolytic copper refinery at Ilo, cathode production increased to 140,859 tons or approximately to the 1980 level. MINERO PERÚ reportedly suffered a setback when a $290 million development plan for the Cerro Verde II deposit was stalled because of unresolved financing problems. After negotiating a $130 million loan, Japanese lenders, who were pondering a worst-possible-case scenario, were reportedly asking the Government to guarantee their loan. The Cerro Verde I oxide ore reportedly will be depleted by mid-1985. Over 1,000 workers will lose their jobs if Cerro Verde II does not come onstream.

Because of a significant increase in ore production from the Cobriza Mine, CENTROMIN PERÚ reduced its production from purchased copper concentrate at the La Oroya metallurgical complex from 45% of output in 1981 to about 28% in 1982. The Monterrosas copper mine near Ica was brought into production in March and reportedly produced 8,907 tons of concentrate in 1982 containing more than 31% copper. CENTROMIN PERÚ deferred its planned copper modernization project at La Oroya as well as its search for partners to develop the 354 million tons of Toromocho copper ore reserves.

In 1982, Empresa Estatal Minera Asociada Tintaya S.A., 90% jointly owned by MINERO PERÚ and CENTROMIN PERÚ and 10% held by the state, obtained the $215 million loan necessary to proceed with development of the 8,000-ton-per-day Tintaya copper project. Production of 160,000 tons per year of copper concentrate from 2% copper sulfide ore was scheduled to begin in September 1984.

Philippines.—Production cuts made during the year by Atlas Consolidated Mining Development Corp., the country's largest and highest cost producer, and closure of several smaller mines in the early part of the year were responsible for the decline in Philippine copper production in 1982. Atlas accounted for about 46% of primary copper production, with nine other companies accounting for the rest.

The financial difficulties of the copper industry in 1981, which resulted in the closure of several mines and the reported layoff of over 3,000 copper mine workers, worsened in 1982 as the price of copper continued to decline. To assist the industry, the Philippine Government established a copper stabilization fund of approximately $25 million. As the situation deteriorated in July, to where it seemed likely that all Philippine copper mines would shut down operations, the President of the Philippines ordered the state-owned National Development Co. (NDC) to offer to purchase copper concentrates for shipment overseas at the guaranteed price of 75 cents per pound of contained copper. Under the agreement, which was accepted by most of the Philippine copper producers, NDC would take the difference between the guaranteed and selling price as profit if the price of copper exceeded 75 cents per pound. At yearend, the Government reportedly had appealed to Japan for a $120 million loan to help finance the copper subsidy program.

Construction of the $390 million Philippine Associated Smelting and Refining Corp. (Pasar) smelter on Leyte Island was reported nearing completion and was scheduled to go onstream in April 1983. The Philippine Government, through NDC, reportedly had increased its interest in the Pasar smelter to over 60%, by takeover of the capital stock assigned to three mining companies that suspended copper production. A Japanese consortium of three trading companies was a major partner in the project and was scheduled to receive 75% of the smelter output.

Poland.—Production of copper was principally from the Lubin, Polkowice, and Rudna Mines, which are in the sedimentary Kupferschiefer beds and are located in the

Legnica-Glogów region of southwest Poland. The increase in 1982 production was attributed to the return to work on Saturdays and to increased production from the Sieroszowice underground mine, which opened in 1977 and was scheduled to become the country's largest copper mine. When completely developed, the mine was projected to have a capacity of 12 to 15 million tons of ore per year with an average grade of about 1.5% copper. Mine development was hindered by thick layers of sand and water, which reportedly had to be frozen in order to reach depths of between 1,800 and 2,400 feet. About one-half of Poland's electrolytic copper refinery output was exported, 92% having gone to market economy countries, of which the Federal Republic of Germany was the largest recipient.

South Africa, Republic of.—Record copper sales were achieved for 1982 by the Palabora Mining Co. Ltd., in which Newmont Mining owned 28.6% and the major shareholder, Rio Tinto Zinc Corp. Ltd., owned 38.9%. Sales amounted to 122,345 tons, about 7,700 tons higher than any previous single year. Production was 4,610 tons lower than in 1981 because the smelter, refinery, and continuous rod casting plant were shut down in March 1982 for maintenance and modifications. Mining and milling activities continued during the shutdown and a large stockpile of copper concentrates was built up. Operating under stringent cost controls, the company reported the unit cost of production increased by only 3.8% during the year, compared to a rise in the South African consumer price index of 14.8%. A significant cost-saving factor was the successful use of overhead electrical trolley assistance for the open pit haul trucks during the year, saving diesel fuel and replacing it with cheaper electric power.

Borrowing for maintaining operations and for development of the Carolusberg Deep Ore Project had caused an O'okiep Copper Co. Ltd. debt buildup to what the company termed an unacceptably high level. Accordingly, O'okiep Copper announced plans to proceed with an equity rights issue in early 1983, to be underwritten by Gold Fields of South Africa Ltd. Under the terms, Newmont Mining would reduce its ownership in O'okiep Copper to 49% from the current 57.5%. AMAX also owned 14.4% of the company.

Development at O'okiep Copper's New Klein Nigramoep Prospect continued to show promise with four high-grade borehole intersections assaying from 6.25% to 7.93% copper. The prospect was 20 kilometers west of Nababeep. O'okiep Copper processed 1,669,000 tons of copper ore in 1982 compared with 1,714,000 tons in 1981; the company had a net loss for both years.

Zaire.—Copper was produced by the Government-owned La Générale des Carrières et des Mines du Zaire (Gécamines) and by a joint Government-private Japanese company, Société de Développement Industriel et Minière du Zaire. Gécamines produced most of Zaire's copper from its 10 mines and accounted for nearly two-thirds of the country's export earnings. In January, the Zairean Government signed an agreement with EEC that was to enable it to obtain a $38 million loan through the European Development Fund under the EEC program for assisting mineral-producing countries. The agreement stipulated that the foreign earnings from copper and cobalt sales be used exclusively for investment in mineral production. The 40-year loan reportedly was to be used for the purchase of new transport equipment, cranes, compressors, and excavators.

Gécamines' new flash smelter and expansion project, which was started in the mid-1970's and later postponed, was not scheduled to resume until at least 1983. The Société Minière de Tenke-Fungurume project, which was halted in 1975-76, with a planned capacity of 130,000 tons per year of electrowon cathode, was re-evaluated in 1981 by Compagnie Générale des Matieres Nucleaires (Cogema), a French Government agency that acquired the 26.5% holding that originally belonged to Amoco Minerals of the United States. Construction was scheduled to begin in late 1982 at the earliest.

Zambia.—In March 1982, the two state-controlled companies, Nchanga Consolidated Copper Mines Ltd. (NCCM) and Roan Consolidated Mines Ltd. (RCM), each of which operated five mines and accounted for two-thirds and one-third, respectively, of Zambian copper production, merged to form the 60% state-owned Zambia Consolidated Copper Mines Ltd. (ZCCM). The merger was designed to slow rising production costs and trim capital expenditure in an ailing copper industry that provides about 95% of Zambia's exports earnings. The decline in copper production was attributed partly to falling reserve grades and partly to the lack of capital investment that had resulted in poor equipment availability and shortage of spare parts.

In May 1981, Zambia and the International Monetary Fund (IMF) agreed on a 3-year, $850 million stabilization program. However, in July 1982, after less than one-half of the funds had been withdrawn, the loan agreement was suspended when Zambia failed to meet certain conditions, reported to include devaluation of the country's currency (kwacha) and closure of some unprofitable mines. At yearend, negotiations with the IMF had been reopened.

It was announced in June that funding arrangements had been completed and contracts awarded for construction of the third stage of the tailings leach plant at the NCCM Chingola Div. The 40,000-ton-per-year plant was scheduled to begin operations in the fourth quarter of 1984 and was expected to produce 524,000 tons of copper over a 15-year period. The project was to recover copper from existing tailings, utilizing leaching, solvent extraction, and electrowinning techniques at a lower cost than copper produced from underground mining. The project had been postponed earlier owing to insufficient sulfuric acid production from NCCM's Rokana Div., Zambia's sole producer. A fourth acid plant at the Rokana smelter was scheduled for completion in 1982.

TECHNOLOGY

Various aspects of metallurgical processes and mining improvements for the copper industry were the subjects of recent research reports, as were some innovative research on the use of copper in medicine and other areas of the economy. Increased copper use in copper-nickel cladding of steel hulls on ships, in solar energy systems, in aquaculture as shellfish trays and fish cages, and in biochemicals for water purification, swine-food additives, cancer research, and for certain types of arthritic diseases were subjects of research funded by the International Copper Research Association Inc.[25] Copper-nickel alloys were particularly well suited to marine environments because of copper's resistance to biofouling. Copper cladding had been used on sailing vessels, but gradually had been discontinued as the steel hull was adapted for the faster steampowered ships. Steel hulls, however, were subject to biofouling; the attached marine life can increase fuel costs as much as 20% or more. With recent increases in fuel costs, copper's superior properties were leading naval engineers to seriously reconsider this metal for cladding ship hulls and offshore structures such as oil rigs.

In the area of mining improvements, Duval announced details of an innovative in-pit ore crushing system that was designed to lower the company's operating costs. This heavy equipment was described as weighing about 2,000 tons, but was so designed that its three units can be moved in the same pit a distance of up to one-half mile and be ready to run at the new location within a 48-hour period.[26]

Applications of computers to mining were cutting costs and improving efficiency. Computers were being used by some mining companies in three areas: mine planning, mine maintenance, and smelter management. The computers used ranged from minicomputers to large mainframe systems located at a central headquarter.[27]

Conferences and papers written on the subject of seabed mining and minerals continued during 1982. Nodule-gathering technology was considered closer to dredging than to mining. Recovering polymetallic nodules from the sea floor in 5-kilometer-deep waters was compared to harvesting wheat from a height of 5 kilometers above the ground covered by thick clouds. The nodules were considered potentially economic to extract if they occur at an average of 10 "wet" kilograms per square meter. Thus, the world's total area potentially worth the effort of mining is about 33 million square kilometers.[28] The National Oceanic and Atmospheric Administration proposed a research program to determine the potential of the west coast sulfide deposits associated with sea-floor spreading centers. The program would begin in fiscal 1983 and last for 5 years. Although these deposits were receiving the most current attention, others such as the famous Red Sea deposits were also being studied. A pilot mining program to recover copper, silver, and zinc from these deposits was completed in 1981 by a group of West German companies.[29]

Research on the improvements of anodes for use with fluidized bed cathodes for electrowinning was the subject of a Bureau of Mines report published in 1982.[30] The state of nonferrous extractive copper metallurgy was reviewed in two journal articles.[31]

[1]Physical scientist, Division of Nonferrous Metals.
[2]In this chapter, ton means metric ton.
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[4]American Bureau of Metal Statistics Inc. Refined Copper Inventories at End of Period In and Outside the United States. Report No. 001, May 20, 1983, p. 2.
[5]American Metal Market. NARI Wins Court Fight To Cut Conrail Rates. V. 91, No. 68, Apr. 7, 1983, p. 3.
[6]Metals Week. AMAX and ARCO Agree on Sale of Anamax, Asking Price Could be $350 Million. Nov. 1, 1982, p. 6.
[7]The Montana Standard (Butte, Mont.). Company Tells Costs, Asks Flexibility. Jan. 12, 1982, p. 6.
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[12]American Metal Market. $98 M. Outlay Set by PD on Projects. V. 91, No. 85, May 3, 1983, p. 7.
[13]Phelps Dodge Corp. 1982 Annual Report. 36 pp.
[14]Work cited in footnote 8.
[15]Page 48 of work cited in footnote 3.
[16]Work cited in footnote 13.
[17]Work cited in footnote 14.
[18]Page 16 of work cited in footnote 9.
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[27]The Arizona Republic. Computerized Mining Cuts Costs, Boosts Efficiency. Aug. 24, 1982, p. A14.
[28]Mining Magazine (London). Of Depths and Diplomats—Technical and Legal Aspects of Sea Bed Mining. September 1982, p. 228.
[29]Chemical and Engineering News. Sulfide Ores May Ease Minerals Shortage. V. 60, No. 1, Jan. 4, 1982, p. 21.
[30]Evans, J. W., M. Dubrovsky, and D. Ziegler. Improvement of the Performance of Copper Electrowinning in Fluidized Bed Cells. BuMines OFR 36-83, Sept. 30, 1982, 11 pp.
[31]Journal of Metals. The State of Nonferrous Extractive Metallurgy. No. 3, October 1982, pp. 35-42.
———. Copper Production and Extractive Metallurgy in 1982. V. 35, No. 4, April 1983, pp. 68-71.

Table 4.—Copper produced from domestic ores in the United States

(Thousand metric tons)

Year	Mine	Smelter	Refinery
1978	1,358	1,270	1,327
1979	1,444	1,313	1,412
1980	1,181	994	1,122
1981	1,538	1,295	1,430
1982	1,140	941	1,065

Table 5.—Percentage of copper ore and recoverable copper extracted from open pit and underground mines in the United States

Year	Open pit		Underground	
	Ore	Copper[1]	Ore	Copper[2]
1978	90	85	10	15
1979	89	84	11	16
1980	91	86	9	14
1981	89	84	11	16
1982	88	82	12	18

[1]Includes copper from dump leaching.
[2]Includes copper from in-place leaching.

Table 6.—Mine production of recoverable copper in the United States, by month

(Metric tons)

Month	1981	1982
January	123,244	112,419
February	117,620	107,435
March	127,559	119,799
April	127,251	111,934
May	130,953	96,997
June	127,188	90,028
July	123,726	84,629
August	136,221	81,047
September	134,731	78,077
October	140,771	86,508
November	134,944	89,702
December	113,952	80,988
Total	1,538,160	1,139,563

Table 7.—Mine production of recoverable copper in the United States, by State

(Metric tons)

State	1978	1979	1980	1981	1982
Alaska	--	--	--	--	W
Arizona	891,404	946,002	770,118	1,040,813	769,974
California	W	W	W	W	W
Colorado	1,191	362	461	W	575
Idaho	3,888	3,618	3,103	4,245	3,074
Michigan	W	W	W	W	W
Missouri	10,819	13,021	13,576	8,411	7,941
Montana	67,326	69,854	37,749	62,485	57,086
Nevada	20,453	W	W	W	W
New Mexico	127,828	164,281	149,394	154,114	W
Oregon	W	2	--	W	--
South Carolina	--	--	--	W	--
Tennessee	11,289	W	W	W	W
Utah	186,330	193,082	157,775	211,276	189,090
Washington	W	W	--	W	W
Total	1,357,586	1,443,556	1,181,116	1,538,160	1,139,563

W Withheld to avoid disclosing company proprietary data; included in "Total."

Table 8.—Twenty-five leading copper-producing mines in the United States in 1982, in order of output

Rank	Mine	County and State	Operator	Source of copper
1	Bingham Canyon	Salt Lake, Utah	Kennecott Minerals Co	Copper ore and copper precipitates.
2	Twin Buttes	Pima, Ariz	Anamax Mining Co	Copper ore.
3	Morenci	Greenlee, Ariz	Phelps Dodge Corp	Copper ore and copper precipitates.
4	San Manuel	Pinal, Ariz	Magma Copper Co	Copper ore and copper tailings (slag).
5	Bagdad	Yavapai, Ariz	Cyprus Bagdad Copper Co	Copper ore.
6	Inspiration	Gila, Ariz	Inspiration Consolidated Copper Co.	Do.
7	Chino	Grant, N. Mex	Chino Mines Co	Copper ore and copper precipitates.
8	Berkeley	Silver Bow, Mont	Anaconda Copper Co	Do.
9	Sierrita	Pima, Ariz	Duval Corp	Copper ore.
10	Pinto Valley	Gila, Ariz	Cities Service Co	Do.
11	Ray	Pinal, Ariz	Kennecott Minerals Co	Copper ore and copper precipitates.
12	Eisenhower	Pima, Ariz	Eisenhower Mining Co	Copper ore.
13	Mission	do	ASARCO Incorporated	Do.
14	Magma	Pinal, Ariz	Magma Copper Co	Do.
15	Tyrone	Grant, N. Mex	Phelps Dodge Corp	Do.
16	White Pine	Ontonagon, Mich	Copper Range Co	Do.
17	Lakeshore	Pinal, Ariz	Noranda Lakeshore Mines Inc	Do.
18	Pima	Pima, Ariz	Cyprus Pima Mining Co	Do.
19	Sacaton	Pinal, Ariz	ASARCO Incorporated	Do.
20	San Xavier	Pima, Ariz	do	Do.
21	New Cornelia	do	Phelps Dodge Corp	Copper ore and copper precipitates.
22	Troy	Lincoln, Mont	ASARCO Incorporated	Silver ore.
23	Copperhill (2 mines).	Polk, Tenn	Tennessee Chemical Co. and Cities Service Co.	Copper-zinc ore.
24	Esperanza	Pima, Ariz	Duval Corp	Copper precipitates.
25	Silver Bell	do	ASARCO Incorporated	Copper ore and copper precipitates.

Table 9.—Mine production of recoverable copper in the United States, by source

Source	Ore treated (thousand metric tons)	Recoverable copper		Remarks
		Metric tons	Percent yield	
1981				
Mined copper ore:				
By concentration or leaching	r 1277,516	1,407,399	0.51	
By direct smelting	158	223	.14	
Total or average	r277,674	1,407,622	.51	
Tailings, dump, in-place material by leaching	--	113,991	--	
Miscellaneous from cleanup, tailings, noncopper ores	--	16,547	--	
Grand total	XX	1,538,160	XX	
1982				
Mined copper ore:				
By concentration or leaching	2182,289	1,007,454	.55	See table 11.
By direct smelting	118	167	.14	See table 12.
Total or average	182,407	1,007,621	.55	
Tailings, dump, in-place material by leaching	--	104,791	--	See table 13.
Miscellaneous from cleanup, tailings, noncopper ores	--	27,151	--	
Grand total	XX	1,139,563	XX	

rRevised. XX Not applicable.
1Includes 14,166,863 tons (revised) of ore leached for electrowinning.
2Includes 7,752,186 tons of ore leached for electrowinning.

Table 10.—Copper ore shipped directly to smelters or concentrated in the United States in 1982, by State, with copper, gold, and silver content in terms of recoverable metal

State	Ore shipped or concentrated (thousand metric tons)	Recoverable metal content				Value of gold and silver per metric ton of ore
		Copper		Gold (troy ounces)	Silver (troy ounces)	
		Metric tons	Percent			
Arizona	115,415	588,566	0.51	W	6,058,403	W
Michigan	W	W	W	--	W	W
Montana	12,847	43,087	.34	W	739,338	W
New Mexico	W	W	W	W	W	W
Tennessee[1]	W	W	W	--	W	W
Utah	33,455	169,877	.51	W	W	W
Total or average	174,655	883,320	.51	233,093	9,511,564	$0.93

W Withheld to avoid disclosing company proprietary data; included in "Total or average."
1Copper produced in Tennessee is from copper-zinc ore.

Table 11.—Copper ore concentrated[1] in the United States in 1982, by State, with content in terms of recoverable copper

State	Ore concentrated (thousand metric tons)	Recoverable copper content	
		Metric tons	Percent
Arizona	115,327	588,411	0.51
Michigan	W	W	W
Montana	12,847	43,087	.34
New Mexico	W	W	W
Tennessee[2]	W	W	W
Utah	33,455	169,877	.51
Total or average	174,537	883,153	.51

W Withheld to avoid disclosing company proprietary data; included in "Total or average."
[1]Includes the following methods of concentration: dual process (leaching followed by concentration), leach-precipitation-flotation (LPF), and froth flotation.
[2]Copper produced in Tennessee is from copper-zinc ore.

Table 12.—Copper ore[1] shipped directly to smelters in the United States in 1982, by State, with content in terms of recoverable copper

State	Ore shipped to smelters		
	Metric tons	Recoverable copper content	
		Metric tons	Percent
Arizona	88,259	155	0.18
New Mexico	29,467	12	.04
Total or average	117,726	167	.14

[1]Primarily smelter fluxing material.

Table 13.—Copper precipitates[1] (leached from dump and in-place material or tailings) shipped directly to smelters in the United States in 1982, by State

(Metric tons)

State	Precipitates shipped	Recoverable copper content
Arizona	86,420	60,589
California	W	W
Montana	7,677	5,057
Nevada	W	W
New Mexico	W	W
Utah	25,864	18,703
Total	147,701	104,791

W Withheld to avoid disclosing company proprietary data; included in "Total."
[1]In terms of recoverable copper.

Table 14.—Copper ore shipped to smelters and ore concentrated and leached in the United States and average yield

Year	Direct smelted ore		Concentrated and leached ore		Total				
	Thousand metric tons	Yield in copper (percent)	Thousand metric tons[1]	Yield in copper (percent)	Thousand metric tons[1]	Yield in copper (percent)	Yield per metric ton in gold (ounce)	Yield per metric ton in silver (ounce)	Value per metric ton in gold and silver
1978	258	0.22	238,989	0.51	239,247	0.51	0.0016	0.056	$0.62
1979	199	.30	264,591	.49	264,790	.49	.0016	.057	1.12
1980	111	.38	221,486	.48	221,597	.48	.0013	.053	1.90
1981	158	.14	277,516	.51	277,674	.51	.0013	.053	1.18
1982	118	.14	182,289	.55	182,407	.55	.0013	.054	.93

[1]Includes some ore classed as copper-zinc and a minor amount of tailings.

Table 15.—Copper produced by primary smelters in the United States

(Metric tons)

Year	Domestic	Foreign	Secondary	Total
1978	1,269,981	18,397	54,216	1,342,594
1979	1,313,224	22,383	60,231	1,395,838
1980	994,479	13,918	44,876	1,053,273
1981	1,294,962	21,794	60,882	1,377,638
1982	940,547	35,148	45,105	1,020,800

Table 16.—Primary and secondary copper produced by primary refineries and electrowinning plants in the United States

(Metric tons)

	1978	1979	1980	1981	1982
PRIMARY					
From domestic ores, etc.:[1]					
Electrolytic	1,124,585	1,207,626	924,190	1,206,404	891,615
Electrowon	98,416	98,801	113,238	149,245	132,141
Fire-refined	104,372	105,091	84,469	74,561	41,060
Total	1,327,373	1,411,518	1,121,897	1,430,210	1,064,816
From foreign ores, etc.:[1]					
Electrolytic[2]	121,684	103,858	88,957	113,807	162,245
Electrowon	W	W	W	W	W
Fire-refined	W	W	W	--	--
Total primary	1,449,057	1,515,376	1,210,854	1,544,017	1,227,061
SECONDARY					
Electrolytic[2]	293,437	298,344	315,062	303,338	268,952
Electrowon	W	W	W	W	W
Fire-refined	W	W	W	W	W
Total secondary	293,437	298,344	315,062	303,338	268,952
Grand total	1,742,494	1,813,720	1,525,916	1,847,355	1,496,013

W Withheld to avoid disclosing company proprietary data; included with "Electrolytic."
[1]The separation of refined copper into metal of domestic and foreign origin is only approximate, because accurate separation is not possible at this stage of processing.
[2]Includes electrowon and fire-refined quantities indicated by symbol W.

Table 17.—Copper cast in forms at primary refineries in the United States

	1981		1982	
	Thousand metric tons	Percent	Thousand metric tons	Percent
Billets	108	6	98	7
Cakes	84	5	37	2
Cathodes	1,128	61	1,170	78
Ingots and ingot bars	62	3	31	2
Wirebars	424	23	149	10
Other forms	41	2	11	1
Total	1,847	100	1,496	100

Table 18.—Production, shipments, and stocks of copper sulfate in the United States

(Metric tons)

Year	Production		Shipments[1]	Stocks, Dec. 31
	Quantity	Copper content		
1978	31,881	8,551	31,208	7,658
1979	35,005	9,286	33,802	8,861
1980	31,010	8,445	34,135	5,736
1981	35,636	9,413	36,103	5,269
1982	32,227	8,385	33,355	4,142

[1]Includes consumption by producing companies.

Table 19.—Byproduct sulfuric acid[1] (100% basis) produced in the United States

(Metric tons)

Year	Copper plants[2]	Lead plants	Zinc plants[3]	Total
1978	2,484,111	202,935	686,275	3,373,321
1979	2,513,035	282,704	773,836	3,569,575
1980	2,097,692	[4]410,266	560,784	3,068,742
1981	2,593,762	[4]405,974	545,890	3,545,626
1982	1,879,983	[4]310,606	341,728	2,532,317

[1]Includes acid from foreign materials.
[2]Excludes acid made from pyrite concentrates.
[3]Excludes acid made from native sulfur.
[4]Includes acid processed at molybdenum plants to avoid disclosing company proprietary data.

Table 20.—Secondary copper produced in the United States

(Metric tons unless otherwise specified)

	1978	1979	1980	1981	1982
Copper recovered as unalloyed copper	437,120	516,271	534,556	514,518	481,565
Copper recovered in alloys[1]	810,115	1,036,254	902,871	903,594	705,901
Total secondary copper[1]	1,247,235	1,552,525	1,437,427	1,418,112	1,187,466
Source:					
New scrap	745,585	948,224	823,969	819,990	669,740
Old scrap	501,650	604,301	613,458	598,122	517,726
Percentage equivalent of domestic mine output	92	108	122	92	104

[1]Includes copper in chemicals, as follows: 1978—2,911; 1979—3,004; 1980—2,869; 1981—3,227 (revised); and 1982—1,823.

Table 21.—Copper recovered from scrap processed in the United States, by kind of scrap and form of recovery

(Metric tons)

	1981	1982
KIND OF SCRAP		
New scrap:		
Copper-base	797,513	649,406
Aluminum-base	22,281	20,192
Nickel-base	162	122
Zinc-base	34	20
Total	819,990	669,740
Old scrap:		
Copper-base	582,814	501,576
Aluminum-base	15,043	16,047
Nickel-base	123	76
Tin-base	--	--
Zinc-base	142	27
Total	598,122	517,726
Grand total	1,418,112	1,187,466
FORM OF RECOVERY		
As unalloyed copper:		
At primary plants	314,053	268,952
At other plants	200,465	212,613
Total	514,518	481,565
In brass and bronze	850,546	660,152
In alloy iron and steel	1,876	1,492
In aluminum alloys	47,728	41,930
In other alloys	217	77
In chemical compounds	3,227	2,250
Total	903,594	705,901
Grand total	1,418,112	1,187,466

Table 22.—Copper recovered as refined copper and in alloys and other forms from copper-base scrap processed in the United States, by type of operation

(Metric tons)

Type of operation	From new scrap		From old scrap		Total	
	1981	1982	1981	1982	1981	1982
Secondary smelters	220,407	186,827	273,693	237,366	494,100	424,193
Primary copper producers	75,049	74,055	239,004	194,897	314,053	268,952
Brass mills	475,883	375,289	31,503	31,271	507,386	406,560
Foundries and manufacturers	23,809	12,118	37,760	37,357	61,569	49,475
Chemical plants	2,365	1,117	854	685	3,219	1,802
Total	797,513	649,406	582,814	501,576	1,380,327	1,150,982

Table 23.—Production of secondary copper and copper-alloy products in the United States, by item produced from scrap

(Metric tons)

Item produced from scrap	1981	1982
UNALLOYED COPPER PRODUCTS		
Refined copper by primary producers	314,053	268,952
Refined copper by secondary smelters	179,499	198,597
Copper powder	13,594	9,686
Copper castings	7,372	4,330
Total	514,518	481,565
ALLOYED COPPER PRODUCTS		
Brass and bronze ingots:		
Tin bronzes	22,064	18,220
Leaded red brass and semired brass	123,286	102,654
High-leaded tin bronze	19,416	11,210
Yellow brass	9,860	6,528
Manganese bronze	9,436	6,959
Aluminum bronze	9,486	5,593
Nickel silver	2,909	2,646
Silicon bronze and brass	4,009	3,330
Copper-base hardeners and master alloys	16,737	12,620
Total	217,203	169,760
Brass-mill products	623,940	500,573
Brass and bronze castings	39,929	34,646
Brass powder	1,102	933
Copper in chemical products	3,227	2,250
Grand total	1,399,919	1,189,727

Table 24.—Composition of secondary copper-alloy production in the United States

(Metric tons)

	Copper	Tin	Lead	Zinc	Nickel	Aluminum	Total
Brass and bronze production:[1]							
1981	193,291	4,280	8,124	11,094	370	44	217,203
1982	144,808	3,969	7,659	12,920	349	55	169,760
Secondary metal content of brass-mill products:							
1981	507,386	302	2,848	110,983	2,392	29	623,940
1982	406,560	387	2,148	89,703	1,769	6	500,573
Secondary metal content of brass and bronze castings:							
1981	32,487	1,244	2,335	3,640	139	84	39,929
1982	28,885	1,002	1,739	2,944	--	76	34,646

[1]About 95% from scrap and 5% from other than scrap in 1981 and 1982.

Table 25.—Stocks and consumption of purchased copper scrap in the United States in 1982, by class of consumer and type of scrap

(Metric tons, gross weight)

Class of consumer and type of scrap	Stocks, Jan. 1	Receipts	Consumption			Stocks, Dec. 31
			New scrap	Old scrap	Total	
SECONDARY SMELTERS						
No. 1 wire and heavy copper	1,926	27,157	3,753	24,136	27,889	1,194
No. 2 wire, mixed heavy and light copper	21,091	203,542	107,191	109,318	216,509	8,124
Composition or red brass	4,076	41,555	8,171	34,483	42,654	2,977
Railroad-car boxes	236	1,747	--	1,626	1,626	357
Yellow brass	4,023	39,724	9,641	29,993	39,634	4,113
Cartridge cases and brass	44	34	--	51	51	27
Automobile radiators (unsweated)	2,223	56,288	--	55,846	55,846	2,665
Bronze	1,709	13,983	2,193	11,486	13,679	2,013
Nickel silver and cupronickel	684	2,408	290	2,178	2,468	624
Low brass	449	1,263	521	871	1,392	320
Aluminum bronze	119	425	419	67	486	58
Low-grade scrap and residues	12,951	158,764	126,710	35,835	162,545	9,170
Total	49,531	546,890	258,889	305,890	564,779	31,642

Table 25.—Stocks and consumption of purchased copper scrap in the United States in 1982, by class of consumer and type of scrap —Continued

(Metric tons, gross weight)

Class of consumer and type of scrap	Stocks, Jan. 1	Receipts	Consumption			Stocks, Dec. 31
			New scrap	Old scrap	Total	
PRIMARY PRODUCERS						
No. 1 wire and heavy copper	2,678	65,963	23,770	42,989	66,759	1,882
No. 2 wire, mixed heavy and light copper	8,135	164,964	41,555	117,712	159,267	13,832
Refinery brass	31,167 (Refinery brass and low-grade scrap and residues combined)	2,596	132	2,795	2,927	19,380 (Refinery brass and low-grade scrap and residues combined)
Low-grade scrap and residues		141,292	38,514	114,234	152,748	
Total	41,980	374,815	103,971	277,730	381,701	35,094
BRASS MILLS[1]						
No. 1 wire and heavy copper	11,614	160,194	129,929	30,265	160,194	13,849
No. 2 wire, mixed heavy and light copper	2,531	36,670	35,595	1,075	36,670	1,237
Yellow brass	17,788	196,985	196,984	1	196,985	18,416
Cartridge cases and brass	8,841	54,006	54,003	3	54,006	11,292
Bronze	543	4,024	4,024	--	4,024	882
Nickel silver and cupronickel	3,020	15,020	14,721	299	15,020	4,182
Low brass	2,142	41,522	41,522	--	41,522	3,120
Aluminum bronze	4	57	57	--	57	--
Total[1]	46,483	508,478	476,835	31,643	508,478	52,978
FOUNDRIES, CHEMICAL PLANTS, AND OTHER MANUFACTURERS						
No. 1 wire and heavy copper	2,368	24,923	5,941	19,094	25,035	2,256
No. 2 wire, mixed heavy and light copper	794	4,153	2,052	2,506	4,558	389
Composition or red brass	705	12,871	1,698	11,319	13,017	559
Railroad-car boxes	1,080	3,578	--	3,967	3,967	691
Yellow brass	942	7,304	4,321	3,538	7,859	387
Automobile radiators (unsweated)	1,912	2,396	22	3,074	3,096	1,212
Bronze	861	469	288	204	492	838
Nickel silver and cupronickel	12	86	--	76	76	22
Low brass	40	917	722	213	935	22
Aluminum bronze	124	865	534	319	853	136
Low-grade scrap and residues	--	1	--	1	1	--
Total	8,838	57,563	[2]15,578	[2]44,311	59,889	6,512
GRAND TOTAL						
No. 1 wire and heavy copper	18,586	278,237	163,393	116,484	279,877	19,181
No. 2 wire, mixed heavy and light copper	32,551	409,329	186,393	230,611	417,004	23,582
Composition or red brass	4,781	54,426	9,869	45,802	55,671	3,536
Railroad-car boxes	1,316	5,325	--	5,593	5,593	1,048
Yellow brass	22,753	244,013	210,946	33,532	244,478	22,916
Cartridge cases and brass	8,885	54,040	54,003	54	54,057	11,319
Automobile radiators (unsweated)	4,135	58,684	22	58,920	58,942	3,877
Bronze	3,113	18,476	6,505	11,690	18,195	3,733
Nickel silver and cupronickel	3,716	17,514	15,011	2,553	17,564	4,828
Low brass	2,631	43,702	42,765	1,084	43,849	3,462
Aluminum bronze	247	1,347	1,010	386	1,396	194
Low-grade scrap and residues[3]	44,118	302,653	165,356	152,865	318,221	28,550
Total	146,832	1,487,746	855,273	659,574	1,514,847	126,226

[1]Brass-mill stocks include home scrap; purchased scrap consumption is assumed equal to receipts, so lines in brass-mill and grand total sections do not balance.
[2]Of the totals shown, chemical plants reported 1,183 tons of new unalloyed copper scrap and 714 tons of old unalloyed copper scrap.
[3]Includes refinery brass.

Table 26.—Consumption of copper and brass materials in the United States, by item

(Metric tons)

Item	Primary producers	Brass mills	Wire rod mills	Foundries, chemical plants, miscellaneous users	Secondary smelters	Total
1981:						
Copper scrap	456,785	633,879	--	76,413	658,490	1,825,567
Refined copper[1]	--	536,210	1,449,583	33,931	5,445	2,025,169
Brass ingot	--	17,824	--	[2]199,460	--	217,284
Slab zinc	--	104,330	--	2,948	5,708	112,986
Miscellaneous	--	--	--	([3])	5,915	[r]5,915
1982:						
Copper scrap	381,701	508,478	--	59,889	564,779	1,514,847
Refined copper[1]	--	393,205	1,232,841	27,732	4,364	1,658,142
Brass ingot	--	12,727	--	[2]161,230	--	173,957
Slab zinc	--	74,483	--	2,623	4,032	81,138
Miscellaneous	--	--	--	--	4,105	4,105

[r]Revised.
[1]Detailed information on consumption of refined copper can be found in table 30.
[2]Shipments to foundries by smelters and changes in stocks at foundries.
[3]Revised to zero.

Table 27.—Foundry consumption of brass ingot in the United States, by type

(Metric tons)

Type	1978	1979	1980	1981	1982
Tin bronzes	35,951	35,242	30,327	28,885	24,577
Leaded red brass and semired brass	106,053	107,596	95,138	94,142	75,402
Yellow brass	21,368	21,138	17,780	19,659	12,584
Manganese bronze	7,430	7,724	6,287	6,270	5,220
Hardeners and master alloys	4,398	5,913	5,446	4,411	2,499
Nickel silver	2,330	2,315	2,579	2,030	1,619
Aluminum bronze	7,071	7,267	6,727	6,853	5,038
Total	184,601	187,195	164,284	162,250	126,939

Table 28.—Foundries and miscellaneous manufacturers consumption of brass ingot and refined copper and copper scrap in the United States in 1982, by geographic division and State

(Metric tons)

Geographic division and State	Tin bronzes	Leaded red brass and semi-red brass	Yellow brass	Manganese bronze	Hardeners and master alloys	Nickel silver	Aluminum bronze	Total brass ingot	Refined copper consumed	Copper scrap consumed
New England:										
Connecticut	359	1,093	560	72			170	3,061	98	656
Maine, New Hampshire, Rhode Island, Vermont	223	1,696	84	262	708	354		2,530		
							109		522	25
Massachusetts	280	2,591	517	146				3,633		
Total	862	5,380	1,161	480	708	354	279	9,224	620	681
Middle Atlantic:										
New Jersey	367	654	196	68			150	1,451		
									2,769	3,549
New York	547	6,037	913	119	302	557	106	7,829		
Pennsylvania	5,201	4,895	643	394			1,082	12,951	2,195	4,497
Total	6,115	11,586	1,752	581	302	557	1,338	22,231	4,964	8,046
East North Central:										
Illinois		5,834	1,358	379			780	9,057	101	
										6,727
Indiana	5,073	6,281	585	129	812	120	33	10,979	329	
Michigan		2,711	654	893			257	5,863	5,799	3,417
Ohio		5,983	2,475	933			318	15,598		7,991
	7,252				525	23			3,997	
Wisconsin		4,647	1,464	192			170	8,384		2,935
Total	12,325	25,456	6,536	2,526	1,337	143	1,558	49,881	10,226	21,070
West North Central:										
Iowa, Kansas, Minnesota	134	2,924	210	476			122	3,897		
					53	5			2,462	11,894
Missouri, Nebraska, South Dakota	68	1,043	705	110			64	2,017		
Total	202	3,967	915	586	53	5	186	5,914	2,462	11,894

Table 28.—Foundries and miscellaneous manufacturers consumption of brass ingot and refined copper and copper scrap in the United States in 1982, by geographic division and State —Continued

(Metric tons)

Geographic division and State	Tin bronzes	Leaded red brass and semi-red brass	Yellow brass	Man-ganese bronze	Hardeners and master alloys	Nickel silver	Alumi-num bronze	Total brass ingot	Refined copper con-sumed	Copper scrap con-sumed
South Atlantic:										
Delaware, District of Columbia, Florida, Georgia, Maryland	282	304	304	44	1	414	25	1,119	1,796	2,889
North Carolina, South Carolina, Virginia, West Virginia	127	7,201		57			359	7,999		
Total	409	7,505	304	101	1	414	384	9,118	1,796	2,889
East South Central:										
Alabama, Kentucky, Mississippi, Tennessee	1,040	7,985	268	256			1,043	9,760		4,790
West South Central:										
Arkansas, Louisiana, Oklahoma, Texas	1,886	7,316	375	142	84	123		10,749	6,736	1,205
Mountain:										
Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah	334	355	195	38			18	949		213
Pacific:										
California	1,304	5,769	1,078	510	14	23	232	8,717	615	6,884
Oregon and Washington	100	83						396		542
Total	1,404	5,852	1,078	510	14	23	232	9,113	615	7,426
Grand total	24,577	75,402	12,584	5,220	2,499	1,619	5,038	126,939	27,419	58,214

Table 29.—Primary refined copper supply and withdrawals on domestic account in the United States

(Metric tons)

	1978	1979	1980	1981	1982
Production from domestic and foreign ores, etc	1,449,057	1,515,376	1,210,854	1,544,017	1,227,061
Imports for consumption[1]	402,673	203,855	426,948	330,625	258,439
Stocks, Jan. 1[1]	212,000	153,000	64,000	49,000	151,000
Total available supply	2,063,730	1,872,231	1,701,802	1,923,642	1,636,500
Copper exports[1]	91,923	73,677	14,489	24,397	30,558
Stocks, Dec. 31[1]	153,000	64,000	49,000	151,000	268,000
Total	244,923	137,677	63,489	175,397	298,558
Apparent withdrawals on domestic account	1,819,000	1,735,000	1,638,000	1,748,000	1,338,000

[1]May include some copper refined from scrap.

Table 30.—Refined copper consumed in the United States, by class of consumer

(Metric tons)

Class of consumer	Cathodes	Wirebars	Ingots and ingot bars	Cakes and slabs	Billets	Other	Total
1981:							
Wire rod mills	950,402	467,654	W	W	--	31,527	1,449,583
Brass mills	236,681	21,546	54,127	121,844	101,862	150	536,210
Chemical plants	--	--	--	--	--	398	398
Secondary smelters	1,356	--	3,515	--	--	574	5,445
Foundries	3,247	W	5,802	--	W	2,290	11,339
Miscellaneous[1]	7,176	W	3,243	W	W	11,775	22,194
Total	1,198,862	489,200	66,687	121,844	101,862	46,714	2,025,169
1982:							
Wire rod mills	1,028,024	183,876	W	W	--	20,941	1,232,841
Brass mills	172,088	11,231	35,203	92,430	82,152	101	393,205
Chemical plants	--	--	--	--	--	361	361
Secondary smelters	897	--	3,335	--	--	132	4,364
Foundries	1,440	W	3,865	--	W	2,340	7,645
Miscellaneous[1]	8,527	W	2,686	W	W	8,513	19,726
Total	1,210,976	195,107	45,089	92,430	82,152	32,388	1,658,142

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes iron and steel plants, primary smelters producing alloys other than copper, consumers of copper powder and copper shot, and other manufacturers.

Table 31.—Stocks of copper in the United States, December 31

(Metric tons)

Year	Blister and materials in process of refining[1]	Refined copper				
		Primary producers	Wire rod mills	Brass mills	Other[2]	New York Commodity Exchange
1978	263,000	153,000	63,000	28,000	7,000	163,000
1979	275,000	64,000	44,000	25,000	9,000	90,000
1980	272,000	49,000	50,000	22,000	10,000	163,000
1981	277,000	151,000	109,000	26,000	9,000	170,000
1982	233,000	268,000	125,000	25,000	9,000	249,000

[1]Includes copper in transit from smelters in the United States to refineries therein.
[2]Includes secondary smelters, chemical plants, foundries, and miscellaneous plants.

Table 32.—Dealers' monthly average buying price for copper scrap and consumers' alloy-ingot prices at New York in 1981,[1] by grade

(Cents per pound)

Grade	Jan.	Feb.	Mar.	Apr.	May	June
No. 2 heavy copper scrap	57.60	55.50	57.14	59.50	58.20	55.32
No. 1 composition scrap (red brass)	60.00	58.50	59.32	60.50	59.85	58.41
No. 115 brass ingot (85-5-5-5)	103.50	103.50	103.50	103.50	103.50	103.50

Grade	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
No. 2 heavy copper scrap	52.68	53.50	53.00	50.16	48.08	46.00	53.89
No. 1 composition scrap (red brass)	56.68	56.93	55.86	54.39	53.29	52.50	57.19
No. 115 brass ingot (85-5-5-5)	102.59	102.50	102.50	99.64	98.29	92.50	101.59

[1]Data not available for 1982.

Source: Metal Statistics, 1982.

Table 33.—Average monthly prices for electrolytic copper in the United States and on the London Metal Exchange

(Cents per pound)

Month	1981				1982			
	Domestic delivered		London spot[1]		Domestic delivered		London spot[1]	
	Cathode	Wirebar	Cathode	Wirebar	Cathode	Wirebar	Cathode	High
January	87.59	88.57	88.05	84.73	77.62	78.63	72.84	73.03
February	85.06	86.07	81.25	81.67	77.62	78.78	72.20	72.36
March	86.19	87.38	81.94	82.44	74.83	75.86	68.27	68.48
April	87.11	88.03	81.90	82.58	75.46	76.27	68.60	69.00
May	84.90	85.80	78.38	79.00	76.83	77.95	68.62	69.27
June	84.43	85.23	76.53	77.09	70.03	71.49	58.32	58.98
July	83.49	84.41	75.85	76.26	70.13	71.05	63.86	65.33
August	86.71	87.39	80.90	81.04	69.93	71.00	63.41	65.81
September	83.95	84.72	77.45	77.55	69.49	71.06	62.39	64.66
October	81.48	82.31	75.29	75.56	70.10	72.41	62.47	66.27
November	80.26	81.22	74.55	74.88	70.01	72.97	62.15	65.47
December	79.31	80.29	74.70	(2)	71.57	74.23	63.74	66.81
Average	84.21	85.12	78.98	[3]79.35	72.80	74.31	65.57	67.14

[1]Based on average monthly rates of exchange.
[2]Wirebar contract replaced by high-grade contract.
[3]Based on January-November monthly averages.

Source: Metals Week.

Table 34.—Average weighted prices of copper delivered

(Cents per pound)

Year	Domestic copper	Foreign copper
1978	66.5	61.9
1979	93.3	90.0
1980	102.4	99.2
1981	85.1	79.0
1982	74.3	67.2

Source: Metals Week.

Table 35.—U.S. exports of copper, by country

Country	Ore and concentrate (copper content)		Ash and residues[1] (copper content)		Refined		Scrap		Blister and precipitates	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
1981	150,782	$207,012	6,284	$7,774	24,397	$43,353	50,078	$70,106	9,227	$16,395
1982:										
Africa	--	--	--	--	--	--	--	--	25	38
Belgium-Luxembourg	--	--	202	2,519	1,045	1,472	2,767	4,785	--	--
Brazil	--	--	--	--	378	592	504	620	1	2
Canada	643	425	791	2,145	2,826	4,031	10,067	10,143	439	1,206
China	--	--	--	--	16,069	21,786	--	--	--	--
France	--	--	--	--	1,100	2,175	56	47	1	2
Germany, Federal Republic of	16,710	16,613	18	275	1,888	2,928	1,395	1,583	1	2
Greece	--	--	--	--	100	135	--	--	--	--
Hong Kong	--	--	--	--	101	180	--	--	16	33
India	--	--	829	989	9	8	5,605	6,010	--	--
Israel	--	--	--	--	6	14	--	--	--	--
Italy	--	--	--	--	105	148	--	--	2	5
Japan	148,249	157,216	102	488	849	1,349	6,721	8,459	6	9
Korea, Republic of	1,558	1,932	--	--	99	181	15,530	19,532	52	51
Mexico	--	--	37	460	1,030	1,692	2,821	3,329	1,411	2,188
Netherlands	--	--	69	78	3,268	6,068	565	632	--	--
Oceania	--	--	--	--	--	--	--	--	9	13
Saudi Arabia	--	--	--	--	5	19	35	50	2	10
Spain	--	--	425	1,197	163	259	3,947	4,329	1	2
Sweden	--	--	--	--	64	118	731	1,119	6	37
Taiwan	--	--	35	24	51	121	1,338	1,011	21	54
Turkey	--	--	--	--	--	--	408	478	--	--
U.S.S.R.	27,516	34,158	--	--	--	--	--	--	--	--
United Kingdom	599	852	366	2,210	1,334	2,342	1,917	1,324	13	21
Venezuela	--	--	--	--	--	--	--	--	--	--
Other	--	--	--	--	68	179	12	33	2	7
Total	195,275	211,196	2,874	10,385	30,558	45,797	54,419	63,484	2,008	3,680

See footnotes at end of table.

Table 35.—U.S. exports of copper, by country—Continued

Country	Pipes and tubing		Plates and sheets		Wire and cable, bare		Wire and cable, insulated		Other copper manufactures[2]	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
1981	10,939	$33,038	2,333	$7,045	7,022	$31,994	82,922	$402,520	18,451	$37,464
1982:										
Africa	125	407	--	--	489	2,919	4,153	16,285	562	1,012
Belgium-Luxembourg	6	15	1	17	11	76	109	2,978	1	1
Brazil	1	2	--	--	74	449	225	1,903	--	--
Canada	1,132	3,149	464	1,265	603	2,966	13,465	52,537	4,650	8,677
China	(3)	4	--	--	1	8	191	1,505	--	--
El Salvador	(3)	1	1	4	6	28	179	644	178	246
France	1	10	10	28	20	350	570	12,442	229	477
Germany, Federal Republic of	3	38	100	131	6	79	541	12,409	43	96
Greece	11	30	--	--	--	--	3,433	15,373	--	--
Haiti	1	2	1	1	163	547	417	1,484	2	6
Hong Kong	8	46	2	9	12	90	273	2,206	--	--
India	--	--	--	--	(3)	2	158	1,746	(3)	2
Israel	98	250	3	10	21	234	337	3,326	10	36
Italy	1	14	(3)	15	2	39	210	3,189	6	29
Japan	58	149	252	1,143	13	177	662	9,672	70	537
Korea, Republic of	69	311	9	37	17	141	1,073	7,738	1	6
Kuwait	350	936	--	--	4	53	36	305	(3)	3
Mexico	374	1,063	280	665	3,565	11,520	13,641	52,665	4,188	7,309
Netherlands	114	392	10,596	16,315	13	169	193	3,688	852	2,582
Oceania	48	239	1	5	33	175	542	4,787	52	262
Saudi Arabia	996	3,012	7	26	797	2,888	8,641	37,487	63	355
Singapore	1	6	3	8	83	523	818	6,879	1	3
Spain	119	353	--	--	5	48	109	1,424	(3)	3
Sweden	(3)	1	--	--	363	463	98	2,368	955	1,512
Taiwan	23	108	31	26	37	368	532	5,008	31	105
Turkey	--	--	--	--	(3)	3	35	422	--	--
U.S.S.R.	--	--	--	--	--	--	46	128	--	--
United Arab Emirates	83	266	--	--	21	141	196	2,516	2	7
United Kingdom	255	870	28	124	51	493	1,861	21,677	128	316
Venezuela	199	1,403	13	91	345	721	1,039	4,947	4,760	7,933
Other	500	1,607	27	116	795	3,707	6,851	38,587	807	1,272
Total	4,576	14,684	11,829	20,036	7,550	29,377	60,634	328,325	17,591	32,787

[1]Includes matte.
[2]Excludes copper wire cloth.
[3]Less than 1/2 unit.

Table 36.—U.S. exports of copper scrap, by country

Country	Unalloyed copper scrap				Copper-alloy scrap			
	1981		1982		1981		1982	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Belgium-Luxembourg	776	$2,031	2,767	$4,785	5,061	$16,354	4,413	$11,428
Brazil	126	203	504	620	405	539	536	507
Canada	9,344	10,592	10,067	10,143	10,302	11,354	11,429	12,713
Finland	34	62	--	--	1,150	2,138	729	1,201
France	201	293	56	47	180	279	427	519
Germany, Federal Republic of	1,298	1,763	1,395	1,583	12,123	7,216	7,297	6,217
Hong Kong	89	113	--	--	291	356	18	23
India	4,257	5,539	5,605	6,010	11,951	13,565	11,105	11,820
Italy	--	--	--	--	154	174	52	59
Japan	7,086	11,278	6,721	8,459	22,631	29,639	18,601	20,121
Korea, Republic of	15,862	22,557	15,530	19,532	5,793	8,411	16,087	18,462
Mexico	5,303	8,375	2,821	3,329	3,697	4,671	1,318	1,530
Netherlands	107	90	565	632	238	296	1,602	2,105
Spain	2,090	2,340	3,947	4,329	4,842	5,572	5,496	7,296
Sweden	105	74	731	1,119	643	3,135	2,068	3,041
Switzerland	--	--	--	--	74	293	405	575
Taiwan	2,038	2,798	1,338	1,011	14,185	14,423	7,021	5,448
Thailand	71	121	--	--	--	--	--	--
Turkey	379	633	408	478	513	605	1,685	3,004
United Kingdom	697	1,081	1,917	1,324	1,402	2,746	1,164	1,671
Other	215	163	47	83	514	783	139	275
Total	50,078	70,106	54,419	63,484	96,149	122,549	91,592	108,015

Table 37.—U.S. imports for consumption[1] of unmanufactured copper (copper content), by country

Country	Ore and concentrate: Quantity (metric tons)	Ore and concentrate: Value (thousands)	Matte: Quantity (metric tons)	Matte: Value (thousands)	Blister: Quantity (metric tons)	Blister: Value (thousands)	Refined: Quantity (metric tons)	Refined: Value (thousands)	Scrap: Quantity (metric tons)	Scrap: Value (thousands)	Total: Quantity (metric tons)	Total: Value (thousands)
1981	39,132	$56,548	2,718	$3,232	30,124	$68,083	330,625	$582,085	27,002	$40,705	429,601	$750,653
1982:												
Australia	3,680	3,727	--	--	--	--	--	--	4	5	3,684	3,732
Belgium-Luxembourg	--	--	--	--	1,041	1,665	1,057	1,615	--	--	2,098	3,280
Canada	23,076	29,171	590	685	1,047	2,564	65,360	105,239	20,941	25,975	111,014	163,634
Chile	1,480	1,386	3,440	2,894	81,327	118,956	145,928	213,549	784	1,021	232,959	337,806
Japan	983	1,915	--	--	--	--	13	19	28	83	1,024	2,017
Korea, Republic of	--	--	--	--	--	--	2,000	3,004	--	--	2,000	3,004
Mexico	52,450	48,913	--	--	4,161	4,985	2,822	4,341	5,029	6,293	64,462	64,532
Norway	--	--	--	--	--	--	2,056	3,163	--	--	2,056	3,163
Peru	8,972	13,990	--	--	9,694	13,764	8,000	12,437	132	210	26,798	40,401
Philippines	27,051	41,465	--	--	--	--	--	--	(2)	1	27,051	41,466
Zaire	--	--	--	--	--	--	19,591	30,520	--	--	19,591	30,520
Zambia	--	--	--	--	--	--	10,457	18,931	--	--	10,457	18,931
Other	363	911	12	30	104	315	1,155	1,836	1,158	1,693	2,792	4,785
Total	118,055	141,478	4,042	3,609	97,374	142,249	258,439	394,654	28,076	35,281	505,986	717,271

[1]Table revised to show imports for consumption rather than general imports.
[2]Less than 1/2 unit.

Table 38.—Copper: World mine production,[1] by country

(Thousand metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Albania[e]	11.5	14.0	15.3	15.5	16.2
Algeria	.2	.2	.2	.2	.2
Argentina	.3	.1	.2	.1	[2].1
Australia	222.1	237.6	243.5	225.9	244.7
Bolivia	2.9	1.8	1.9	2.6	[2]2.3
Botswana[3]	14.6	14.6	15.6	17.8	[2]18.4
Brazil	([4])	5.3	1.4	13.9	16.7
Bulgaria	58.0	58.0	60.0	[e]62.0	63.0
Burma[3]	.1	.1	.1	.2	1.0
Canada[5]	659.4	636.4	716.4	691.3	[2]606.2
Chile[6]	[r]1,034.2	[r]1,062.7	1,067.9	1,081.1	[2]1,240.7
China[e]	200.0	200.0	200.0	200.0	200.0
Colombia	.1	.1	.1	.1	.1
Congo (Brazzaville)	.8	1.0	1.3	.2	.3
Cuba	2.8	2.8	3.3	2.9	[2]2.7
Cyprus[7]	5.8	1.2	--	--	--
Czechoslovakia[e]	4.7	6.2	6.6	5.2	5.2
Ecuador	.8	1.2	[e]1.2	[e]1.2	.8
Finland	46.9	41.1	36.9	38.5	38.5
France	[r].2	[r].1	.1	.1	.1
German Democratic Republic[e]	16.0	15.0	15.0	16.0	16.0
Germany, Federal Republic of[5]	.8	.9	1.3	1.4	1.3
Greece	1.5	([8])	.1	.1	--
Guatemala	2.1	1.8	.8	.7	.7
Honduras	.6	1.4	.3	.5	.5
Hungary[9]	.5	.1	--	--	--
India	[r]26.6	[r]27.7	27.6	25.2	[2]24.0
Indonesia	[r]58.9	60.2	59.0	62.5	73.0
Iran[10]	[r]6.0	[r]3.0	1.0	2.0	[11]23.5
Ireland	4.8	4.9	4.9	3.5	1.6
Israel	--	--	.8	--	3.5
Italy	.5	.5	.6	.8	.8
Japan	72.0	59.1	52.5	51.5	[2]51.0
Korea, North[e]	15.0	15.0	15.0	15.0	15.0
Korea, Republic of	.7	.5	.4	1.1	.5
Malaysia	[r]25.9	[r]24.5	27.0	28.6	30.0
Mauritania	1.8	--	--	--	1.0
Mexico[6]	87.2	107.1	175.4	230.5	[2]239.1
Mongolia[e]	4.0	21.7	47.0	80.0	118.0
Morocco	4.7	7.0	7.2	[e]6.7	18.0
Mozambique[e]	.1	.2	.2	.2	.2
Namibia	37.7	41.9	39.2	46.1	[2]49.8
Nepal	([4])	--	--	([4])	([4])
Nicaragua	[e].1	--	--	--	--
Norway[7]	29.1	[r]28.0	28.9	28.2	[2]27.9
Papua New Guinea	198.6	170.8	146.8	165.4	[2]170.0
Peru[6]	366.4	390.7	366.8	342.1	[2]369.4
Philippines	263.6	298.3	304.5	302.3	280.0
Poland	321.0	325.0	346.1	[e]315.2	338.0
Portugal[6]	3.6	3.6	3.0	2.4	2.5
Romania[5]	27.0	29.0	28.0	[e]27.0	26.0
South Africa, Republic of[6]	205.7	190.6	200.7	208.7	[2]188.7
Spain[12]	33.9	25.6	42.5	50.9	50.0
Sweden	47.6	45.8	42.8	51.1	51.1
Taiwan	.8	.8	1.2	[e]1.0	.4
Turkey[9]	27.3	31.4	26.4	31.9	29.2
U.S.S.R.[e 5]	865.0	885.0	900.0	950.0	1,000.0
United Kingdom	[r].2	([8])	.2	.7	.8
United States[5]	1,357.6	1,443.6	1,181.1	1,538.2	[2]1,139.6
Yugoslavia[9]	123.3	111.4	114.8	110.9	115.0
Zaire	423.8	400.0	459.4	505.0	[2]495.0
Zambia	643.0	588.3	595.8	588.0	530.0
Zimbabwe	33.8	29.7	27.0	24.6	25.0
Total	[r]7,604.2	[r]7,674.6	7,663.3	8,174.8	7,963.3

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Data represent copper content by analysis of concentrates produced except where otherwise noted. Table includes data available through June 1, 1983.
[2]Reported figure.
[3]Copper content of matte produced.
[4]Less than 1/2 unit.
[5]Recoverable content.
[6]Copper content by analysis of concentrates for export plus nonduplicative total of copper content of all metal and metal products produced indigenously from domestic ores and concentrates.
[7]Includes copper content of cupriferous pyrite.
[8]Revised to zero.
[9]Copper content by analysis of ore mined.
[10]Data are for years beginning Mar. 21 of that stated.
[11]Figure reported by World Metal Statistics, apparently based on official Iranian reporting, but may represent gross weight of concentrates produced.
[12]Excludes an unreported quantity of copper in iron pyrites, which may or may not be recovered.

Table 39.—Copper: World smelter production,[1] by country

(Thousand metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Albania, primary[e]	9.5	9.7	9.9	10.0	10.0
Argentina, primary[e]	(2)	(2)	(2)	(2)	(2)
Australia:					
Primary	164.4	163.2	174.9	173.5	[3]175.9
Secondary	2.8	6.2	7.1	5.0	[3]4.5
Total	167.2	169.4	182.0	178.5	[3]180.4
Austria, secondary	[r]19.8	[r]21.8	26.1	27.1	[3]24.0
Belgium:[e]					
Primary	9.0	1.5	.7	.5	.5
Secondary	46.9	47.8	49.3	47.5	47.5
Total	55.9	49.3	50.0	48.0	48.0
Brazil, primary	--	--	--	--	9.6
Bulgaria:[e]					
Primary	61.0	61.0	61.0	61.0	61.0
Secondary	3.0	3.0	3.0	3.0	3.0
Total	64.0	64.0	64.0	64.0	64.0
Canada:					
Primary[e]	410.3	374.5	473.7	450.1	394.3
Secondary[e]	15.0	10.0	19.0	15.0	10.0
Total	425.3	384.5	492.7	465.1	[3]404.3
Chile, primary	927.4	946.9	953.1	953.9	[3]1,046.8
China, primary[e]	[r]210.0	[r]210.0	[r]210.0	[r]210.0	210.0
Czechoslovakia:[e]					
Primary	6.7	8.2	7.6	7.4	7.4
Secondary	3.3	1.8	2.4	2.4	2.4
Total	10.0	10.0	10.0	9.8	9.8
Finland:					
Primary	53.7	55.3	[e]49.2	[e]54.7	53.5
Secondary	10.0	9.9	[e]10.0	[e]13.0	12.7
Total	63.7	65.2	59.2	67.7	[3]66.2
France, secondary	3.2	5.0	7.3	6.5	7.0
German Democratic Republic, primary	17.0	19.0	18.0	18.0	18.0
Germany, Federal Republic of:					
Primary	165.8	158.2	153.9	163.1	[3]161.8
Secondary	55.7	92.5	103.9	88.3	[3]78.2
Total	221.5	250.7	257.8	251.4	[3]240.0
Hungary, secondary	.3	.1	.1	.1	.1
India, primary	19.5	21.4	28.5	25.7	[3]32.6
Iran, primary	6.0	.7	.8	.8	13.5
Japan:					
Primary	854.5	853.7	889.5	930.0	991.4
Secondary	[r]51.4	67.7	40.3	50.1	53.4
Total	[r]905.9	921.4	929.8	980.1	[3]1,044.8
Korea, North:[e]					
Primary	15.0	15.0	15.0	15.0	15.0
Secondary	5.0	3.0	3.0	3.0	3.0
Total	20.0	18.0	18.0	18.0	18.0
Korea, Republic of, primary and secondary	45.9	48.2	64.1	101.2	[3]102.0
Mexico, primary	87.0	83.9	85.6	69.2	[3]77.4
Namibia, primary	45.9	42.7	40.0	39.7	[3]49.8
Norway, primary	20.1	27.3	33.7	32.0	[3]24.4
Peru, primary	318.9	371.4	356.3	312.6	[3]327.9
Poland:					
Primary[e]	320.0	325.0	346.0	315.0	338.0
Secondary[e]	17.0	16.0	17.0	15.8	6.0
Total	337.0	341.0	363.0	330.8	344.0

See footnotes at end of table.

Table 39.—Copper: World smelter production,[1] by country —Continued

(Thousand metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Portugal:					
Primary	2.8	5.1	6.1	4.8	4.1
Secondary	.2	.4	.5	.4	.4
Total	3.0	5.5	6.6	5.2	4.5
Romania:					
Primary	38.9	41.1	40.7	40.5	35.0
Secondary[e]	4.0	4.0	4.0	4.0	4.0
Total[e]	42.9	45.1	44.7	44.5	39.0
South Africa, Republic of, primary	[r]189.4	[r]182.3	185.8	185.4	[3]184.7
Spain:					
Primary	95.5	90.3	85.1	87.9	88.0
Secondary	17.0	18.0	18.0	20.0	20.0
Total	112.5	108.3	103.1	107.9	[3]108.0
Sweden:					
Primary	53.2	51.7	45.7	60.6	[3]72.5
Secondary	13.8	12.9	10.7	13.2	[3]17.4
Total	67.0	64.6	56.4	73.8	[3]89.9
Taiwan, primary	[r]13.0	[r]14.3	17.0	53.1	[3]47.3
Turkey:					
Primary	25.6	21.6	15.3	26.7	24.9
Secondary	.6	.6	.6	.6	.5
Total	26.2	22.2	15.9	27.3	25.4
U.S.S.R.:[e]					
Primary	865.0	885.0	900.0	950.0	1,000.0
Secondary	90.0	95.0	95.0	95.0	95.0
Total	955.0	980.0	995.0	1,045.0	1,095.0
United States:					
Primary[4]	1,288.4	1,335.6	1,008.4	1,316.8	[3]975.7
Secondary	54.2	60.2	44.9	60.9	[3]45.1
Total	1,342.6	1,395.8	1,053.3	1,377.7	[3]1,020.8
Yugoslavia, primary[5]	107.5	108.7	93.8	92.5	92.0
Zaire, primary	400.1	382.4	447.8	480.4	[3]466.4
Zambia, primary	653.9	582.1	609.9	560.6	[3]584.7
Zimbabwe, primary[e]	32.2	28.5	26.1	23.0	23.0
Grand total	[r]7,946.3	[r]8,001.4	7,915.4	8,296.6	8,153.3
Of which:					
Primary	[r]7,487.2	[r]7,477.3	7,389.1	7,724.5	7,617.1
Secondary	[r]413.2	[r]475.9	462.2	470.9	434.2
Undifferentiated	[r]45.9	[r]48.2	64.1	101.2	102.0

[e]Estimated. [p]Preliminary. [r]Revised.

[1]This table includes total production of copper metal at the unrefined stage, but also includes cathode produced by electrowinning methods unless otherwise noted. The smelter feed may be derived from ore, concentrates, copper precipitate or matte (primary), and/or scrap (secondary). To the extent possible, primary and secondary output of each country is shown separately. In some cases, total smelter production is officially reported, but the distribution between primary and secondary has been estimated. Table includes data available through June 10, 1983.

[2]Argentina presumably produces some smelter copper utilizing its own small mine output together with domestically produced cement copper, and possibly using other raw materials including scrap, but the levels of such output cannot be reliably estimated. Estimates provided in last year's edition are not regarded as reliably based.

[3]Reported figure.

[4]Figures for U.S. primary smelter production may include a small amount of copper derived from precipitates shipped directly to the smelter for further processing; production derived from electrowinning and fire-refining is not included. Copper content of precipitates shipped directly to smelter are as follows, in metric tons: 1978—111,164; 1979—126,514; 1980—107,980; 1981—113,991; and 1982—104,791.

[5]Figures reported in previous editions as secondary smelter copper are reported as remelted and as such presumably should not have been included here, although they may include small quantities of true secondary smelter copper. Quantities reported as remelted were as follows, in thousand metric tons: 1978—87.7; 1979—71.3; 1980—78.6; 1981—86.2; and 1982—86.0 (estimated).

Table 40.—Copper: World refinery production,[1] by country

(Thousand metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Albania, primary[e]	7.0	7.5	7.7	9.0	9.0
Australia:					
Primary	152.6	138.4	144.8	164.2	[2]165.3
Secondary	26.3	[r]33.1	37.6	27.8	[2]17.4
Total	178.9	[r]171.5	182.4	192.0	[2]182.7
Austria:					
Primary[e]	[r]11.9	[r]8.8	[r]8.8	[r]8.4	8.6
Secondary[e]	[r]20.0	[r]24.0	[r]34.5	[r]30.7	33.0
Total	[r]31.9	32.8	43.3	39.1	[2]41.6
Belgium:					
Primary[e]	332.6	318.8	321.7	[r]368.5	419.6
Secondary[e]	56.0	50.0	52.0	[r]60.0	60.0
Total	388.6	368.8	373.7	428.5	[2]479.6
Brazil:					
Primary	--	--	--	--	[2]9.6
Secondary	45.0	53.1	63.0	45.0	[2]47.4
Total	45.0	53.1	63.0	45.0	[2]57.0
Bulgaria, primary and secondary[e]	62.0	62.0	62.0	62.0	62.0
Canada:					
Primary[e]	[r]411.3	[r]360.3	[r]465.2	[r]447.7	283.3
Secondary[e]	[r]35.0	[r]37.0	[r]40.0	[r]29.0	15.0
Total	446.3	397.3	505.2	476.7	[2]298.3
Chile, primary	749.1	779.5	810.7	775.6	[2]851.6
China:[e]					
Primary	245.0	255.0	255.0	255.0	255.0
Secondary	25.0	25.0	25.0	25.0	25.0
Total	270.0	280.0	280.0	280.0	280.0
Czechoslovakia, primary and secondary	23.8	24.6	25.6	25.6	25.5
Egypt, secondary	2.0	2.0	2.0	2.0	2.4
Finland:					
Primary	32.7	33.0	30.5	23.8	38.0
Secondary[e]	10.0	10.0	10.0	10.0	10.0
Total[e]	42.7	43.0	40.5	33.8	[2]48.0
France:					
Primary[e]	20.7	22.0	23.0	23.0	23.0
Secondary[e]	20.6	[r]23.4	[r]23.5	[r]23.4	23.6
Total	41.3	[r]45.4	46.5	46.4	[2]46.6
German Democratic Republic, primary and secondary[e]	49.0	51.0	51.0	51.0	51.0
Germany, Federal Republic of:					
Primary	318.6	303.1	302.5	304.0	[2]313.7
Secondary	84.9	79.4	61.3	83.3	[2]80.3
Total	403.5	382.5	363.8	387.3	[2]394.0
Hungary, primary and secondary[e]	13.1	12.0	12.0	12.0	[2]12.2
India:					
Primary	[r]17.7	14.7	17.0	14.9	15.0
Secondary	[e]4.0	4.6	6.2	8.2	12.0
Total	21.7	19.3	23.2	23.1	27.0
Iran, primary[e] [3]	6.0	3.0	.8	.8	--
Italy:					
Primary[e]	3.5	[r]6.6	2.0	1.0	--
Secondary[e]	14.0	[r]9.0	10.2	22.7	[2]19.6
Total	17.5	15.6	12.2	23.7	[2]19.6

See footnotes at end of table.

Table 40.—Copper: World refinery production,[1] by country —Continued

(Thousand metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Japan:					
Primary	854.5	853.7	889.5	930.0	[2]948.2
Secondary	104.6	130.0	124.8	120.2	[2]126.8
Total	959.1	983.7	1,014.3	1,050.2	[2]1,075.0
Korea, North, primary and secondary[e]	25.0	22.0	22.0	22.0	22.0
Korea, Republic of:					
Primary[e]	[r]52.4	[r]63.1	[r]72.9	[r]108.0	110.8
Secondary[e]	[r]13.0	[r]13.0	[r]12.0	[r]5.0	5.0
Total	[r]65.4	[r]76.1	84.9	113.0	115.8
Mexico:					
Primary	70.0	[r]71.8	74.6	61.3	[2]61.4
Secondary[e]	5.0	[r]10.0	[r]11.0	[r]10.0	14.0
Total[e]	75.0	81.8	85.6	71.3	75.4
Norway:					
Primary	15.7	22.0	[e]25.8	26.1	[2]18.0
Secondary	([4])	([4])	([4])	([4])	--
Total	[r]15.7	[r]22.0	[e]25.8	26.1	[2]18.0
Peru, primary	182.8	230.8	226.3	209.1	[2]224.9
Poland, primary[5]	332.2	335.8	357.3	327.2	[2]348.0
Portugal, primary	3.0	3.4	3.1	4.8	[2]4.6
Romania:					
Primary	[r]40.5	[r]42.0	[r]42.0	[r]42.0	40.0
Secondary[e]	[r]26.2	[r]24.3	[r]23.0	[r]18.0	20.0
Total[e]	[r]66.7	[r]66.3	[r]65.0	[r]60.0	60.0
South Africa, Republic of, primary[6]	149.1	150.8	140.9	144.1	142.8
Spain:					
Primary[e]	[r]122.0	[r]126.0	[r]138.7	[r]137.1	151.3
Secondary[e]	[r]25.0	[r]18.6	[r]15.0	[r]15.0	16.0
Total	147.0	[r]144.6	153.7	152.1	[2]167.3
Sweden:					
Primary	[r]52.6	[r]50.7	45.7	48.9	52.3
Secondary	[r]11.8	[r]11.0	11.0	13.0	10.0
Total	64.4	61.7	56.7	61.9	[2]62.3
Taiwan:					
Primary[e]	7.4	8.3	11.5	45.2	39.4
Secondary[e]	7.0	7.0	8.0	8.0	8.0
Total	14.4	15.3	19.5	53.2	[2]47.4
Turkey, primary	30.1	22.2	18.8	24.2	32.2
U.S.S.R.:[e]					
Primary	810.0	830.0	845.0	890.0	950.0
Secondary	170.0	170.0	170.0	170.0	170.0
Total	980.0	1,000.0	1,015.0	1,060.0	1,120.0
United Kingdom:					
Primary	46.2	48.5	68.3	59.8	[2]63.1
Secondary	79.4	73.2	93.0	76.3	[2]71.0
Total	125.6	121.7	161.3	136.1	[2]134.1
United States:					
Primary	1,449.1	1,515.4	1,210.9	1,544.0	[2]1,227.5
Secondary	420.1	498.4	515.1	493.6	[2]458.9
Total	1,869.2	2,013.8	1,726.0	2,037.6	[2]1,686.4
Yugoslavia:					
Primary	103.9	99.2	91.8	90.7	90.0
Secondary	46.9	38.3	39.5	41.9	36.9
Total	150.8	137.5	131.3	132.6	[2]126.9

See footnotes at end of table.

Table 40.—Copper: World refinery production,[1] by country —Continued

(Thousand metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Zaire, primary	[r]103.0	[r]130.2	144.2	151.5	[2]175.1
Zambia, primary	627.7	561.9	607.6	560.4	584.6
Zimbabwe, primary	3.0	3.0	3.1	8.0	8.0
Grand total	[r]8,788.6	[r]8,935.5	8,968.0	9,319.0	9,118.9
Of which:					
Primary	[r]7,363.9	[r]7,419.5	7,407.7	7,808.3	7,663.9
Secondary	[r]1,251.8	[r]1,344.4	1,387.7	1,338.1	1,282.3
Undifferentiated	[r]172.9	[r]171.6	172.6	172.6	172.7

[e]Estimated. [p]Preliminary. [r]Revised.

[1]This table includes total production of refined copper, whether produced by pyrometallurgical or electrolytic refining methods, and whether derived from primary unrefined copper or from scrap. Copper cathode derived from electrowinning processing is also included. To the extent possible, primary and secondary output of each country is shown separately. In most cases, total refinery production is officially reported, and in some, the distribution between primary and secondary has been estimated. Table includes data available through June 22, 1983.

[2]Reported figure.

[3]Data are for years beginning Mar. 21 of that stated.

[4]Revised to zero.

[5]May include small quantities of secondary.

[6]Although only primary production is reported, an unknown but small additional output of secondary refined copper may have been produced.

Diatomite

By A. C. Meisinger[1]

The quantity of processed diatomite produced in 1982, all in four Western States, was 613,000 short tons, a decrease of 11% from that produced in 1981. California continued to be the leading State.

Exports of diatomite, 23% of production, decreased 13% from that of 1981. Apparent domestic consumption decreased 10% to 472,000 tons.

Domestic Data Coverage.—Domestic production data for diatomite are developed by the Bureau of Mines from one voluntary survey of U.S. operations. Of the 10 operations to which a survey request was sent, 90% responded, representing 99% of the total production shown in table 1. Production for the remaining nonrespondent was estimated using reported prior year production levels adjusted by trends in employment and other guidelines.

Table 1.—Diatomite sold or used by producers in the United States

(Thousand short tons and thousand dollars)

	1978	1979	1980	1981	1982
Domestic production (sales)	651	717	689	687	613
Total value of sales	$72,429	$90,323	$100,610	$113,010	$107,619

DOMESTIC PRODUCTION

U.S. production of diatomite in 1982 declined 11% in tonnage and 5% in value to 613,000 tons valued at about $108 million. The output was processed at 10 plants by 8 companies in 4 Western States. California was again the principal producing State, followed by Nevada, Washington, and Oregon.

The major diatomite producers continued to be Manville Products Corp., with operations at Lompoc, Calif.; Grefco, Inc., Dicalite Div., at Lompoc, Calif., and Mina, Nev.; Eagle-Picher Industries, Inc., at Sparks and Lovelock, Nev.; and Witco Chemical Corp., Inorganic Specialties Div., at Quincy, Wash. Diatomite was also mined and processed during the year by Excel-Mineral Co., Taft, Calif.; Lassenite Industries, Inc., Doyle, Calif.; Cyprus Diatomite Co., a division of Amoco Minerals Co., Fernley Nev.; and Oil-Dri Production Co., Christmas Valley, Oreg.

American Resources Equity Corp., Denver, Colo., was reported in 1982 to have shipped 60,000 tons of bulk (unprocessed) diatomite to the Calaveras Div. cement plant of Genstar Cement and Lime Co., Redding, Calif., as a source of silica in cement manufacture.[2] American Resources diatomite deposits are situated on more than 5,000 acres of claims in the vicinity of Lake Britton, Shasta County, Calif.

CONSUMPTION AND USES

Apparent domestic consumption of diatomite in 1982 decreased by 10% to 472,000 tons compared with that in 1981. Demand for diatomite as a filtration medium decreased by only 5% to 419,000 tons, and thereby increased its market share as shown in table 2. The quantity used for fillers declined by 28% to 113,000 tons and that used for insulation declined by 58% to 6,100 tons. Other uses included abrasives, absorbents, catalysts, lightweight aggregates, and unspecified industrial products.

Table 2.—Diatomite sold or used,[1] by principal use

(Percent of U.S. production)

Use	1978	1979	1980	1981	1982
Filtration	63	65	66	64	68
Fillers	23	21	21	23	19
Insulation	3	3	3	2	1
Other	11	11	10	11	12

[1]Includes exports.

PRICES

The average unit value of sales for processed diatomite increased by 7% to $176 per ton.

Table 3.—Average annual value per ton[1] of diatomite, by use

Use	1980	1981	1982
Abrasives	W	W	W
Fillers	$132.56	$153.14	$160.72
Filtration	158.88	179.01	191.85
Insulation	103.47	125.02	121.61
Miscellaneous[2]	101.79	110.19	111.55
Weighted average	146.02	164.50	175.63

W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous."
[1]Based on unrounded data.
[2]Includes absorbents, abrasives, catalysts (1980, 1982), fertilizer coatings (1980-81), and lightweight aggregates.

FOREIGN TRADE

U.S. exports of diatomite in 1982 totaled 141,000 tons, a 13% decrease from that exported in 1981. The average unit value increased by 4% to $212 per ton. The quantity of diatomite exported in 1982 represented 23% of U.S. production, indicating little pattern change in recent years. Diatomite was exported to 85 countries, and the following 5 countries received 61% of the total: Canada, 29,400 tons; Japan, 21,600 tons; Australia, 13,200 tons; the Federal Republic of Germany, 12,000 tons; and the United Kingdom, 10,000 tons.

Imports of diatomite declined from 385 tons in 1981 to 252 tons; of this, 198 tons valued at $271 per ton was received from Mexico.

Table 4.—U.S. exports of diatomite

(Thousand short tons and thousand dollars)

Year	Quantity	Value[1]
1979	170	26,496
1980	173	32,238
1981	162	32,933
1982	141	29,863

[1]U.S. Customs.

WORLD REVIEW

World production of diatomite in 1982 was an estimated 1.5 million tons, down about 100,000 tons from that of 1981. The United States produced 40% of the world output, followed by the U.S.S.R. and France with 17% and 14%, respectively.

Canada.—The Crownite Industrial Minerals, Ltd., diatomite operation at Quesnel, British Columbia, was bought by Microsil Industrial Minerals Limited Partnership. The new owners made plans to dismantle the old processing plant and build a new one to produce granular aggregate sizes for use as absorbents, soil conditioners, and chemical carriers.[3]

[1]Industry economist, Division of Industrial Minerals.
[2]American Resources Group. First Phase Testing of Diatomite Deposit Completed. Min. Rec. (Denver), v. 95, No. 4, Jan. 26, 1983, p. 3.
[3]Pettifer, L. Diatomite—Growth in the Face of Adversity. Ind. Miner. (London), No. 175, April 1982, p. 47.

Table 5.—Diatomite: World production, by country[1]

(Thousand short tons)

Country	1978	1979	1980	1981[p]	1982[e]
Algeria	4	5	5	5	6
Argentina	8	8	7	7	8
Australia	3	4	3	1	2
Austria	1	--	--	--	--
Brazil (marketable)	13	[r]19	17	19	18
Canada	2	2	[e]2	2	2
Chile	6	1	1	1	1
Colombia	1	1	1	1	1
Costa Rica	1	1	1	1	1
Denmark:					
Diatomite	[r] [e]17	[e]28	[e]28	3	--
Moler[e] [2]	[r]176	[r]138	[r]138	[r]138	138
Egypt	(3)	(3)	--	--	--
France	[e]220	[e]220	[e]240	230	220
Germany, Federal Republic of	[r]53	[r]54	58	46	46
Iceland	22	23	20	21	22
Italy[e]	[r]33	[r]33	[r]33	[r]28	22
Kenya	2	2	2	2	2
Korea, Republic of	21	26	28	46	33
Mexico	45	49	62	62	63
New Zealand	(4)	(4)	(4)	(4)	--
Peru	5	(4)	--	--	--
Portugal	3	3	3	3	3
Romania[e]	45	45	45	45	45
South Africa, Republic of	1	1	1	1	1
Spain	[r]23	30	26	26	22
Thailand	1	4	2	(3)	(3)
Turkey	10	[e]10	NA	NA	NA
U.S.S.R.[e]	240	250	250	250	260
United Kingdom[e]	2	2	2	2	2
United States	651	717	689	687	613
Total	[r]1,609	[r]1,676	1,664	1,627	1,531

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.
[1]Table includes data available through Apr. 5, 1983.
[2]Estimated diatomite content of moler produced.
[3]Less than 1/2 unit.
[4]Revised to zero.

Feldspar, Nepheline Syenite, and Aplite

By Michael J. Potter[1]

Total U.S. feldspar output in 1982, including soda, potash, and mixed varieties, decreased by 8% to 615,000 short tons. Feldspar continued to be mined in six States, with North Carolina in the lead, followed by Connecticut and Georgia. The other producing States continued to be California, Oklahoma, and South Dakota. Shipments went to at least 31 States and to foreign destinations, primarily Canada and Mexico. Aplite of glassmaking quality continued to be produced only in Virginia; output figures cannot be released, but the tonnage produced was approximately 5% less than in 1981. Imports of crude and ground nepheline syenite in 1982 decreased 10% to 456,000 tons although its total value increased 19% to $14 million.

The 1982 end-use distribution of feldspar in the United States indicated that 55% went into glassmaking and 41% into pottery. The remaining 4% was used in applications such as enamels and sanitary ware. Glass containers continued to face stiff competition from plastic bottles and metal cans.

Domestic Data Coverage.—Domestic production data for feldspar are developed by the Bureau of Mines by means of a voluntary domestic survey. Of the 16 active mines, 14, or 88%, responded, and an estimated 95% of the total production data for feldspar shown in table 1 was represented. Production for the remaining two nonrespondents was estimated from prior years' data adjusted to current industry levels.

Legislation and Government Programs.—According to provisions of the Tax Reform Act of 1969, which continued in force throughout 1982, the depletion rate allowed on domestic and foreign feldspar production was 14%.

Table 1.—Salient feldspar and nepheline syenite statistics

	1978	1979	1980	1981	1982
United States:					
Feldspar:					
Produced[1] ... short tons	735,000	740,000	710,000	665,000	615,000
Value ... thousands	$18,200	$21,500	$23,200	$21,000	$20,300
Exports ... short tons	10,330	12,300	13,000	14,025	10,800
Value ... thousands	$853	$1,025	$896	$1,110	$989
Imports for consumption ... short tons	39	266	404	206	48
Value ... thousands	$3	$31	$133	$61	$24
Nepheline syenite:					
Imports for consumption ... short tons	548,000	536,000	504,340	506,100	455,596
Value ... thousands	$10,446	$10,846	$11,264	$11,529	$13,751
Consumption, apparent[2] (feldspar plus nepheline syenite) thousand short tons	1,273	1,264	1,202	1,157	1,060
World: Production (feldspar) ... do	r3,345	r3,429	3,454	p3,463	e3,416

eEstimated. pPreliminary. rRevised.
[1]Includes hand-cobbed feldspar, flotation-concentrate feldspar, and feldspar in feldspar-silica mixtures; includes potash feldspar (8% K_2O or higher).
[2]Measured by quantity produced plus imports, minus exports (rounded figures).

FELDSPAR

DOMESTIC PRODUCTION

Soda feldspar is defined commercially as containing 7% Na_2O or higher; potash feldspar contains 10% K_2O or higher. However, in this report, feldspars containing more than 8% K_2O are defined as potash feldspars. Hand-cobbed or hand-sorted feldspar is usually obtained from pegmatites and is relatively high in K_2O compared with Na_2O. Hand cobbing had decreased and was a minor fraction of total production in 1982. Feldspar flotation concentrates, most of the U.S. output, are classified as either soda, potash, or "mixed" feldspar, depending on the relative amounts of Na_2O and K_2O present. Feldspar-silica mixtures, feldspathic sand, can either be a naturally occurring material such as sand deposits, or a flotation product. Total feldspar content of this mixture was 24% of total feldspar output in 1982.

Feldspar was mined in six States in 1982, led by North Carolina and followed in descending order by Connecticut, Georgia, California, Oklahoma, and South Dakota. The combined output of the top four States was about 95% of the U.S. total. Eleven U.S. companies operating 16 mines and 12 plants produced feldspar for shipment to at least 31 States and to foreign countries, primarily Canada and Mexico; of these companies, 4 produced potash feldspar and the remainder produced mixed feldspar. North Carolina had five plants, California had three, and Connecticut, Georgia, South Carolina, and South Dakota each had one.

The data for potash feldspar in tables 1-6 were collected from the four U.S. producers of this material; some of this feldspar contained less than 10% K_2O (8% to 10% K_2O). Therefore, in order to publish potash feldspar data and to maintain proprietary company data, the potash feldspar included in tables 1-6 has a K_2O content of 8% or higher.

Table 2.—Feldspar produced in the United States[1]

(Thousand short tons and thousand dollars)

Year	Hand-cobbed		Flotation concentrate		Feldspar-silica mixtures[2]		Total[3]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1978	26	400	568	13,240	140	4,550	735	18,200
1979	20	238	580	16,460	140	4,770	740	21,500
1980	14	229	566	18,240	130	4,780	710	23,200
1981	11	194	504	16,850	149	4,000	665	21,000
1982	10	172	457	16,090	147	4,040	615	20,300

[1]Includes potash feldspar (8% K_2O or higher).
[2]Feldspar content.
[3]Data may not add to totals shown because of independent rounding.

CONSUMPTION AND USES

In 1982, there continued to be no significant consumption of run-of-mine feldspar. The majority of users acquired their supplies already ground and sized by the feldspar producers, although some manufacturers of pottery, soaps, and enamels continued to purchase feldspar for grinding to their preferred specifications in their own mills. A substantial portion of the material classified as feldspar-silica mixtures served in glassmaking without additional processing.

In 1982, 55% of the total feldspar consumed in the United States was used in glassmaking including container glass and fiberglass, 41% was used in pottery, and the remaining 4% was used in enamels, sanitary wares, electrical insulators, etc.

Glass container manufacturers and the Glass Packaging Institute were conducting their own campaign to combat inroads from plastics and were making steady gains in the no-return market.[2] According to an independent study conducted in 10 major urban areas, the U.S. consumer prefers food and beverage containers made of glass. Consumers believed that soft drinks, fruit drinks, and beer tasted better in glass containers, looked more appealing, and retained carbonation better.[3]

The U.S. ceramic tile market has become a highly competitive area for both domestic and foreign ceramic tile producers. Also, the United States is perceived as the world's largest undeveloped ceramic tile market. In addition to new housing, potential growth areas for tile are seen in commercial remodeling and do-it-yourself outlets.[4]

Table 3.—Destination of shipments of feldspar sold or used by producers in the United States, by State[1]

(Short tons)

State	1978	1979	1980	1981	1982
Alabama	35,500	13,900	21,100	19,600	16,500
Arkansas	5,200	W	W	W	W
California	(2)	(2)	(3)	(4)	(5)
Connecticut	23,800	21,600	18,400	17,800	18,800
Florida	20,000	23,600	32,800	25,700	21,000
Georgia	35,800	69,000	64,700	68,300	74,600
Illinois	47,600	43,700	36,600	31,100	26,900
Indiana	32,600	25,300	26,700	22,700	20,200
Kentucky	10,200	13,100	12,800	11,700	13,400
Louisiana	19,200	16,900	14,600	13,900	12,200
Maryland	6,500	7,600	5,100	4,300	4,600
Massachusetts	W	W	11,100	8,800	9,300
Michigan	2,500	4,000	2,700	W	2,000
Mississippi	22,000	17,600	15,600	13,000	15,800
Missouri	4,200	7,600	4,900	4,300	4,100
New Jersey	50,400	59,600	64,600	63,400	51,700
New York	21,400	22,000	23,100	19,400	17,800
North Carolina	W	W	W	17,000	16,500
Ohio	59,200	64,400	56,400	52,800	51,600
Oklahoma	33,600	31,700	31,000	34,700	31,900
Pennsylvania	55,400	52,900	46,200	42,900	28,800
South Carolina	W	17,700	15,600	16,400	14,900
Tennessee	19,700	19,400	18,300	16,100	15,300
Texas	38,800	40,400	35,000	39,400	36,700
West Virginia	38,200	59,800	55,400	36,100	31,600
Other destinations[6]	153,200	112,200	97,300	r75,600	73,800
Total	735,000	744,000	710,000	655,000	610,000

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Other destinations."
[1]Includes potash feldspar (8% K_2O or higher).
[2]Data are incomplete; included with "Other destinations."
[3]Data are incomplete; Bureau of Mines estimate is 40,000 tons or more; included with "Other destinations."
[4]Data are incomplete; Bureau of Mines estimate is 35,000 tons or more; included with "Other destinations."
[5]Data are incomplete; Bureau of Mines estimate is 30,000 tons or more; included with "Other destinations."
[6]Includes Colorado, Kansas, Minnesota, Rhode Island, Virginia, Wisconsin, States indicated by symbol W, and unspecified States. Also includes exports to Canada, Mexico, and other foreign countries.

Table 4.—Destination of shipments of potash feldspar sold or used by producers in the United States[1]

(Short tons)

Destination	1978	1979	1980	1981	1982
Illinois, Indiana, Wisconsin	14,900	15,500	13,400	11,300	8,000
Maryland, New York, West Virginia	27,500	29,500	28,200	24,800	21,600
Massachusetts	W	1,400	W	W	W
Ohio	12,100	12,000	10,700	9,800	8,100
Pennsylvania	12,000	9,000	8,200	9,100	6,400
Texas	400	W	400	200	200
Canada	4,600	5,200	4,300	4,900	3,200
Mexico	1,500	2,900	1,600	2,800	2,400
Other[2]	18,300	18,600	18,200	17,500	16,300
Total	91,300	94,100	85,000	80,400	66,200

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]K_2O content of 8% or higher.
[2]Includes Alabama, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Kansas, Kentucky, Michigan, Minnesota, Missouri, New Jersey, North Carolina, Tennessee, States indicated by symbol W, and other unspecified States. May include small amounts to other foreign countries.

Table 5.—Feldspar sold or used by producers in the United States, by use[1]

(Thousand short tons and thousand dollars)

Use	1981 Quantity	1981 Value	1982 Quantity	1982 Value
Hand-cobbed:				
Pottery	13	935	W	W
Other	1	45	W	W
Total[2]	13	980	10	735
Flotation concentrate:				
Glass	251	7,310	212	6,662
Pottery	236	10,610	227	10,637
Other	19	1,160	18	1,082
Total[2]	505	19,080	458	18,381
Feldspar-silica mixtures:[3]				
Glass	118	4,900	125	5,699
Pottery	15	935	W	W
Other	3	310	W	W
Total	136	6,145	142	6,884
Total:[2]				
Glass[4]	369	12,210	337	12,360
Pottery	264	12,480	251	12,205
Other[5]	22	1,510	22	1,434
Total	655	26,200	610	26,000

W Withheld to avoid disclosing company proprietary data; included in "Total."
[1]Includes potash feldspar (8% K_2O or higher).
[2]Data may not add to totals shown because of independent rounding.
[3]Feldspar content.
[4]Includes container glass and fiberglass.
[5]Includes enamel, sanitary ware, etc., and unknown.

Table 6.—Potash feldspar sold or used by producers in the United States, by use[1]

Use	1981 Quantity (short tons)	1981 Value (thousands)	1982 Quantity (short tons)	1982 Value (thousands)
Pottery	66,850	$4,538	54,600	$3,879
Other[2]	13,550	620	11,600	596
Total	80,400	5,158	66,200	4,475

[1]K_2O content of 8% or higher.
[2]Includes glass, enamel, sanitary ware, etc.

PRICES

Engineering & Mining Journal, December 1982, listed the following prices for feldspar, per short ton, f.o.b. mine or mill, carload lots, bulk, depending on grade:

	1981	1982
North Carolina:		
20 mesh, flotation	$27.50	$27.50
40 mesh, flotation	46.00	51.00
200 mesh, flotation	$41.25- 65.00	70.25
Georgia:		
40 mesh, granular	46.00	51.00
200 mesh	64.00	69.25
Connecticut:		
20 mesh, granular	34.50	37.25
200 mesh	46.75	50.50

FOREIGN TRADE

U.S. exports in 1982 classified as feldspar, leucite, and nepheline syenite, but presumably mostly feldspar, decreased 23% to about 10,800 tons valued at $989,000. Chief recipients were Mexico, 41%; Canada, 21%; the Dominican Republic, 8%; and Venezuela, 8%. The remaining 22% was shared among 17 other countries.

In addition to feldspar and nepheline syenite, in 1982 the United States imported 457 tons of "Other mineral fluxes, crushed" with a value of $274,444 and 21,673 tons of "Other crude natural mineral fluxes" with a value of $490,399.

The tariff schedule in force throughout 1982 for most favored nations provided for a 3.2% ad valorem duty on ground feldspar; imports of unground feldspar were admitted duty free.

Table 7.—U.S. exports of feldspar, by country

Country	1981		1982	
	Short tons	Value	Short tons	Value
Canada	6,680	$510,400	2,290	$251,400
Chile	600	24,900	--	--
Dominican Republic	440	43,000	820	57,700
Leeward and Windward Islands	--	--	300	29,300
Mexico	4,440	310,000	4,480	338,400
Philippines	--	--	270	35,400
Taiwan	420	88,800	580	120,000
Venezuela	930	71,500	820	81,600
Other	515	61,400	1,240	75,200
Total	14,025	1,110,000	10,800	989,000

Table 8.—U.S. imports for consumption of feldspar, by type and country

Type and country	1981		1982	
	Short tons	Value	Short tons	Value
Crude:				
Canada	93	$42,597	48	$23,804
Japan	15	1,138	--	--
Ground, crushed, or pulverized:				
Germany, Federal Republic of	2	484	--	--
Japan	1	326	--	--
Peru	([1])	1,230	--	--
Sweden	85	11,970	--	--
United Kingdom	10	3,630	--	--
Total	206	61,375	48	23,804

[1]Less than 1/2 unit.

WORLD REVIEW

Finland.—Flotation feldspar produced by Oy Lohja Ab from its Kemiö plant was reported to be in the range of 71,000 to 77,000 tons per year of concentrate, along with 33,000 tons per year of quartz concentrate. Approximately equal amounts of concentrate feldspar were used in the glass and ceramics industries. Approximately 80% of production was being exported, mainly to the Federal Republic of Germany, Sweden, and the United Kingdom.

In western Finland at Haapaluoma, potash feldspar was produced by Oy Lohja at a rate of 22,000 tons per year.[5]

New Zealand.—Geological occurrence of feldspar was briefly discussed in a paper.[6] There was no known feldspar production in the country.

Pakistan.—Various mineral developments were reported to be taking place in Azad Kashmir. Among these was the export of 3,800 tons of feldspar to Kuwait with more shipments on a regular basis possible in the future.[7]

Portugal.—A paper discussed feldspar and quartz in Portugal, including a description of the pegmatite deposits, production, product specifications, and end uses. The pegmatite deposits are limited; however, the new Seixoso industrial complex in northern Portugal, which will utilize 900,000 tons of feldspathic tailings produced by a former tin-mining operation, should alleviate any feldspar shortage. This new operation was expected to produce around 13,000 tons per year, initially, of "Felquar," which is comprised of two parts of feldspar and one part of quartz.[8]

South Africa, Republic of.—Industrial aluminosilicate minerals were discussed in a paper, including a brief description of deposits, chemical analyses, and production of feldspar.[9]

Spain.—A very brief description of feldspar production, end uses, etc., was given in a paper.[10]

Yugoslavia.—Preparations began on the new development of a feldspar, mica, kaolin, and quartz sand mine in the Vrsac region of Vojvodina Province. It was estimated that the deposits could support production of about 100,000 tons per year of feldspar. Mine startup was being considered for late 1982, with an investment of approximately $20 million.[11]

Zimbabwe.—The three feldspar producing companies in the country were very briefly discussed in a paper. Production in 1980 totaled 1,400 tons.[12]

Table 9.—Feldspar: World production, by country[1]

(Thousand short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Argentina	46	37	36	36	35
Australia	3	5	4	4	5
Austria	3	8	12	11	10
Brazil[3]	[r]112	[r]159	173	106	105
Burma	[r]1	[r]3	4	4	3
Chile	1	(4)	2	3	3
Colombia	29	32	28	31	30
Egypt	4	4	4	4	3
Finland	78	75	82	69	100
France	233	215	231	211	200
Germany, Federal Republic of	425	411	420	377	375
Guatemala	17	12	24	11	15
Hong Kong	3	1	3	4	5
India	57	55	67	65	70
Italy	277	325	379	472	440
Japan[5]	46	42	33	29	35
Kenya	1	1	(4)	(4)	(4)
Korea, Republic of	76	[r]40	79	114	110
Madagascar	(4)	(4)	(4)	(4)	(4)
Mexico	121	122	129	136	130
Mozambique[e]	1	--	--	--	--
Nigeria[e]	6	6	6	6	6
Norway	[6]66	97	75	[e]80	80
Pakistan	15	17	12	12	12
Peru	[r]2	2	18	24	30
Philippines	20	19	18	18	20
Poland[e]	44	44	44	90	90
Portugal	24	37	[e]45	[e]50	45
Romania[e]	66	66	66	66	66
South Africa, Republic of	58	52	57	57	55
Spain[7]	128	128	114	116	110
Sri Lanka	3	4	4	4	5
Sweden	60	[r]65	64	[e]66	70
Thailand	36	29	26	26	30
Turkey	83	[e]80	[e]80	[e]80	80
U.S.S.R.[e]	330	340	340	350	360
United Kingdom (china stone)[e]	55	55	55	55	55
United States	735	740	710	[8]665	[8]615
Uruguay	3	3	3	3	3
Venezuela	77	98	7	8	10
Zambia	(4)	(4)	(4)	(4)	(4)
Total	[r]3,345	[r]3,429	3,454	3,463	3,416

[e]Estimated. [p]Preliminary. [r]Revised.

[1]Table includes data available through Apr. 14, 1983.

[2]In addition to the countries listed, Czechoslovakia, Namibia, and Romania produce feldspar, but output is not officially reported and available general information is inadequate for the formulation of reliable estimates of output levels.

[3]Series revised to exclude production of leucite and sodalite; data presented now consist only of that material reported by Brazil under the heading of "Feldspar." Data represent the sum of (1) run-of-mine production for direct sale and (2) salable beneficiated product; total run-of-mine feldspar production was as follows in thousand short tons: 1978—109; 1979—156 (revised); 1980—136; 1981—106; and 1982—100 (estimated).

[4]Less than 1/2 unit.

[5]In addition, the following quantities of aplite were produced in thousand short tons: 1978—416 (revised); 1979—435; 1980—334 (revised); 1981—386; and 1982—380 (estimated).

[6]Described in source as lump feldspar; does not include 256,000 tons of nepheline syenite.

[7]Includes pegmatite.

[8]Reported figure.

TECHNOLOGY

As part of a research program for recovering alumina from domestic nonbauxitic resources, the Bureau of Mines investigated a lime-sinter, caustic leach technology for anorthosite, a lime-soda-feldspar rock. The published report discussed the unit operations—feed preparation, sintering, and leaching. Leaching the sinter with 10% soda ash at 140° F extracted 85% to 90% of the alumina.[13]

In another study, the Bureau of Mines investigated a bench-scale leaching process using hydrochloric acid (HCl) and fluoride to extract alumina from Wyoming anorthosite. Using 95% stoichiometric HCl, 90% of the alumina was extracted by countercurrent leaching.[14]

The possibility of using flotation feldspar tailings as a replacement for traditional nonplastic materials in a vitreous sanitary ware body was investigated. The unfired and fired properties of a control casting body containing 35% feldspar and 15% flint were successfully matched by a body in which 32% of the nonplastics component was replaced by properly beneficiated feldspar tailings.[15]

Although adversely affected by the housing slump of the past few years, porcelain enamel has seen some fast technological changes in coating methods, etc. Also, given a turnaround in the economy, a substantial replacement and remodeling market was forecast for 1982 to 1985 for household appliances, including refrigerators, ranges, hot water heaters, etc.[16]

NEPHELINE SYENITE

Nepheline syenite is a quartz-free, light-colored rock that, although resembling medium-grained granite in texture, consists principally of nepheline and alkali feldspars, usually in association with minor amounts of other minerals. Large quantities of nepheline syenite, after processing to remove contaminants, especially iron-bearing minerals, are consumed in making glass and ceramics. There is no domestic production of nepheline syenite in grades suitable for these purposes, and U.S. needs are wholly supplied by imports.

In Canada, Indusmin, Ltd., and International Minerals & Chemical Corp. (Canada) Ltd. mined nepheline syenite from the deposit at Blue Mountain, Ontario. Canadian production in 1981 totaled approximately 668,000 tons valued at $17.8 million.

Other than Canada, only two countries were known to have produced significant quantities of nepheline syenite. Norway had an estimated output of 242,000 tons in 1981, virtually all of which went to Western European consumers. The U.S.S.R. production was unknown, but output was reported to provide feed for domestic alumina plants. Alumina from nepheline-bearing material reportedly accounted for about one-sixth of primary aluminum production in the U.S.S.R.[17]

The Canâan nepheline syenite venture in Brazil of Austral Mineração e Servicos Ltda. was discussed in a paper. Included was background information leading to the discovery of the deposit, geology of the deposit, reserves, the pilot plant, and glass and ceramic markets in Brazil. The project, in the design stage, included erection of a commercial plant in two stages of 40,000 tons per year and 79,000 tons per year. Capital investment was expected to total $3 million.[18]

Table 10.—U.S. imports for consumption of nepheline syenite

Year	Crude		Ground	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1980	6,760	$71	497,580	$11,193
1981	2,780	25	503,320	11,504
1982	316	16	455,280	13,735

APLITE

Aplite is another rock of granitic texture containing quartz mixed with varying proportions of soda or lime-soda feldspar. Aplite is usually not suitable for use in ceramics, but if sufficiently low in iron, has been used in the manufacture of glass, especially container glass. Japan, with an annual production of 350,000 to 450,000 tons, has recently been the world's foremost producer of aplite.

Aplite of glassmaking quality was produced in the United States in 1982 from one surface mine. The Feldspar Corp. mined aplite near Montpelier, Hanover County, Va., and treated the material by wet-grinding, classification, and spiraling to remove biotite, ilmenite, and rutile, followed by dewatering and high-intensity magnetic separation to eliminate iron-bearing minerals.

Domestic output in 1982 was approximately 5% lower in tonnage than in the previous year. Data on aplite production, sales, and value could not be released for publication. Aplite traditionally has a somewhat lower price than feldspar. Industrial Minerals (London), December 1982, gave a value of about $24 per ton for glass grade, bulk, 100% plus 200 mesh, f.o.b. Montpelier, Va.

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[1]Physical scientist, Division of Industrial Minerals.

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[9]Heckroodt, R. O. The Industrial Alumino—Silicate Minerals of South Africa. Pres. at 5th Internat. Cong., spons. by "Industrial Minerals" magazine, Madrid, Spain, Apr. 25-28, 1982, pp. P/13-P/14.

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Ferroalloys

By Raymond E. Brown[1]

Global demand for ferroalloys continued to weaken in 1982 because the iron and steel industry, the major consumer of ferroalloys, failed to recover from the worldwide recession. Production and consumption of ferroalloys in the United States declined by a greater percentage than that of most other nations. Weak demand for ferroalloys created excess capacity, forcing some countries to initiate trade actions to protect their industries from other countries competing for a larger share of the shrinking world market. Although production was down in most countries, new capacity was planned, under construction, or started in countries that have competitive advantages such as low-cost electrical power or indigenous ores.

Domestic Data Coverage.—Domestic production data for ferroalloys are developed by the Bureau of Mines by means of monthly and annual voluntary domestic surveys. Typical of these surveys are the three separate monthly surveys for chromium alloys and metal, manganese alloys and metal, and silicon alloys and metal, and the annual survey for ferroalloys. Data presented in table 2 represent close to 100% of all ferroalloys and ferroalloy metals produced and/or shipped.

Legislation and Government Programs.—The U.S. Department of Commerce announced on December 3 that the President had moved to upgrade stockpiled manganese and chromium ores into 577,000 short tons of high-carbon ferromanganese and 519,000 tons of high-carbon ferrochromium over a 10-year period. This action was prompted by a petition filed by The Ferroalloys Association with Commerce in August 1981 requesting an investigation be conducted, under the authority of section 232 of the Trade Expansion Act of 1962, Public Law 87-794, to determine the impact of imported bulk ferroalloys on national security. The upgrading program was designed to improve stockpile readiness and help maintain domestic ferroalloy furnace and processing capacity. After an interagency review on whether to withdraw or limit the duty-free treatment allowed high-carbon ferromanganese under the Generalized System of Preferences (GSP) and a review by Commerce of the initial results of the stockpile upgrading program, the President will reassess whether ferroalloy imports threaten national security.[2]

In addition to the section 232 investigation, there were three other significant Government actions relative to ferroalloy trade. The extra duty of 4 cents per pound of contained chromium that had been in effect since 1978 on all high-carbon ferrochromium entering the United States below a floor price of 38 cents per pound of contained chromium expired November 15. In March the Administration rejected the Government of Zimbabwe's request to add ferrochromium and ferrochromium-silicon to the list of materials allowed duty-free entry under the GSP. The outcome of a petition filed with the U.S. Trade Representative by The Ferroalloys Association in 1981, requesting that Brazil be removed from the GSP, which affects seven ferroalloy products, rests on a final decision concerning the section 232 investigation.

Other options recommended by The Ferroalloys Association as a possible means of preserving the domestic ferroalloy industry included the application of breakpoint trigger prices on imports plus some control over imports.

A Senate Foreign Relations staff report dealing with short- to medium-term interruptions in the supply of strategic materials from the Republic of South Africa included a policy option for taking steps to preserve the U.S. ferroalloy industry. To maintain domestic ferroalloy capacity, the report suggests that some deferred tax incentives or subsidies might be provided to firms operating uneconomic minerals processing facilities. The report states that this would allow the United States to quickly mobilize to process ferroalloy ores obtained from the National Defense Stockpile, from commercial stocks, or from other source countries, if imports of processed alloys, such as ferrochromium and ferromanganese from the Republic of South Africa, were disrupted. The report also discussed other policy options relative to U.S. dependence on the Republic of South Africa for strategic materials.[3]

Legislative bill H.R. 4796 was introduced in late 1981 to exempt chromite and chromium metal from the superfund tax, Public Law 96-510. The current tax for each ton purchased is $1.52 for chromite and $4.45 for chromium metal. Chromite, which must be imported because the United States has no reserves, is used in the production of ferrochromium. Since there is no superfund tax on ferrochromium, this penalizes domestic producers of this material, and coincidentally, tends to encourage foreign producers to export ferrochromium, a higher valued product, to the United States, rather than chromite.

Table 1.—Government inventory of ferroalloys, December 31, 1982

(Thousand short tons)

Alloy	Stockpile grade	Nonstockpile grade	Total
Ferrochromium:			
High-carbon	402	1	403
Low-carbon	300	19	319
Ferrochromium-silicon	57	1	58
Ferrocolumbium (contained columbium)	.3	.2	.5
Ferromanganese:			
High-carbon	600	--	600
Medium-carbon	29	--	29
Ferrotungsten (contained tungsten)	.4	.6	1
Silicomanganese	24	--	24

DOMESTIC PRODUCTION

Total domestic production of ferroalloys and ferroalloy metals in 1982 was about 840,000 tons, down sharply by 46% from the low levels of 1981. This is the lowest production figure recorded since 1939. Major factors contributing to the decline in production were weak demand and continued competition from low-priced imports. Production and shipments of the bulk ferroalloys (chromium, manganese, and silicon) and their respective metals in 1982 fell by 47% and 41%, respectively, compared with those of 1981. Bulk ferroalloys and their respective metals represent close to 90% of total production and of total shipments of all ferroalloys and ferroalloy metals. Demand for bulk ferroalloys and their respective metals decreased 42% in 1982 compared with that of 1981, and imports in 1982 amounted to 53% of the domestic market, essentially unchanged from those of 1981. Toward yearend, overall capacity utilization for the bulk ferroalloys industry was only 12%, and only 11 out of the total 97 furnace, electrolytic, and/or metallothermic reduction operations were running. Overall capacity utilization averaged 34% in 1982 compared with 65% in 1981. About 5,000 employees out of a normal work force of 7,700 were laid off in 1982. Producers of other ferroalloys, including the specialty ferroalloys, experienced similar cutbacks in production and shipments.

Thus, because of weak demand by the steel and ferrous foundry industries for ferroalloys and by the aluminum and chemical industries for silicon metal, along with intense competition from low-priced imports, there were numerous plant closures, production cutbacks, and other related events in 1982. Alabama Alloy Co. Inc.'s ferrosilicon plant in Bessemer, Ala., had been closed since November 24, 1981. Northwest Alloys Inc. halted ferrosilicon production at its Addy, Wash., plant on November 28, 1982. Autlan Manganese Corp.'s silicomanganese furnace in Mobile, Ala., was only operational from early June to mid-August 1982. The Chromium Mining & Smelting Corp. had not produced chromium or silicon ferroalloys in the Woodstock, Tenn., furnaces since July 26, 1980. The company produced only chromium concentrates, reclaimed from slagpiles, from November 1980 to December 19, 1982, and ceased all manufacturing operations on December 20.

Elkem Metals Co. produced a full line of silicon products at its Alloy, W. Va., and Ashtabula, Ohio, plants and a full line of manganese products at its Marietta, Ohio, plant, though at reduced rates in 1982. In March 1982, Foote Mineral Co. began operating one of its three ferrosilicon furnaces at its Graham, W. Va., facility.

Table 2.—Ferroalloys produced and shipped from furnaces in the United States[1]

	1981				1982			
	Production		Shipments		Production		Shipments	
	Gross weight (short tons)	Alloy element contained (average percent)	Gross weight (short tons)	Value (thousands)	Gross weight (short tons)	Alloy element contained (average percent)	Gross weight (short tons)	Value (thousands)
Ferromanganese[2]	192,690	[r]80	188,255	$104,072	119,200	82	98,400	$64,961
Silicomanganese	173,263	66	172,542	81,849	68,867	66	82,900	40,787
Manganese metal	24,222	100	22,779	31,891	18,589	100	18,085	25,319
Ferrosilicon[3]	[r]580,086	[r]54	[r]510,361	[r]295,104	298,947	53	317,345	161,715
Silicon metal	129,813	[r]98	121,148	154,034	76,603	98	80,805	102,787
Chromium alloys:								
Ferrochromium	[r]164,040	[r]57	[r]134,766	[r]84,993	91,905	62	82,353	53,087
Other alloys[4]	[r]62,456	[r]45	[r]53,880	[r]61,269	27,380	48	36,961	30,602
Total	[r]226,496	[r]53	[r]188,646	[r]146,262	119,285	57	119,314	83,689
Ferrocolumbium	887	64	807	12,608	W	65	W	W
Ferrophosphorus	80,547	22	[r]42,671	[r]9,442	61,547	25	W	W
Other[5]	137,649	XX	127,680	270,295	74,723	XX	109,177	172,962
Grand total	[r]1,545,653	XX	[r]1,374,889	[r]1,105,557	837,761	XX	826,026	652,220

[r]Revised. W Withheld to avoid disclosing company proprietary data; included with "Other." XX Not applicable.
[1]Does not include alloys consumed in the making of other ferroalloys.
[2]Includes fused-salt electrolytic low- and medium-carbon ferromanganese (massive manganese).
[3]Includes miscellaneous silicon alloys.
[4]Includes ferrochromium-silicon, chromium briquets, exothermic chromium additives, other miscellaneous chromium alloys, and chromium metal.
[5]Includes ferroaluminum, ferroboron and other complex boron additive alloys, ferromolybdenum, ferronickel, ferrotitanium, ferrotungsten, ferrovanadium, ferrozirconium, silvery iron, and other miscellaneous alloys.

The Hanna Mining Co. closed its ferronickel plant in Riddle, Oreg., on April 19 and its Wenatchee, Wash., ferrosilicon and silicon metal plant October 1. Hanna is the Nation's only integrated mine-to-metal producer of nickel. Norcen Energy Resources Ltd., a Toronto, Ontario, Canada, firm, attempted to buy a controlling interest in Hanna. Following legal moves by Hanna to block the acquisition, the two companies agreed that Norcen would limit its interest to a 20% share in Hanna's common stock for a period of 8 years.

Globe Metallurgical Div. halted ferrochromium, ferrosilicon, and silicon metal production at its Beverly, Ohio, plant in early November, but continued to produce silicon metal in one of its two furnaces in Selma, Ala. International Minerals & Chemical Corp. ceased ferrosilicon production at its plants in Bridgeport, Ala., and Kimball, Tenn., on November 1. Macalloy Inc., the only remaining producer of 50% to 55% charge chrome, the major grade used in steelmaking, idled the last of its two ferrochromium furnaces in Charleston, S.C., in late December when its toll conversion contract with Phibro Corp. expired. In January 1982, Phibro negotiated with principal owners Macalloy and Satra Corp. about acquiring a controlling interest in Macalloy, but withdrew its offer in early February. On February 9, Macalloy filed for protection under Chapter 11 of the Federal Bankruptcy Code.

Ohio Ferro-Alloys Corp. continued to be plagued by financial losses, which totaled $20.3 million in 1982. Ohio Ferro-Alloys' four silicon metal furnaces in Powhatan Point, Ohio, have been down since November 1981. The company operated only one of the three silicon metal furnaces at the Montgomery, Ala., facility in 1982. Ohio Ferro-Alloys' Philo, Ohio, plant produced no high-carbon ferromanganese in its two furnaces and operated four ferrosilicon furnaces at less than one-fourth capacity. Reynolds Metals Co.'s Sheffield, Ala., facility restarted one of two silicon metal furnaces in May 1982. Both furnaces had been down since February 1981. Reynolds, which previously produced silicon metal for its own consumption, also emerged as a supplier of silicon metal. Satralloy Inc. indefinitely closed its ferrochromium and ferrochromium-silicon plant in Steubenville, Ohio, in early November 1982. The plant had been running at about one-fourth of its total capacity of 96,000 tons per year.

Table 3.—Producers of ferroalloys in the United States in 1982

Producer	Plant location	Products[1]	Type of furnace
FERROALLOYS (EXCEPT FERROPHOSPHORUS)			
A. Johnson & Co. Inc	Lionville, PA	FeAl, FeTi, FeZr	Electric.
Alabama Alloy Co. Inc	Bessemer, AL	FeSi	Do.
Aluminum Co. of America, Northwest Alloys, Inc.	Addy, WA	FeSi, Si	Do.
Autlan Manganese Corp	Mobile, AL	FeMn, SiMn	Do.
AMAX Inc., Climax Molybdenum Co. Div	Langeloth, PA	FeMo	Metallothermic.
Cabot Corp., KBI Div., Penn Rare Metal Div	Revere, PA	FeCb	Do.
Chromasco Ltd., Chromium Mining & Smelting Corp. Div.	Woodstock, TN	FeCr, FeCrSi	Electric.
Dow Corning Corp	Springfield, OR	Si	Do.
Elkem AS, Elkem Metals Co	Alloy, WV Ashtabula, OH Marietta, OH Niagara Falls, NY	Cr, FeB, FeCr, FeMn, FeSi, Mn, Si, SiMn, other.[2]	Electric and electrolytic.
Engelhard Corp., Chemstone Corp	Strasburg, VA	FeV	Metallothermic.
Foote Mineral Co., Ferroalloys Div	Cambridge, OH Graham, WV Keokuk, IA New Johnsonville, TN.	FeSi, FeV, Mn, silvery pig iron, other.[2]	Electric and electrolytic.
Hanna Mining Co., The:			
Hanna Nickel Smelting Co	Riddle, OR	FeNi, FeSi	Electric.
Silicon Div	Wenatchee, WA	FeSi, Si	Do.
Interlake, Inc., Globe Metallurgical Div	Beverly, OH Selma, AL	FeCr, FeSi, Si, SiMn	Do.
International Minerals & Chemical Corp., Industry Group, TAC Alloys Div.	Bridgeport, AL	FeSi	Do.
	Kimball, TN	FeSi, other[2]	Do.
Kerr-McGee Chemical Corp	Hamilton (Aberdeen), MS.	Mn	Electrolytic.
Macalloy Inc	Charleston, SC	FeCr, FeCrSi	Electric.
Metallurg, Inc., Shieldalloy Corp	Newfield, NJ	Cr, FeAl, FeB, FeCb, FeTi, FeV, other.[2]	Metallothermic.
Ohio Ferro-Alloys Corp	Montgomery, AL Philo, OH Powhatan Point, OH	FeSi, Si	Electric.
Pennzoil Co., Duval Corp	Sahuarita, AZ	FeMo	Metallothermic.
Pesses Co., The	Fort Worth, TX Newton Falls, OH Pulaski, PA Solon, OH	FeAl, FeB, FeCb, FeMo, FeNi, FeTi, FeW, other.[2]	Electric and metallothermic.
Reactive Metals and Alloys Corp	West Pittsburg, PA	FeAl, FeB, FeTi, other[2]	Electric.
Reading Alloys, Inc	Robesonia, PA	FeCb, FeV	Metallothermic.
Reynolds Metals Co	Sheffield, AL	Si	Electric.
Satra Corp., Satralloy Inc. Div	Steubenville, OH	FeCr	Do.
SEDEMA S.A., Chemetals Corp	Kingwood, WV	FeMn	Fused-salt electrolytic.
SKW Alloys Inc	Calvert City, KY Niagara Falls, NY	FeCr, FeCrSi, FeMn, FeSi, SiMn.	Electric.
South African Manganese Amcor, Ltd., Roane Ltd.	Rockwood, TN	FeMn, FeSi, SiMn	Do.
Teledyne, Inc., Teledyne Wah Chang, Albany Div.	Albany, OR	FeCb	Metallothermic.
Union Carbide Corp., Metals Div	Marietta, OH Niagara Falls, NY	FeV, FeW, other[2]	Electric.
Union Oil Co. of California, Molycorp, Inc	Washington, PA	FeB, FeMo	Electric and metallothermic.
FERROPHOSPHORUS			
Electro-Phos Corp	Pierce, FL	FeP	Electric.
FMC Corp., Industrial Chemical Div	Pocatello, ID	do	Do.
Monsanto Co., Monsanto Industrial Chemicals Co.	Columbia, TN Soda Springs, ID	do	Do.
Occidental Petroleum Corp., Hooker Chemical Co., Industrial Chemicals Group.	Columbia, TN	do	Do.
Stauffer Chemical Co., Industrial Chemical Div.	Mt. Pleasant, TN Silver Bow, MT Tarpon Springs, FL	do	Do.

[1]Cr, Chromium metal; FeAl, ferroaluminum; FeB, ferroboron; FeCb, ferrocolumbium; FeCr, ferrochromium; FeCrSi, ferrochromium-silicon; FeMn, ferromanganese; FeMo, ferromolybdenum; FeNi, ferronickel; FeP, ferrophosphorus; FeSi, ferrosilicon; FeTi, ferrotitanium; FeV, ferrovanadium; FeW, ferrotungsten; FeZr, ferrozirconium; Mn, manganese metal; Si, silicon metal; SiMn, silicomanganese.
[2]Includes specialty silicon alloys, zirconium alloys, and miscellaneous ferroalloys.

Chemetals Corp., using its fused-salt electrolytic process in Kingwood, W. Va., continued to be the only domestic producer of low-carbon ferromanganese. Production in 1982, like that of most other ferroalloy producers, was down about one-half. SKW Alloys Inc.'s Niagara Falls, N.Y., facility shut down its ferrosilicon furnace on October 1. The second furnace at Niagara Falls, which had been producing ferrochromium-silicon, was idled earlier in the year. Both furnaces were restarted in December. The number of furnaces operating at SKW's Calvert City, Ky., facility varied during the year. The Calvert City plant normally produces ferrosilicon, magnesium-ferrosilicon, silicomanganese, and medium-carbon ferromanganese in its eight furnaces. In spite of weak demand and competition from imports, SKW began an expansion program in January 1982 to increase ferrosilicon capacity by approximately one-third at its Niagara Falls plant by adding a new 20- to 25-megawatt furnace. The expansion was made possible by an agreement with Niagara Mohawk Power Co. and the Power Authority of the State of New York in which SKW was to be provided additional hydroelectric power. The expansion was to be completed by 1986.

Roane Ltd. halted all ferromanganese and silicomanganese operations at its Rockwood, Tenn., facility on October 1. Three of Roane's submerged-arc furnaces, which had operated with amorphous-carbon electrodes, were retrofitted with Soderberg self-baking electrodes in a project begun in March 1981 and completed by mid-year 1982.

The Ferroalloys Association reported that its member companies consumed 4.0 billion kilowatt-hours of electricity in 1982, down from 7.5 billion in 1981.

CONSUMPTION AND USES

Total consumption of ferroalloys and ferroalloy metals dropped sharply to 1.32 million gross tons in 1982, about 40% lower than in 1981. The decline was primarily due to weak demand by the steel and ferrous foundry industries, the major consumers of ferroalloys, representing about 90% of all ferroalloy consumption end uses. A decline in steel and ferrous casting production that began in the first half of 1981 and continued through 1982 was the result of the worldwide recession. Raw steel production and ferrous casting shipments in 1982 fell 39% to 75 million tons and 33% to 9 million tons, respectively, compared with the 1981 figures, for the lowest combined total since 1946. In general, consumption patterns for ferroalloys paralleled the overall production patterns for steel and for ferrous castings.

Table 4.—Consumption of ferroalloys as additives in the United States in 1982, by end use[1]

(Short tons of alloys unless otherwise specified)

End use	FeMn	SiMn	FeSi	FeTi	FeP	FeB
Steel:						
Carbon	334,502	66,601	[2]61,918	374	7,094	(3)
Stainless and heat-resisting	9,920	3,178	[2]33,310	1,203	(3)	15
Other alloy	83,384	25,483	[2]33,374	658	1,371	154
Tool	257	36	[2]1,298	(3)	(3)	--
Unspecified	392	551	30,574	5	6	761
Total	428,455	95,849	160,474	2,240	8,471	930
Cast irons	12,987	7,736	177,890	47	2,189	W
Superalloys	[4]350	W	177	W	--	W
Alloys (excluding alloy steels and superalloys)	10,157	1,785	36,838	156	67	58
Miscellaneous and unspecified	925	225	53,052	32	2,011	58
Total consumption	452,874	105,595	428,431	2,475	12,738	1,046
Percent of 1981	54	68	66	77	64	58

W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous and unspecified."
[1]FeMn, ferromanganese including spiegeleisen and manganese metal; SiMn, silicomanganese; FeSi, ferrosilicon including silicon metal, silvery pig iron, and inoculant alloys; FeTi, ferrotitanium; FeP, ferrophosphorus; FeB, ferroboron including other boron materials.
[2]Part included with "Steel: Unspecified."
[3]Included with "Steel: Unspecified."
[4]Part included with "Miscellaneous and unspecified."

Table 5.—Consumption of ferroalloys as alloying elements in the United States in 1982, by end use[1]

(Short tons of contained elements unless otherwise specified)

End use	FeCr	FeMo	FeW	FeV	FeCb	FeNi
Steel:						
Carbon	3,642	62	--	698	569	--
Stainless and heat-resisting	109,929	228	15	15	225	11,519
Other alloy	29,225	725	12	1,959	706	2,917
Tool	1,171	104	53	273	(2)	(3)
Unspecified	(4)	(4)	--	--	4	--
Total[5]	143,967	1,119	80	2,945	1,504	14,436
Cast irons	4,285	516	--	20	--	102
Superalloys	5,556	76	W	6	324	436
Alloys (excluding alloy steels and superalloys)	[5]2,412	140	2	23	9	451
Miscellaneous and unspecified	787	24	12	1	2	1
Total consumption	157,007	1,875	94	2,995	1,839	15,426
Percent of 1981	62	51	45	50	59	59

W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous and unspecified."
[1]FeCr, ferrochromium including other chromium ferroalloys and chromium metal; FeMo, ferromolybdenum including calcium molybdate; FeW, ferrotungsten; FeV, ferrovanadium including other vanadium-carbon-iron ferroalloys; FeCb, ferrocolumbium including nickel columbium; FeNi, ferronickel.
[2]Included with "Steel: Unspecified."
[3]Included with "Steel: Other alloy."
[4]Included with "Miscellaneous and unspecified."
[5]Part included with "Miscellaneous and unspecified."

Table 6.—Stocks of ferroalloys held by producers and consumers in the United States at yearend

(Short tons)

	Producer		Consumer		Total	
	1981 (gross weight)	1982 (gross weight)	1981 (gross weight)	1982 (gross weight)	1981 (gross weight)	1982 (gross weight)
Manganese ferroalloys[1]	95,909	98,185	172,023	183,119	267,932	281,304
Silicon alloys[2]	167,026	177,726	43,587	28,728	210,613	206,454
Ferrochromium[3]	60,002	62,532	56,068	29,082	116,070	91,614
Ferroboron[4]	W	W	317	192	317	192
Ferrophosphorus	133,296	153,822	2,887	1,345	136,183	155,167
Ferrotitanium	W	W	655	481	655	481
Total	456,233	492,265	275,537	242,947	731,770	735,212
	1981 (contained element)	1982 (contained element)	1981 (contained element)	1982 (contained element)	1981 (contained element)	1982 (contained element)
Ferrocolumbium[5]	W	W	W	W	934	380
Ferromolybdenum[6]	1,010	2,195	457	308	1,467	2,503
Ferronickel	W	W	2,257	1,122	2,257	1,122
Ferrotungsten	W	W	48	45	48	45
Ferrovanadium[7]	1,683	1,148	548	280	2,231	1,428
Total	2,693	3,343	3,310	1,755	6,937	5,478

W Withheld to avoid disclosing company proprietary data.
[1]Includes ferromanganese, silicomanganese, and manganese metal.
[2]Includes ferrosilicon, miscellaneous silicon alloys, and silicon metal.
[3]Includes other chromium alloys and chromium metal.
[4]Consumer totals include other boron materials.
[5]Consumer totals include nickel columbium.
[6]Consumer totals include calcium molybdate.
[7]Includes other vanadium-iron-carbon ferroalloys.

Combined consumption for bulk ferroalloys and their respective metals, accounting for about 95% of all ferroalloys and metals consumed, decreased 40% in 1982 compared with that of 1981. Consumption of chromium ferroalloys in stainless steel, its major end use, was down by a larger percentage than that for other bulk ferroalloys in 1982, because the quantity of stainless steel scrap consumed to make raw stainless steel increased from approximately 50% in 1981 to about 60% in 1982. Demand for ferronickel to make stainless steel, its major end use, was also weakened owing to the higher stainless steel scrap recycling rates. Demand was weakest for the specialty alloys ferrovanadium and ferromolybdenum, partly the result of sharply reduced orders for oil country tubular goods, and for ferrotungsten because of a reduction in tool steel production.

Ferrosilicon consumption for cast irons in 1982 was higher than that for total steel, which is normal. This was not the case for the 2 previous years when demand for cast irons by the automotive industry was weak relative to demand for steel products. The average number of pounds of silicomanganese consumed per ton of raw steel produced had steadily risen from 1.9 in 1973 to 2.6 in 1982. This trend coincides with increased continuous casting of steel and the larger electric-furnace steelmaking share of domestic raw steel production.

According to reported data on consumption of silicomanganese, ferromanganese, and ferrosilicon, a trend towards increased use of silicomanganese in both steel and ferrous castings appears to be emerging. In general, the ratios of silicomanganese to ferromanganese, and of silicomanganese to ferrosilicon, have tended to increase in both steel and ferrous casting production over the past decade.

Consumption of ferrochromium in steel continues to shift from low-carbon to high-carbon owing to increased use of the argon-oxygen decarburization (AOD) process.

PRICES

Virtually all ferroalloy prices were depressed in 1982 because of weak markets and strong competition among producers. In many instances, ferroalloys were reported to be selling below listed prices. Posted prices of domestic producers remained unchanged in 1982 for ferrochromium-silicon, ferromolybdenum, ferronickel, ferrotungsten, ferrovanadium, electrolytic chromium metal, and regular-grade manganese metal, and for all grades of low-carbon ferrochromium, ferromanganese, magnesium-ferrosilicon, and silvery pig iron. Posted prices for other domestically produced ferroalloys declined in 1982, from as little as 3% for Ferovan, which went from $7.75 per pound of contained vanadium to $7.50, to as much as 20% for 50% to 55% charge chrome, which went from $0.475 per pound of contained chromium to $0.380 after the extra import duty on ferrochromium expired on November 15. Percentage price declines in 1982 for other ferroalloys within this range included 4% for regular-grade ferrocolumbium, 5% for Carvan, 8% for silicomanganese and all grades of silicon metal, 9% for 50% ferrosilicon, 12% for 75% ferrosilicon, 15% for high-purity ferrocolumbium, and 17% for 66% to 70% charge chrome. Except for ferronickel, the average posted price in 1982 for individual imported ferroalloys was lower than that of domestic ferroalloys, by 4% for 50% to 55% charge chrome, 6% for low-carbon ferrochromium, 9% for both 60% to 70% charge chrome and 50% ferrosilicon, 10% for silicon metal, 17% for medium-carbon ferromanganese, 20% for silicomanganese, 21% for high-carbon ferromanganese, and 22% for 75% ferrosilicon. The following tabulation shows the prices for domestic ferroalloys:

Alloy	End of year price[1]	
	1981	1982
Charge chromium (66% to 70%)	$0.52	$0.43
Low-carbon ferrochromium, 0.02% maximum carbon (Simplex)	1.00	1.00
Standard 78% ferromanganese, per long ton of alloy	490.00	490.00
Ferromolybdenum, lump	9.40	[2]9.40
Ferronickel	3.16	3.16
Ferrosilicon, 50%	.4925	.4500
Ferrosilicon, 75%	.5325	.4700

[1]Per pound contained, except as noted otherwise. If range of prices was quoted, the lowest price is shown.
[2]List price suspended on Dec. 16.

FOREIGN TRADE

Because of weak demand, the trade deficit for ferroalloys dropped sharply from $701 million in 1981 to $323 million in 1982. A surplus for ferroalloy metals of $23 million in 1980 and $2 million in 1981 became a deficit of $1 million in 1982.

The quantity of exported ferroalloys and ferroalloy metals on a gross weight basis decreased 36% to about 48,000 tons in 1982. The value and quantity of exported ferroalloys and ferroalloy metals in 1982 were 20% and 6% those of imports, respectively, compared with 15% and 5%, respectively, in 1981.

Total imports of ferroalloys and ferroalloy metals fell 44% in 1982, compared with those of 1981, to about 840,000 tons. Imports increased for low-carbon ferromanganese, two grades of ferrosilicon, and one grade of silicon metal, but overall imports for bulk ferroalloys and respective metals declined 43%. The most marked change occurred for high-carbon ferrochromium and ferronickel imports, primarily consumed in stainless steels, each of which decreased 69%. Except for ferromolybdenum, which increased 42%, virtually all ferroalloy imports were down. Ferroalloy and ferroalloy metal imports in 1982 were equal to 64% of reported domestic consumption, down from 69% in 1981. Domestic producers continued to find it difficult to compete with low-priced foreign imports, a situation that was exacerbated by the continuing strength of the U.S. dollar.

Ferroalloys and ferroalloy metals imported into the United States in 1982 had the following breakdown by source: Africa, 43%; Europe, 26%; the Western Hemisphere, 23%; and Asia, 4%, compared with 43%, 30%, 21%, and 3%, respectively, in 1981. The Republic of South Africa and Zimbabwe together supplied the United States with 64% of its imported chromium ferroalloys in 1982, down from 76% in 1981 and 90% in 1980. Zimbabwe's and Brazil's shares of chromium ferroalloy imports to the United States in 1982 increased from 16% to 27% and 5% to 12%, respectively, compared with those of 1981, but the Republic of South Africa's share declined from 60% to 37%. Yugoslavia's share of chromium ferroalloys imported into the United States in 1982 was unchanged at 11%. Major sources for imported manganese ferroalloys in 1982 were the Republic of South Africa with 46% and France with 19%, compared with 37% and 24%, respectively, in 1981. The Western Hemisphere suppliers, Canada, Brazil, and Mexico, furnished 19% of the manganese ferroalloy imports in 1982, compared with 20% in 1981. Brazil's and Mexico's shares of manganese ferroalloy imports were up slightly, but Canada's share was down by one-half. Leading suppliers of ferrosilicon in 1982 continued to be Brazil (40%), Norway (14%), Canada (14%), and Venezuela (11%), compared with 29%, 20%, 13%, and 15%, respectively, in 1981. Combined imports of ferronickel from Japan and New Caledonia increased from 53% in 1981 to 99% in 1982. Major suppliers of ferroalloy metal imports in 1982 were Canada with 45% of the silicon metal, the Republic of South Africa with 97% of the manganese metal, and Japan and the United Kingdom combined with 81% of the chromium metal, compared with 46%, 99%, and 85%, respectively, in 1981.

Table 7.—U.S. exports of ferroalloys and ferroalloy metals

Alloy	1980		1981		1982	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Ferroalloys:						
Ferrocerium and alloys	17	$196	11	$117	27	$264
Ferrochromium and ferrochromium-silicon	31,705	22,233	14,098	10,361	4,943	5,081
Ferromanganese	11,686	7,657	14,925	12,477	10,311	7,517
Silicomanganese	6,489	3,468	3,941	2,172	2,952	1,532
Ferromolybdenum	880	17,104	228	2,984	128	675
Ferrophosphorus	44,692	6,778	7,463	2,031	4,031	1,402
Ferrosilicon	27,488	18,572	15,768	12,136	14,932	11,996
Ferrovanadium	802	6,995	434	4,397	326	3,436
Ferroalloys, n.e.c	4,710	10,130	6,358	8,439	4,980	8,481
Total ferroalloys[1]	128,470	93,133	63,226	55,114	42,630	40,388
Metals:						
Manganese	12,320	11,460	2,523	3,980	2,948	3,861
Silicon	14,372	65,478	8,673	57,001	2,411	34,335
Chromium	350	3,789	395	5,209	213	2,685
Total ferroalloy metals[1]	27,042	80,727	11,592	66,190	5,572	40,881
Grand total	155,512	173,860	74,818	121,304	48,202	81,269

[1]Data may not add to totals shown because of independent rounding.

Table 8.—U.S. imports for consumption of ferroalloys and ferroalloy metals

Alloy	1981 Gross weight (short tons)	1981 Content (short tons)	1981 Value (thousands)	1982 Gross weight (short tons)	1982 Content (short tons)	1982 Value (thousands)
Manganese alloys:						
Ferromanganese containing less than 1% carbon	3,207	2,788	$3,065	3,858	3,393	$3,807
Ferromanganese containing over 1% and less than 4% carbon	31,904	25,749	18,496	25,907	21,124	15,159
Ferromanganese containing 4% or more carbon	636,067	493,289	205,057	462,944	359,185	135,524
Ferrosilicon-manganese (Mn content)	129,005	84,900	49,754	62,095	41,121	21,471
Spiegeleisen	103	(1)	67	43	(1)	25
Total manganese alloys[2]	800,286	606,726	276,439	554,846	424,824	175,986
Ferrosilicon:						
8% to 30% silicon	2,783	393	177	641	162	204
30% to 60% silicon, over 2% magnesium	4,360	2,011	3,671	5,805	2,653	4,657
30% to 60% silicon, n.e.c	14,242	7,451	9,522	11,940	5,984	6,733
60% to 80% silicon, over 3% calcium	16,217	11,089	11,343	5,526	3,771	5,155
60% to 80% silicon, n.e.c	116,778	87,963	54,918	50,642	37,816	22,850
80% to 90% silicon	1,153	980	568	698	601	208
Over 90% silicon	115	111	118	1,490	1,361	536
Total ferrosilicon	155,648	109,998	80,317	76,742	52,348	40,343
Chromium alloys:						
Ferrochromium containing 3% or more carbon	387,637	219,961	173,529	118,491	69,357	55,796
Ferrochromium containing less than 3% carbon	40,602	27,453	40,082	22,819	15,417	21,699
Ferrosilicon-chromium	11,435	4,402	5,224	6,993	2,725	3,322
Total chromium alloys[2]	439,674	251,816	218,835	148,304	87,499	80,817
Ferronickel	69,853	20,247	119,321	21,351	5,344	28,215
Other ferroalloys:						
Ferrocerium and other cerium alloys	92	(1)	1,249	95	(1)	1,092
Ferromolybdenum	587	459	6,353	832	609	6,308
Ferrophosphorus	61	(1)	28	22	(1)	4
Ferrotitanium and ferrosilicon-titanium	615	(1)	1,582	152	(1)	263
Ferrotungsten and ferrosilicon-tungsten	198	162	3,020	95	77	1,222
Ferrovanadium	1,236	984	13,288	852	669	8,065
Ferrozirconium	877	(1)	1,223	683	(1)	881
Ferroalloys, n.e.c.[3]	5,816	(1)	34,392	6,273	(1)	19,764
Total other ferroalloys[2]	9,482	XX	61,135	9,003	XX	37,599
Total ferroalloys	1,474,943	XX	756,047	810,246	XX	362,960
Metals:						
Manganese	8,343	(1)	8,419	5,226	(1)	5,213
Silicon (96% to 99% silicon)	17,776	(1)	18,485	13,366	(1)	13,494
Silicon (99% to 99.7% silicon)	11,026	10,926	12,188	12,322	12,214	13,246
Chromium	3,539	(1)	24,626	1,850	(1)	10,078
Total ferroalloy metals[2]	40,684	XX	63,718	32,764	XX	42,032
Grand total[2]	1,515,627	XX	819,765	843,011	XX	404,992

XX Not applicable.
[1]Not recorded.
[2]Data may not add to totals shown because of independent rounding.
[3]Principally ferrocolumbium.

WORLD REVIEW

World production and consumption of ferroalloys in 1982 were lower for the third consecutive year, following the overall trend of steel production, which has also declined progressively since 1979. Production and consumption of ferroalloys in the United States in 1982 were down by a greater percentage than in most other nations. The only market economy countries that increased production in 1982 were

Finland, Iceland, and Switzerland. Three countries with centrally planned economies, including China, and seven developing countries, including Brazil, Mexico, and Venezuela, also showed a slight increase in production in 1982. However, production of ferroalloys in all other countries in 1982 was down. Except for China and the United States, which exchanged places, the ranking of the world's top 10 ferroalloy producers in 1982 remained unchanged compared with that of 1981. China moved up from sixth place in 1981 to fourth in 1982. Although most ferroalloys were in abundant supply in 1982 owing to the depressed state of world steel production, new capacity was being added. Most of the new capacity was being constructed near the supply of ore rather than near the consumption site.

World ferroalloy producers, faced with overcapacity in 1982 owing to weak markets for their products, initiated various types of trade actions to protect their domestic markets. For example, the European Economic Community (EEC), in response to dumping complaints filed with the EEC by producers of ferroalloys from its 10 member countries, began an investigation to determine if Iceland, Norway, Sweden, Venezuela, and Yugoslavia were dumping ferroalloy products in the EEC's common market.[4] Actions taken by the EEC to protect ferroalloy producers of member countries from low-priced imports included setting quotas on duty-free imports of high-carbon ferrochromium,[5] ferrosilicon, silicomanganese, and low-carbon ferrochromium,[6] setting minimum prices on imported high-carbon ferromanganese,[7] and imposing an extra duty of 8% on ferrochrome imported from nonexempt countries such as the Republic of South Africa.[8]

Belgium.—Sadaci, the ferroalloys division of Sadacem Ltd., had been having financial problems for several years with its manganese ferroalloy operations at its Langerbruggekaai plant near Ghent, although production of specialty ferroalloys had realized a profit. Manganese ferroalloy production had to be cut back progressively in response to reduced demand by Société Nationale de Financement et de Participations de la Sidérurgie (SNS), the state-owned steel company. The Belgian Government, concerned that the closing of Sadaci's ferromanganese operations would leave its state-owned steel industry entirely dependent on imports, agreed to provide financial assistance to the ailing ferroalloy producer. The new company created from that assistance is owned 50% by Sadacem and 50% by the Belgian Government via SNS, the state steel holding company.[9]

Brazil.—Development of the $60 billion Carajás minerals project to extract manganese, nickel, and other ores is a prelude to the Brazilian Government's commitment to significantly boost ferroalloys production in Brazil. In September, the Interministerial Council for the Grande Carajás Development Project awarded the state-owned mining company, Cia. Vale do Rio Doce (CVRD), exclusive rights to develop the Igarapé Azul manganese deposit, the largest in Carajás, containing about 46 million tons of ore grading 42% manganese.[10]

A $100 million nickel laterite mine and adjacent ferronickel smelting plant, 112 miles north of Brasilia, was commissioned by Empresa de Desenvolvimento de Recursos Minerais S.A. (CODEMIN) toward year-end. CODEMIN is owned principally by the Hochschild Group and Anglo American Corp. do Brasil. The two furnaces have a combined capacity of about 6,000 tons per year of nickel contained in ferronickel.[11]

Cia. Brasileira de Metalurgia e Mineração (CBMM), the world's largest supplier of ferrocolumbium, began producing 99.99% pure columbium metal from columbium oxides of 99% purity on a pilot plant scale. After the metal has been tested against international quality standards, it should reach the market by early 1983, when production should be at capacity of 44 tons per year. A commercial-scale facility for CBMM's aluminothermic-columbium metal process will be added at the Araxa, Minas Gerais State, mine and mill location, where the company produces ferrocolumbium, if pilot tests are successful.[12]

Cia. Brasileira Carbureto de Cálcio (CBCC), Brazil's major producer of 75% ferrosilicon, plans to increase its production to 88,000 tons per year by 1995. The plan consists of adding a second 22,000-ton-per-year furnace in 1984 and two more in the following 10 years.[13]

Ferroalloy production in Brazil continued to take a larger share of the world ferroalloy market. Brazil's total ferroalloy production, as a percentage of the world total, has increased from less than 3% in 1978 to more than 4% in 1982. Brazil was ranked as the world's eighth major producer of ferroalloys in 1982, the same as in 1980 and 1981 In addition, Brazil was the third leading producer of silicomanganese in 1982.

Table 9.—Ferroalloys: World production, by country, furnace type, and alloy type[1]

(Thousand short tons)

Country,[2] furnace type,[3] and alloy type[4]	1978	1979	1980	1981[p]	1982[e]
Albania: Electric furnace, ferrochromium[e]	--	NA	4	31	33
Argentina: Electric furnace:					
Ferromanganese	28	[r]38	26	25	[5]26
Silicomanganese	11	[r]17	13	14	[5]17
Ferrosilicon	11	[r]15	13	11	[5]10
Other	1	3	2	3	[5]11
Total	51	[r]73	54	53	[5]64
Australia: Electric furnace:[6]					
Ferromanganese	105	95	104	[e]94	93
Silicomanganese	--	22	20	[e]21	20
Ferrosilicon	21	21	20	[e]20	20
Total	126	138	144	[e]135	133
Austria: Electric furnace, undistributed	8	10	[e]9	[e]9	9
Belgium: Electric furnace, ferromanganese[7]	96	99	94	99	99
Brazil: Electric furnace:					
Ferromanganese	130	147	155	119	[5]133
Silicomanganese	117	141	148	157	[5]190
Ferrosilicon	80	83	120	140	[5]134
Silicon metal	6	6	14	21	[5]20
Ferrochromium	69	93	103	131	[5]107
Ferrochromium-silicon	5	8	9	10	[5]3
Ferronickel	12	13	12	12	[5]14
Other	32	[r]43	47	41	[5]39
Total	451	[r]534	608	631	[5]640
Bulgaria: Electric furnace:[e]					
Ferromanganese[8]	31	31	31	37	37
Ferrosilicon	19	18	18	22	22
Other	1	1	1	1	1
Total	51	50	50	60	60
Canada: Electric furnace:					
Ferromanganese[e 8]	[r]62	45	95	120	116
Ferrosilicon	[r]115	105	153	121	116
Silicon metal	[r]24	29	43	31	30
Other[e 9]	[r]19	[r]14	28	38	36
Total	[r]220	[r]193	319	310	298
Chile: Electric furnace:					
Ferromanganese	6	6	6	6	6
Silicomanganese	(10)	(10)	(10)	(10)	(10)
Ferrosilicon	2	6	6	5	5
Other	(10)	1	1	(10)	(10)
Total	8	13	13	11	11
China: Furnace type unspecified:[e 11]					
Ferromanganese[8]	340	375	390	415	430
Ferrosilicon	165	180	190	205	215
Silicon metal	9	10	15	17	25
Ferrochromium[12]	100	100	110	120	130
Other[9]	46	55	65	70	80
Total	660	720	770	827	880
Colombia: Electric furnace, ferrosilicon[13]	1	1	1	1	1
Czechoslovakia: Electric furnace:					
Ferromanganese[e 8]	110	110	110	110	110
Ferrosilicon[e]	39	36	35	35	35
Silicon metal[e]	6	6	6	6	6
Ferrochromium[e]	33	31	30	30	30
Other[e 9]	13	10	10	10	10
Total[14]	201	193	191	191	191

See footnotes at end of table.

Table 9.—Ferroalloys: World production, by country, furnace type, and alloy type[1] —Continued

(Thousand short tons)

Country,[2] furnace type,[3] and alloy type[4]	1978	1979	1980	1981[p]	1982[e]
Dominican Republic: Electric furnace, ferronickel	41	73	47	55	17
Egypt: Electric furnace, ferrosilicon	[e]5	--			
Finland: Electric furnace, ferrochromium	49	54	58	57	60
France:					
Blast furnace:					
Spiegeleisen	[r]8	[r]2	([15])	1	1
Ferromanganese	430	[r]493	529	344	366
Electric furnace:					
Silicomanganese[16]	21	14	22	11	11
Ferrosilicon	219	300	283	208	[5]186
Silicon metal	46	61	66	66	66
Ferrochromium[12]	102	105	49	30	[5]16
Other[17]	143	157	137	131	115
Total	[r]969	1,132	1,086	791	761
German Democratic Republic:					
Blast furnace, spiegeleisen	4	--	--		--
Electric furnace:					
Ferromanganese[e 8]	88	88	86	86	86
Ferrosilicon[e]	34	33	32	32	32
Silicon metal[e]	4	4	4	4	4
Ferrochromium[e]	28	23	22	22	22
Other[e 9]	23	22	21	21	21
Total[14]	181	170	165	165	165
Germany, Federal Republic of:					
Blast furnace:					
Ferromanganese	231	257	220	236	220
Ferrosilicon	86	87	71	55	55
Electric furnace:					
Ferromanganese[e 8]	17	33	28	21	21
Ferrosilicon[e]	33	55	55	46	47
Ferrochromium[e]	55	66	66	55	55
Other[e 9]	48	56	55	47	48
Total	470	554	495	460	446
Greece: Electric furnace, ferronickel	61	60	57	56	56
Hungary: Electric furnace:					
Ferromanganese[8]	([15])	([15])	([15])	([15])	--
Ferrosilicon	8	9	11	12	12
Silicon metal[e]	2	2	2	2	2
Other	[r]3	[r]5	3	3	3
Total[14]	13	16	16	17	17
Iceland: Electric furnace, ferrosilicon	--	17	28	37	[5]46
India: Electric furnace:					
Ferromanganese	243	[r]206	179	230	220
Silicomanganese	[r]5	6	14	11	11
Ferrosilicon	58	[r]59	47	66	44
Silicon metal	3	3	3	4	4
Ferrochromium	24	24	18	34	44
Ferrochromium-silicon	4	4	4	5	4
Other	1	1	1	1	1
Total	[r]338	[r]303	266	351	328
Indonesia: Electric furnace, ferronickel	22	20	20	23	20
Italy:					
Blast furnace:					
Spiegeleisen	3	3	6	1	1
Ferromanganese	68	74	[e]67	65	65
Electric furnace:					
Ferromanganese	31	24	[e]24	14	13
Silicomanganese	47	60	50	60	58
Ferrosilicon	75	89	79	61	60
Silicon metal	16	[e]17	[e]17	[e]17	17
Ferrochromium	41	47	45	11	11
Ferrochromium-silicon	([10])	[r]([10])	--	--	--
Other[18]	8	12	16	14	13
Total[18]	289	326	304	243	238

See footnotes at end of table.

Table 9.—Ferroalloys: World production, by country, furnace type, and alloy type[1] —Continued

(Thousand short tons)

Country,[2] furnace type,[3] and alloy type[4]	1978	1979	1980	1981[p]	1982[e]
Japan: Electric furnace:					
Ferromanganese	502	665	627	626	[5]593
Silicomanganese	334	330	342	312	[5]297
Ferrosilicon	298	352	335	259	[5]212
Silicon metal	16	17	17	13	13
Ferrochromium	302	403	444	337	[5]362
Ferrochromium-silicon	10	14	23	12	[5]11
Ferronickel	219	335	305	269	[5]236
Other	22	24	26	16	[5]17
Total	1,703	2,140	2,119	1,844	1,741
Korea, North: Furnace type unspecified:[e] [11]					
Ferromanganese[8]	72	72	77	77	77
Ferrosilicon	33	33	33	33	33
Other[9]	15	15	22	22	22
Total	120	120	132	132	132
Korea, Republic of: Electric furnace:					
Ferromanganese	[e] [19]52	[19]58	60	71	71
Ferrosilicon	[19]34	[19]42	33	39	39
Other[19] [20]	[e]1	23	27	31	29
Total	87	123	120	141	[5]139
Mexico: Electric furnace:					
Ferromanganese	118	136	138	144	144
Silicomanganese	37	34	34	29	33
Ferrosilicon	27	27	30	31	31
Ferrochromium	5	5	--	--	--
Other	1	1	2	2	2
Total	188	203	204	206	210
New Caledonia: Electric furnace, ferronickel	[e]86	136	145	121	116
Norway: Electric furnace:					
Ferromanganese	301	372	316	248	248
Silicomanganese	147	203	180	218	218
Ferrosilicon	293	[r]385	338	302	302
Silicon metal[e]	[r]64	77	94	61	61
Ferrochromium	17	13	12	13	13
Ferrochromium-silicon	1	1	([10])	1	1
Other	33	[r]32	8	13	13
Total[14]	[r]856	[r]1,083	948	856	856
Peru: Electric furnace:[e]					
Ferromanganese	1	1	1	1	1
Ferrosilicon	1	1	1	1	1
Total	2	2	2	2	2
Philippines: Electric furnace:[e]					
Ferrosilicon	15	20	22	25	30
Ferrochromium	[r]11	[r]11	11	11	13
Total	[r]26	[r]31	33	36	43
Poland:					
Blast furnace:					
Spiegeleisen	8	9	8	8	8
Ferromanganese	131	143	131	131	131
Electric furnace:					
Ferromanganese[e] [8]	[r]52	[r]54	52	52	52
Ferrosilicon[e]	[r]55	[r]60	55	55	55
Silicon metal[e]	[r]11	[r]11	11	11	11
Ferrochromium[e]	[r]52	[r]54	52	52	52
Other[e] [9]	[r]16	[r]15	17	17	17
Total[14]	[r]325	[r]346	326	326	326
Portugal: Electric furnace:					
Ferromanganese[e] [21]	86	83	82	72	71
Silicomanganese[e] [21]	17	17	19	20	19
Ferrosilicon[e]	33	28	28	26	24
Silicon metal[e]	22	35	36	35	35
Other[e]	([10])	([10])	([10])	([10])	([10])
Total[14]	158	163	165	153	149

See footnotes at end of table.

Table 9.—Ferroalloys: World production, by country, furnace type, and alloy type[1] —Continued

(Thousand short tons)

Country,[2] furnace type,[3] and alloy type[4]	1978	1979	1980	1981[p]	1982[e]
South Africa, Republic of: Furnace type unspecified:[11]					
Ferromanganese[e]	364	617	573	496	485
Silicomanganese[e]	24	50	77	55	44
Ferrosilicon[e]	83	164	179	121	110
Silicon metal[e]	36	39	33	33	33
Ferrochromium[e]	728	860	882	827	661
Ferrochromium-silicon[e]	25	r31	42	22	22
Other[e] [22]	(10)	(10)	(10)	(10)	(10)
Total[14]	1,260	r1,761	1,786	1,554	1,355
Spain: Electric furnace:					
Ferromanganese	148	r157	135	106	99
Silicomanganese	120	r131	104	77	96
Ferrosilicon	108	r126	136	94	73
Silicon metal[e]	22	22	22	20	20
Ferrochromium	15	22	18	19	25
Other	r6	r8	7	7	7
Total[14]	r419	r466	422	323	320
Sweden: Electric furnace:					
Ferrosilicon	1	--	--	--	--
Silicon metal	10	r14	20	18	18
Ferrochromium	183	209	159	208	208
Ferrochromium-silicon	5	32	9	22	22
Other	2	3	2	3	3
Total[14]	201	r258	190	251	251
Switzerland: Electric furnace:[e]					
Ferrosilicon	r3	r3	3	3	3
Silicon metal	r2	r2	2	2	3
Total	r5	r5	5	5	6
Taiwan: Electric furnace, ferrosilicon	33	41	39	44	[5]51
Thailand: Electric furnace:					
Ferromanganese	1	r2	(10)	(10)	(10)
Ferrosilicon	2	r3	(10)	1	1
Total	3	r5	(10)	1	1
Turkey: Electric furnace:[e]					
Ferromanganese	(15)	(15)	(15)	(15)	
Ferrosilicon	(15)	(15)	(15)	(15)	3
Ferrochromium	44	33	35	36	39
Total	r44	r33	35	36	42
U.S.S.R.:					
Blast furnace:[e]					
Spiegeleisen[e]	r55	55	55	55	55
Ferromanganese[e]	r606	r606	606	606	606
Other	110	110	110	(15)	
Electric furnace:[23]					
Ferromanganese[e]	810	r1,003	1,003	1,003	1,003
Silicomanganese[e]	33	33	35	35	35
Ferrosilicon[e]	683	694	694	717	750
Silicon metal[e]	52	63	65	65	65
Ferrochromium[e]	610	610	661	661	661
Ferrochromium-silicon[e]	11	11	11	11	11
Other[17]	204	214	220	230	248
Total	r3,174	r3,399	3,460	3,383	3,434
United Kingdom:					
Blast furnace, ferromanganese	76	r150	57	93	67
Electric furnace, undistributed[e]	18	18	13	14	12
Total	94	r168	70	107	79

See footnotes at end of table.

Table 9.—Ferroalloys: World production, by country, furnace type, and alloy type[1] —Continued

(Thousand short tons)

Country,[2] furnace type,[3] and alloy type[4]	1978	1979	1980	1981[p]	1982[e]
United States: Electric furnace:[24]					
Ferromanganese	273	317	189	193	[5]119
Silicomanganese	142	165	188	173	[5]69
Ferrosilicon	703	712	559	[r]580	[5]299
Silicon metal	116	145	127	130	[5]77
Ferrochromium	[r]176	[r]247	[r]184	[r]164	[5]92
Ferrochromium-silicon	[r][25]43	[r][25]48	[r][25]54	[r][25]62	[5][25]27
Other[26]	213	241	[r]245	219	[5]136
Total[27]	1,666	1,875	1,547	1,521	[5]819
Uruguay: Electric furnace, ferrosilicon	([10])	([10])	--	--	--
Venezuela: Electric furnace:					
Ferromanganese	--	1	2	2	2
Silicomanganese	--	1	2	2	2
Ferrosilicon	[e]31	[r]39	52	24	52
Total	[e]31	[r]41	56	28	56
Yugoslavia: Electric furnace:					
Ferromanganese	41	50	37	56	46
Silicomanganese	31	32	36	32	21
Ferrosilicon	66	75	73	88	77
Silicon metal	34	35	33	31	26
Ferrochromium	56	72	76	76	66
Ferrochromium-silicon	9	7	11	6	7
Other	3	4	1	1	1
Total	240	275	267	290	[5]244
Zimbabwe: Electric furnace:					
Ferromanganese[e]	[r]3	3	3	2	1
Ferrochromium[e]	220	220	287	231	176
Total	[r]223	223	290	233	177
Grand total[27]	[r]15,255	[r]17,646	17,160	16,206	15,122
Of which:					
Blast furnace:					
Spiegeleisen[28]	[r]78	[r]69	69	65	65
Ferromanganese[28]	[r]1,542	[r]1,723	1,610	1,475	1,455
Other[29]	196	197	181	55	55
Total blast furnace	[r]1,816	1,989	1,860	1,595	1,575
Electric furnace:[11]					
Ferromanganese[30]	[r]3,335	[r]3,824	3,583	3,537	3,410
Silicomanganese[30] [31]	[r]1,086	[r]1,256	1,284	1,227	1,141
Ferrosilicon	[r]3,387	[r]3,832	3,701	3,465	3,131
Silicon metal	[r]501	[r]598	630	587	536
Ferrochromium[32]	[r]2,920	[r]3,302	3,327	3,156	2,876
Ferrochromium-silicon[25] [32]	[r]113	[r]156	163	151	108
Ferronickel[33]	441	637	586	536	459
Other[33]	[r]854	[r]960	964	941	873
Undistributed	26	28	22	23	21

See footnotes at end of table.

Table 9.—Ferroalloys: World production, by country, furnace type, and alloy type[1] —Continued

(Thousand short tons)

Country,[2] furnace type,[3] and alloy type[4]	1978	1979	1980	1981[p]	1982[e]
Total electric furnace	[r]12,663	[r]14,593	14,260	13,623	12,555
Furnace type unspecified: Ferromanganese[11]	[r]776	[r]1,064	1,040	988	992

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.
[1]Table includes data available through June 15, 1983.
[2]In addition to the countries listed, Romania is known to produce electric furnace ferroalloys, but output is not reported quantitatively and no basis is available for estimation.
[3]To the extent possible, ferroalloy production of each country has been separated according to the furnace type from which production is obtained; production derived from metallothermic operations is included with electric furnace production.
[4]To the extent possible, ferroalloy production of each country has been separated so as to show individually the following major types of ferroalloys: spiegeleisen, ferromanganese, silicomanganese, ferrosilicon, silicon metal, ferrochromium, ferrochromium-silicon, and ferronickel. Ferroalloys other than those listed that have been identified specifically in sources, as well as those ferroalloys not identified specifically but which definitely exclude those listed previously in this footnote, have been reported as "Other." For countries for which one or more of the individual ferroalloys listed separately in this footnote have been inseparable from some other ferroalloys owing to the nation's reporting system, such deviations are indicated by individual footnotes. In instances where ferroalloy production has not been subdivided in sources, and where no basis is available for estimation of individual component ferroalloys, the entry has been reported as "Undistributed."
[5]Reported figure.
[6]Data for year ending Nov. 30 of that stated.
[7]Reported as blast furnace ferromanganese and spiegeleisen but believed to be electric furnace output.
[8]Includes silicomanganese.
[9]Includes ferrochromium-silicon and ferronickel, if any was produced.
[10]Less than 1/2 unit.
[11]Although furnace type has not been specified for any ferroalloy production for China, North Korea, and the Republic of South Africa, all output of these countries has been included under electric furnace (and metallothermic) output except for their production of ferromanganese, which is reported separately.
[12]Includes ferrochromium-silicon, if any was produced.
[13]Colombia is reported to produce ferromanganese also, but output is not reported quantitatively and no basis is available for estimation.
[14]Totals for 1978-82 represent estimates for silicon metal plus reported totals for all other types.
[15]Revised to zero.
[16]Includes silicospiegeleisen.
[17]Includes ferronickel, if any was produced.
[18]Series excludes calcium silicide.
[19]It appears likely that the Republic of Korea produced silicomanganese during 1978-82; during 1978-79, silicomanganese output presumably was included in reported output, but whether it was included with ferromanganese or with ferrosilicon is not clear; in 1980-82, it presumably was included with "Other."
[20]Estimates for 1978-79 represent ferrotungsten only; figures for 1980-82 presumably include silicomanganese as well as other unspecified ferroalloys, possibly ferrochromium, but available information is inadequate to permit distribution by type.
[21]Estimated figures based on reported exports and an allowance for domestic use.
[22]Ferrovanadium only; other minor ferroalloys may be produced, but no basis is available for estimation.
[23]Soviet production of electric furnace ferroalloys is not reported; estimates provided are based on crude source material production and availability for consumption (including estimates) and upon reported ferroalloy trade, including data from trading partner countries.
[24]U.S. production of ferronickel cannot be reported separately in order to conceal corporate proprietary information.
[25]U.S. output of ferrochromium-silicon includes chromium briquets, exothermic chromium additives, other miscellaneous chromium alloys, and chromium metal.
[26]Includes ferronickel.
[27]Data may not add to totals shown because of independent rounding.
[28]Spiegeleisen for the Federal Republic of Germany is included with blast furnace ferromanganese.
[29]Includes the following quantities specifically identified as ferrosilicon: 1978—86; 1979—87; 1980—71; 1981—55; 1982—55. The remainders are not identified except that they are not spiegeleisen or ferromanganese.
[30]Ferromanganese includes silicomanganese (if any was produced) for countries carrying footnote 8 on ferromanganese data line.
[31]Includes silicospiegeleisen for France.
[32]Ferrochromium includes ferrochromium-silicon (if any was produced) for countries carrying footnote 12 on ferrochromium data line.
[33]"Other" includes ferronickel production for France, Norway, the U.S.S.R., and the United States.

Canada.—Union Carbide of Canada Ltd. temporarily shut down all ferrosilicon and silicon metal operations at its Beauharnois, Quebec, plant in May because of weak demand. The facility has two 50% ferrosilicon furnaces with a combined capacity of 61,000 tons per year and one silicon metal furnace with a capacity of 7,700 tons per year. Production of Union Carbide's standard-grade ferromanganese in a single furnace rated at 99,000 tons per year at the Beauharnois plant and of 50% ferrosilicon in a single furnace rated at 24,000 tons per year at Chicoutimi, Quebec, was not affected.[14]

China.—A severe drought in China's Sichuan Province at the beginning of the year reduced hydroelectric power supplies to ferrosilicon plants there, but apparently had only a moderate impact on China's total ferrosilicon output.[15] Although China's exports in 1982 of ferrosilicon to Japan were 37,000 tons, down about one-third from 1981 exports, 1982 exports of silicon metal to Japan were 15,000 tons, about two-fifths higher than those of 1981.[16] China continued to take a larger share of the total world ferroalloy market, moving up from sixth place in 1981 to fourth place in 1982.

On June 1, China imposed new export taxes on a wide variety of commodities. The new taxes on some of the ferroalloy products were 10% for ferromanganese, ferrochromium, and ferrovanadium, 20% for ferrotungsten and ferromolybdenum, and 30% for ferrosilicon.[17]

The 25-year-old Shanghai ferroalloys plant, one of 49 metallurgical operations under the jurisdiction of the Shanghai municipal government, has been upgraded and is currently producing 130,000 tons of ferroalloys per year, compared with a maximum output of 110,000 tons in previous years. The Shanghai ferroalloys plant, one of the largest in China, produces a full line of ferroalloys. Challenges facing the plant's overseers are to continue to improve the facilities, upgrade the quality of products, and adopt technology that would lower energy consumption and reduce costs.[18] The Shanghai plant's capacity represented about 15% of China's total ferroalloy production in 1982.

Colombia.—Cerro Matoso S.A.'s new nickel mine and ferronickel smelter in northern Colombia were dedicated on June 20. The facilities are situated about 250 miles northwest of Bogota, near Montelibano in Córdoba Province. The smelter, located near the mine and designed to produce 20,000 to 25,000 tons of contained nickel per year in the form of ferronickel, began significant production in August. The ferronickel product contains 35% to 40% nickel. Despite depressed nickel prices in 1982, the relatively high grade of the Cerro Matoso deposit and its availability to relatively low-cost hydroelectric and natural gas energy sources made it one of the few such facilities in the world that was economically viable.[19]

Dominican Republic.—Falconbridge Dominicana C. por A. resumed production at reduced rates at its nickel-bearing lateritic ferronickel operation near Bonao in September. The smelter, which has a capacity of 31,500 tons of contained nickel per year as ferronickel, had been shut down since January. The facility had operated at reduced capacity since 1980 owing to poor market conditions for nickel and high production costs because of extensive energy requirements in the form of oil.[20]

Finland.—Outokumpu Oy established a new marketing company, Outokumpu Metals (USA) Inc. in Detroit, Mich., to handle sales of its products, such as ferrochromium, in the United States.[21] The state-owned Outokumpu Oy is the largest mining and metallurgical company in Finland. Expertise in these areas and in other areas such as exploration methods, design of special equipment and plants, and technological know-how have enabled the firm to offer its services on a worldwide basis.

Gabon.—The Governments of Gabon and France are studying plans for the eventual erection of plants in Gabon that would produce 94,000 tons per year of ferromanganese using ore from the Ogoove Mine at Moanda and 55,000 tons per year of other ferroalloys. The project would involve considerable infrastructure, such as a railway system and a hydroelectric plant, making it unlikely for production to begin before the 1990's.[22]

Greece.—Hellenic Ferroalloys S.A. (ELSI), a 96%-owned subsidiary of Hellenic Industrial & Mining Co. of Athens (HIMIC), was on schedule to introduce high-carbon ferrochromium production into Greece for the first time by early 1983. Production of ferrochromium at the plant near Volos was anticipated to be 50,000 tons per year. The ferrochromium plant is part of a planned $65 million complex comprising mines, ferroalloy plants, and a stainless steel plant. ELSI reached an agreement with Outokumpu Oy of Finland in mid-1980 for construction of the ferrochromium plant. Outokumpu Oy supplied the equipment and know-how and provided engineering and supervision of services.[23]

Société Minière et Métallurgique de Larymna S.A. (LARCO S.A.), the sole ferronickel producer in Greece, became the first Greek company to be nationalized in 1982. The company had been operating in the red owing to increased production costs and was declared by the Government as "problematic."[24]

India.—India appears to have recovered completely from a severe power shortage, the result of a drought, which forced it to cut back production in late 1979. India was the world's 10th leading producer of ferroalloys in 1982, up from 16th place in 1980.

The new 55% charge chrome plant of Ferro Alloys Corp. Ltd. (FACOR) located at Randia, near Bhadrak, Balasore district, Orissa State, was expected to start production in 1983 at a 55,000-ton-per-year capacity. The 45-megavolt-ampere, semiclosed stationary-type electric smelting furnace, built by M/s. Tanabe Kakoki Co. Ltd. of Japan with technical guidance from Nippon Kokan Co. Ltd. of Japan, will use local low-grade ores from two captive mines, Kathpal and Boula, Orissa. Design and engineering services for the plant were provided by M. N. Dastur & Co. Ltd. of Calcutta. This will be India's first charge chrome plant, although FACOR currently is India's only noncaptive producer of high-carbon ferrochromium.[25]

In 1982, Indian Metals and Ferro Alloys Ltd. (IMFA) was nearing completion of one charge chrome plant and beginning construction on another. The first plant, one of the largest of its kind in the world, is located at Therubali, Koraput district, Orissa State, and is expected to begin production in 1983 at a 50,000-ton-per-year capacity. Indian and Albanian ores will be used as a feed source to the smelter. Construction of IMFA's second charge chrome plant near Talcher, Cutlack district, Orissa State, began in late 1982, and the plant is expected to come onstream by 1985. The smelter, which has an annual capacity of 55,000 tons, was purchased from Elkem for $23.5 million. This facility will include a captive powerplant, which uses local low-grade lignite coal.[26]

Orissa Mining Corp. Ltd. (OMC) planned to commission a 55,000-ton-per-year charge chrome plant that would be built at Bamnipal, Keonjhar district, Orissa State, by 1984. Technology would be provided by Outokumpu Oy and equipment by Voest-Alpine AG of Austria. Estimated cost is $37 million. The smelter will consume Indian low-grade pelletized fines.[27]

Mettur Chemical and Industrial Corp. Ltd. is to begin marketing electronic-grade silicon metal by mid-1983. The metal would be of a purity comparable to that of metal produced elsewhere in the world.[28]

Italy.—At the end of March, Ferroleghe, a subsidiary of Montedison S.p.A., resumed ferroalloy operations at two plants. Both plants were closed in December 1980 owing to weak steel demand. The high-carbon ferrochromium plant at Carrara Avenza had an annual capacity of 44,000 tons, and the ferrosilicon plant at Domodossola had a capacity of 20,000 tons. Combined employment of the two plants is 320.[29]

Japan.—Japan continued to be the world's second leading producer of ferroalloys, but Japanese ferroalloy producers, faced with the possibility of a declining market share due to rising energy costs and competition from imports, have requested Government help. The rescue scheme proposed to the Ministry of International Trade and Industry (MITI) is similar to the one granted the Japanese aluminum industry to help structurally depressed industries.[30] Japanese ferroalloy producers are also planning to file dumping suits against foreign suppliers.[31]

Japan's energy agency, a Government-controlled body, announced that stockpiling of rare metals would begin officially in October 1983. The stockpile program will include chromium, manganese, vanadium, and other metals.[32]

New Caledonia.—A cutback in Société Métallurgique le Nickel's (SLN) ferronickel production at its Doniambo facility resulted in drastic curtailment of operations at two of the company's four nickel mines, Poro and Nepoui. Weak markets worldwide for nickel were cited as the reason.[33]

Norway.—Norway remained the world's fifth leading producer, and the cost of power continued to be the main problem confronting Norwegian ferroalloy producers. Ferroalloy producers have joined with other power-intensive industries to put pressure on the Norwegian Government to cut power costs. Norwegian companies have also asked the Government to devalue their currency to offset Sweden's October 8 devaluation.[34] Elkem AS and four other smaller Norwegian ferroalloy producers have started preliminary negotiations for the establishment of a jointly owned company. The new firm would supersede the Fesil Group, which has marketed much of Norway's ferrosilicon, and would combine all its ferroalloy assets and operations, representing more than 15% of Western World ferroalloys production capacity.[35] Tinfos Jernverk AS withdrew from the Fesil Group in July, believing that it would be more cost effective to sell its ferrosilicon in conjunction with its manganese alloys, instead of dividing its sales organization as it did with the Fesil Group. The departure of Tinfos means that the Fesil Group no longer controls the majority of Norway's ferrosilicon capacity. Elkem is now Norway's major producer of ferrosilicon.[36] Most Norwegian producers of ferroalloys operated at 50% to 75% of capacity in 1982. Fesil-Nord & Co. closed its ferrosilicon plant in Finnshes on July 16 because of weak markets and high power costs.[37] Associated Metals and Minerals Corp., a metals trading firm in New York, had taken a 50% interest in the Thamshavn ferrosilicon plant of Orkla Industrier AS. The plant produced 75% ferrosilicon and had a capacity of 66,000 tons per year.[38]

Papua New Guinea.—The Bureau of Mines has cooperated with Nord Resources Corp. to evaluate the feasibility of smelting a lateritic chromite concentrate from New Guinea by electric arc furnace processing. Results at the Bureau's Albany Research Center showed that a commercially acceptable grade of high-carbon ferrochromium can be prepared from the concentrate.[39]

Philippines.—Ferrochrome Philippines Inc. (FPI) began testing its new 55,000-ton-per-year high-carbon ferrochromium smelter located at Tagaloan, Misamis Oriental Province, on Mindanao Island in September 1982. The $70 million smelter represents a joint venture comprising Voest-Alpine (80%) and the Herdis Group of Manila (20%). Production was to begin in early 1983.[40] FPI is the Philippines' second ferrochromium plant. The first, Ferro-Chemicals Inc., began producing high-carbon ferrochromium in Manticao, Misamis Oriental Province, Mindanao Island, in 1976 with an annual capacity of 13,000 tons.

Portugal.—Cia. Portuguesa de Fornos Electricos Sarl and Milnorte-Metalurgia do Norte Sarl, which produced silicon metal at annual capacities of 26,000 and 22,000 tons, respectively, shut down their operations in May. Fornos Electricos resumed production in July in one of its two furnaces following repairs, but Milnorte's two furnaces remained down pending contract negotiations with the Government regarding power charges.[41]

South Africa, Republic of.—The world's major producer of both ferrochromium and vanadium products and the third leading producer of ferromanganese, South Africa suffered from weak demand due to the worldwide reduction in steel production. As a result of reduced demand for ferroalloy products, many South African producers operated at significantly reduced rates. South African Manganese Amcor Ltd. (SAMANCOR), the world's largest integrated producer of ferroalloys, cut back production at a number of its facilities at the beginning of the year in an attempt to reduce stockpiled materials.[42] Highveld Steel and Vanadium Corp. Ltd., cut its output of vanadium slag, containing about 25% V_2O_5, by one-third at its Witbank iron and steel works in the Transvaal when it shut down two of its six submerged-arc ironmaking furnaces in November.[43] A strike by the white South African mine workers' unions over wages was averted following intervention by the Pretoria Government, but black mine workers, who have no trade union, continued to cause disturbances at and around the mines in protest of wage levels.[44]

Middelburg Steel and Alloys (Pty.) Ltd., a major South African producer and exporter of ferrochrome, plans to double its ferrochromium capacity of about 300,000 tons per year within 10 years by converting its existing furnaces from the conventional submerged-arc type to the direct-current thermal plasma type. Middelburg has ordered a 20-megavolt-ampere direct-current arc pilot furnace from ASEA AB, the Swedish-based international manufacturer of electrical equipment. The pilot furnace represents the first step in the conversion program and is scheduled for commissioning in October 1983 at Middelburg's Krugersdorp works near Johannesburg. The pilot furnace will have an initial capacity of 28,000 tons per year, to be increased to 55,000 tons per year, and will operate on chromite and coke fines. The relatively new plasma technology was developed as a spin-off of the U.S. space program.[45]

SAMANCOR, Johannesburg, a principal world producer of both manganese ferroalloys and ferrochromium, acquired Middelplaats Manganese Ltd., also of Johannesburg, from Anglo American Corp. of South Africa Ltd. The acquisition has also made SAMANCOR a minority owner of Eurominas Electrometalurgica SARL, the major Portuguese producer of ferromanganese, by taking over shares in Eurominas formerly held by Middelplaats.[46]

Spain.—In addition to the general problems of weak ferroalloy markets experienced by most bulk ferroalloy producers in the world, Spanish ferroalloy producers continued to suffer in particular from high energy costs and from a weakening peseta. Spanish bulk ferroalloy producing companies such as Carburos Metalicos, Silicio de Sabon, Hidro Nitro Espanola, and Ferroaleaciones Espanolas operated their plants at only 50% capacity and have requested the Government's help to lower energy rates.[47] The Spanish Government also added a 9% duty on ferrotitanium imports, effective February 11, to protect its ferroalloy industry.[48] Spain, ranked as the world's 10th leading producer of ferroalloys in 1980, dropped to 12th place in 1981 and remained at that level in 1982.

Turkey.—The state-owned Etibank is increasing its high-carbon ferrochromium capacity at Elazig from 49,000 to 170,000 tons per year. The technology provided by Outokumpu Oy is expected to decrease unit energy costs. The private sector of Turkey has also expressed interest in establishing a ferrochromium smelter, possibly with a foreign partner.[49] An old calcium carbide furnace at Etibank's Antalya plant has been converted for production of 75% ferrosilicon at an annual capacity of 6,000 tons. Power will be taken from the regular hydroelectric supply system. The Turkish Government introduced a tariff of 20,000 liras per ton on imported ferrosilicon in January, equivalent to almost one-quarter of the selling price of foreign ferrosilicon.[50] Etibank and Outokumpu Oy formed a joint venture, Etikumpu, which will market Etibank's ferroalloys and its metals in Scandinavia.[51]

U.S.S.R.—The U.S.S.R., the world's leading producer of ferroalloys, has developed a new, low-cost technique for producing ferrovanadium, according to Novosti. The agency stated that the new process produces nitrated ferrovanadium with five times the normal nitrogen level and claims the process uses less energy and costs one-third as much as conventional processes. No details of the process were available.[52]

Yugoslavia.—Trial production of the new FENI ferronickel smelter located in the region of Kosovo, near Pristina, in southeast Yugoslavia, started late in 1982. The smelter, which has an annual capacity of 13,000 tons of nickel as ferronickel, will consume blended ore from two open pit mines, Staro Cikatovo and Glavica. The ore will be blended to assay 1.32% nickel and will produce ferronickel containing 23% to 25% nickel.[53]

Zimbabwe.—Zimbabwe, the world's fifth leading producer of ferrochromium and possessing the second largest chromite reserve base, following the Republic of South Africa, had to cut back production because of weak demand by the international steel market. Zimbabwe Alloys (formerly Rhodall), the Anglo American-controlled plant in Que Que, and the second largest producer of ferrochromium in Zimbabwe, was having financial problems and to avoid imminent cutbacks in output and staff, requested Government help.[54]

The Government of Zimbabwe continued with its plan for establishment of its state-owned Minerals Marketing Corp., which would ultimately take over all export marketing from private mining companies such as chrome ore and ferrochromium producers.[55] To assist its industries, the Zimbabwe Government was also attempting to develop closer ties between its ferroalloy and fledgling steel industries as part of its continuing goal to export value-added products rather than ores or other raw materials.[56] The Zimbabwe Government also moved to devalue its currency by 20% to boost sagging export-derived revenue.[57]

TECHNOLOGY

Bureau of Mines research programs to reduce U.S. dependence on imported strategic and critical materials were continued during 1982. Many recent research investigations were conducted by the Bureau of Mines to help assure an adequate and dependable supply of minerals and materials necessary for national, economic, and strategic needs, and to conserve energy. Feasibility studies were conducted to determine if a satisfactory ferrochromium product could be obtained from domestic low-grade chromite from mines in the Western States by prereduction of the chromite to provide suitable charge material for conventional submerged-arc smelting.[58] Methods to prepare ferrochromium containing less than 2% carbon by vacuum reduction of chromite with carbonaceous materials to reduce energy requirements were investigated.[59] Technology was also developed to recycle stainless and other specialty steelmaking wastes,[60] to recover chromium from nickel-cobalt laterite and laterite leach residue,[61] and to recover chromium and other critical and strategic elements from superalloy scrap and other types of scrap metals.[62] Methods for identifying scrap metals to select those most suited for effective recycling of critical and strategic materials were also assessed.[63] Additionally, substitutes were developed to replace part or all of the chromium in stainless steels.[64] Japanese steelmakers continued to work toward their goal of producing totally additive-free high-strength steels. Nippon Steel Corp. is investigating high-strength, low-alloy steel technology in an attempt to develop controlled rolling methods that will enable use of less alloying elements in order to reduce costs. Nippon Steel and Sumitomo Metal Industries Ltd. are planning to use less ferrovanadium and ferrocolumbium in line pipe steel and to replace these ferroalloys with ferrotitanium or other ferroalloys such as ferromanganese.[65]

Amorphous metals have the potential for significant energy savings in electrical devices such as the cores of transformers and motors. Amorphous metals are described as glassy metals because they are produced by very rapid cooling from the molten state, which results in a random structure similar to that of glass. In 1977, core losses from electrical devices amounted to 97 billion kilowatt-hours of power. The lost energy was worth $2.9 billion and equivalent to the capacity of nineteen 1,000-megawatt powerplants. One of the leading companies in the amorphous metal field is Allied Corp., which has developed a product under the trade name, Metglas. The composition of amorphous metals typically is iron or iron and nickel mixed with relatively inexpensive metalloids such as boron or silicon, normally added as a ferroalloy. Allied claims that if the silicon-steel cores now used in powerline transformers were replaced by a Metglas alloy, power losses could be reduced by about two-thirds.[66]

Distington Engineering Contracting, the engineering and plant construction subsidiary of British Steel Corp. (BSC), developed a new process for the casting and fragmentizing of ferroalloys and other products. The process involves the pouring of molten material, such as a ferroalloy, from a tundish over a weir onto an open conveyor, followed by cooling. The resulting cast strip is fragmentized in a conventional hammer mill. The fragmented product can be produced in a range of sizes suitable for continuous feeding to electric arc furnaces. Fines can be reduced to 0.5% of the total fragmented product.[67]

Laclede Steel Co., Alton, Ill., recently acquired calcium wire injection technology to improve the properties of its strand-cast bar products. Developed by Pfizer Calcium Metal Products, a department of Pfizer Inc.'s Pigments, Metals and Minerals Div., Wallingford, Conn., the new wire injection technology uses steel-sheathed, calcium-iron-cored wire to enhance the surface and internal quality of aluminum-treated, fine-grained steels. The wire can be injected deep into the molten steel via the continuous caster's tundish or ingot molds, or into a ladle. Until recently, calcium metal, one of the most powerful deoxidizers used in steelmaking and an excellent desulfurizer, could not be readily injected into steel melts because metallurgical-grade calcium metal boils at 1350° C and was ineffective at steelmaking temperatures owing to rapid vaporization. Experience with the new technique of injecting calcium as a calcium-iron alloy, cladded with steel, indicates that this method of addition is superior to other commercially tested aluminum oxide and sulfide shape control methods.[68]

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Fluorspar

By Lawrence Pelham[1]

Domestic shipments of finished fluorspar decreased in 1982 by 33% and, for only the second time since 1938, failed to exceed 100,000 short tons. The decline in domestic production was caused primarily by the closure for most of the year of mining operations by the Inverness Mining Co. and by reduced demand for fluorine materials by the aluminum and steel industries. Domestic fluosilicic acid (H_2SiF_6) recovery, a byproduct of phosphoric acid plants, was below 1981 production. In the chemical industry, H_2SiF_6 augments fluorspar as a source of fluorine. Reported domestic and world prices showed little change.

The United States continued to depend on foreign sources to supply over 85% of its fluorspar requirements. Mexico remained the largest supplier of metallurgical- and acid-grade fluorspar, but with a significantly smaller share of the U.S. market than in recent years. The Republic of South Africa, the second largest supplier, maintained the same U.S. market share as in 1981, whereas China, Italy, Spain, and Morocco made significant gains in market share.

Domestic Data Coverage.—Domestic production data for fluorspar are developed by the Bureau of Mines by means of four separate, voluntary surveys of U.S. operations. Surveys are conducted to obtain fluorspar mine production and shipments, H_2SiF_6 production, briquet production, and fluorspar consumption. Of the five fluorspar mining operations, eight H_2SiF_6 producers, and six briquet producers to which a survey request was sent for the three production surveys, 100% responded, representing 100% of the production data shown in table 1. The consumption survey covers approximately 190 operations quarterly and 67 additional operations on an annual basis. A response of 85% to 90% is common for the quarterly survey; 70% of the annually canvassed operations typically respond, and 86% of the apparent consumption data shown in table 1 are accounted for by reported data.

Table 1.—Salient fluorspar statistics[1]

	1978	1979	1980	1981	1982
United States:					
Production:					
Mine production ---- short tons	447,876	407,054	372,092	415,862	199,714
Material beneficiated ---- do	447,560	355,655	321,219	419,058	231,726
Material recovered ---- do	124,947	106,099	88,831	111,281	76,316
Finished (shipments) ---- do	129,428	109,299	92,635	115,404	77,017
Value f.o.b. mine ---- thousands	$13,261	$12,162	$12,611	$18,412	$13,293
Exports ---- short tons	8,267	14,454	17,865	11,261	10,573
Value ---- thousands	$978	$1,339	$1,660	$1,194	$1,084
Imports for consumption ---- short tons	916,703	1,021,085	899,219	826,783	543,723
Value[2] ---- thousands	$67,569	$80,090	$94,103	$104,938	$67,665
Consumption (reported) ---- short tons	1,203,448	1,135,451	976,644	932,855	530,565
Consumption (apparent)[3] ---- do	1,062,988	1,090,665	1,017,559	897,572	618,493
Stocks, Dec. 31:					
Domestic mines:					
Crude ---- do	121,329	166,619	213,204	200,698	164,094
Finished ---- do	4,322	5,400	8,930	12,924	10,816
Consumer ---- do	201,158	226,423	182,853	216,207	207,880
World: Production ---- do	[r]5,142,356	[r]5,083,570	5,314,221	[p]5,567,872	[e]5,003,248

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Does not include fluosilicic acid (H_2SiF_6) or imports of hydrofluoric acid (HF) and cryolite.
[2]C.i.f. U.S. port.
[3]Apparent consumption includes finished shipments plus imports, minus exports, minus consumer stocks difference.

Legislation and Government Programs.—On March 13, 1981, the President announced the beginning of a major purchase program for the National Defense Stockpile. Fluorspar was listed as a priority material to be acquired. Although funds were appropriated for the program in 1982, no fluorspar was added to or deleted from the stockpile. The current U.S. Government stockpile goals for fluorspar are 1.4 million tons for acid grade and 1.7 million tons for metallurgical grade. At yearend, the Government stockpile inventory was 895,983 tons of acid grade and 411,738 tons of metallurgical grade.

The ban on the sale and manufacture of "nonessential" aerosol products containing chlorofluorocarbons (CFC), which was instituted in April 1979, continued. The ban was instituted because of the uncertainty of the role of CFC in the depletion of stratospheric ozone.

As in previous years, a 22% depletion allowance was granted against Federal income tax applied to the mining of domestic fluorspar compared with a 14% allowance for foreign production.

U.S. import duties remained in effect for all grades of fluorspar. The duty was $1.875 per ton for acid grade and 13.5% ad valorem for ceramic and metallurgical grades.

DOMESTIC PRODUCTION

Shipments of finished fluorspar from domestic mining operations decreased 33% to 77,000 tons in 1982. Illinois was the leading producing State, accounting for well over 90% of all U.S. shipments. Statistics on shipments of fluorspar by State and by grade are withheld to avoid disclosing company proprietary data.

Ozark-Mahoning Co., the Nation's largest fluorspar producer, operated mines and plants in Pope and Hardin Counties, Ill. In April, Inverness stopped production from its mines and mill near Cave-In-Rock, Ill., and did not reopen in 1982. According to its management, the Inverness operation was closed because of high mining costs and the high value of the dollar, making foreign material attractive economically. Inverness, while closed, serviced its customers by delivering fluorspar that had been purchased from Mexico and dried. The only other active fluorspar producer in Illinois was the Hastie Trucking and Mining Co., which operated near Cave-In-Rock.

In the West, J. Irving Crowell, Jr. and Sons operated its Crowell-Daisy Mine in Nye County, Nev. D & F Minerals Co. continued operations at its Paisano Mines, south of Alpine, Tex.

Reported production of fluorspar briquets for use in steel furnaces was approximately 74,000 tons; 1981 production was approximately 127,000 tons. Two of the six plants that operated in 1981 closed during 1982. Fluorspar briquets, made mostly from imported concentrates, range in calcium fluoride (CaF_2) content from 25% to 95% and contain various combinations of manganese dioxide, ferric oxide, alumina, dolomite, hydrated lime, flue dust, feldspar, soda ash, olivine, ilmenite, and mill scale sweepings, along with binding agents.

Eight plants processing phosphate rock for the production of phosphoric acid recovered nearly 36,700 tons of H_2SiF_6 in 1982 compared with nearly 43,000 tons in 1981. Total H_2SiF_6 shipments were 36,400 tons in 1982; 35% was used to make silicofluoride; 32%, for water fluoridation chemicals; 26%, for aluminum fluoride (AlF_3) and synthetic cryolite; and 7%, for other chemicals.

Allied Chemical Co., the world's largest producer of elemental fluorine, broke ground for a pilot plant in Metropolis, Ill., to develop products based on fluorinated carbon. The plant, designed with a capacity of several thousand pounds per year, was intended to provide a domestic source of fluorinated carbon, stimulate faster development of uses for fluorinated carbon, and provide operating experience for a commercial plant in the future.

Halocarbon Products Corp. began construction of a plant in Aiken County, S.C., to make trifluoroacetic acid and trifluoroethanol; completion was scheduled for 1983.

Pennwalt Corp. planned to modernize and expand its Isotron gaseous-chlorofluorocarbon plant at Calvert City, Ky.; these products are used primarily as refrigerants, blowing agent for foamed plastics, and as precursors in the production of plastic and elastomers. Pennwalt was also expanding its capacity at Calvert City, Ky., to produce Isotron polyvinylidene-fluoride (PVDF) resins. Pennwalt announced plans to build a Kynar PVDF plant in New Jersey. The new plant was expected to double the company's PVDF capacity. Kynar polymer is a high-performance plastic resin traditionally used in the architectural and construction industries as a base for long-life finishes to protect aluminum and galvanized steel exteriors. It is also used as an insulator in the electronics industry and in lining materials for piping, valves, and pumps in the chemical process industry.

CONSUMPTION AND USES

Certain fluorspar end users require a specified grade of material. Acid-grade fluorspar, containing greater than 97% CaF_2, is used as feedstock in the manufacture of hydrofluoric acid (HF), a key ingredient in the aluminum, fluorochemical, and uranium industries. Ceramic-grade fluorspar, containing 85% to 95% CaF_2, is used in the ceramics industry for the production of glass and enamel. Metallurgical-grade fluorspar (met-spar), containing 60% to 85% or more CaF_2, is used primarily by the iron and steel industry as a flux. Traditionally, U.S. steelmakers have used met-spar containing a minimum of 70% effective CaF_2; however, lower grade material and briquets have gained widespread usage.

Reported domestic consumption of fluorspar in 1982 decreased 43% from the 1981 total. The HF and steel industries accounted for 59% and 39%, respectively, of 1982 demand. According to the American Iron and Steel Institute (AISI), raw steel production was 72.9 million tons in 1982, or 47.0 million tons less than in 1981. A comparison of the AISI data with fluorspar consumption data collected in the Bureau of Mines canvass of U.S. steel producers shows a decreasing rate of fluorspar consumption per ton of raw steel produced during 1980-82. On the basis of furnace type, the average fluorspar consumption per ton of raw steel was as follows:

Type of furnace	Fluorspar consumption (pounds per ton)		
	1980	1981	1982
Open hearth	8.90	9.90	9.89
Basic oxygen	7.08	6.59	5.65
Electric	4.20	3.20	3.69
Industry average	6.51	6.02	5.43

In the ceramics industry, fluorspar was used as a flux and as an opacifier in the production of flint glass, white or opal glass, and enamels. Fluorspar was used in the manufacture of fiberglass, aluminum, cement, and brick, and was also used in the melt shop by the foundry industry.

Seven companies operating 11 plants produced HF in 1982. The U.S. Department of Commerce, Bureau of the Census, reported that HF "produced and withdrawn from the system" in 1982 amounted to approximately 138,500 tons on an anhydrous basis, compared with 171,500 tons in 1981. Imports of 70% HF augmenting domestic production amounted to 103,000 tons in 1982, a 2.5% decrease from that of 1981.

CFC production in 12 plants by 5 producing companies was a major end use for HF. According to U.S. International Trade Commission data, 1982 production of trichlorofluoromethane (F-11) was 73,300 tons, dichlorodifluoromethane (F-12) output was 128,200 tons, and chlorodifluoromethane (F-22) production was 88,100 tons. Compared with 1981 production, F-11 production decreased 7.1%, F-12 output decreased 13.8%, and F-22 production decreased 25.8%. The major uses of CFC were as refrigerants, foam-blowing agents, and fluorinated solvents. The use of CFC as aerosol spray propellants was restricted to essential products; by and large, CFC had been replaced by hydrocarbons and carbon dioxide.

Another major use of HF was in the synthesis of fluorine chemicals used in the Hall process to reduce alumina to primary aluminum. Six companies accounted for most of the domestic production of AlF_3 and synthetic cryolite for use by the aluminum industry. Domestic primary aluminum production was 3.6 million tons in 1982. An estimated 40 to 60 pounds of fluorine was consumed for each ton of aluminum produced.

HF was consumed in the process to concentrate uranium isotope 235 for use as nuclear fuel. In this process, the U_3O_8 concentrate from ore is reacted with HF to produce UF_4, which is converted to gaseous UF_6 upon the addition of fluorine gas.

HF was also used in stainless steel pickling, petroleum alkylation, glass etching, oil and gas well treatment, and in the manufacture of a host of fluorine chemicals used in dielectrics, metallurgy, wood preservatives, pesticides, mouthwashes and decay-preventing dentifrices, plastics, and water fluoridation.

H_2SiF_6 supplemented fluorspar as a source of fluorine. Approximately 36,700 tons of H_2SiF_6 was produced in 1982 and 36,400 tons was sold or used. Of the total sold or used, 11,800 tons valued at $739,000 was used for water fluoridation and 9,500 tons valued at $427,000 was used in the aluminum industry. H_2SiF_6 was also used in the production of silicofluoride, laundry sour, and concrete conditioner.

Table 2.—Reported domestic consumption of fluorspar, by end use and grade

(Short tons)

End use or product	Containing more than 97% CaF_2 1981	Containing more than 97% CaF_2 1982	Containing not more than 97% CaF_2 1981	Containing not more than 97% CaF_2 1982	Total 1981	Total 1982
Hydrofluoric acid	525,764	311,641	--	--	525,764	311,641
Glass and fiberglass	5,510	3,877	4,715	1,996	10,225	5,873
Enamel and pottery	W	W	1,224	1,009	1,224	1,009
Welding rod coatings	728	480	1,122	1,382	1,850	1,862
Primary aluminum and magnesium	526	W	--	--	526	W
Iron and steel castings	--	--	12,304	10,403	12,304	10,403
Open-hearth furnaces	--	--	66,595	30,201	66,595	30,201
Basic oxygen furnaces	W	W	241,156	127,955	241,156	127,955
Electric furnaces	18,056	11,222	53,159	28,429	71,215	39,651
Other	119	180	1,877	1,790	1,996	1,970
Total	550,703	327,400	382,152	203,165	932,855	530,565
Stocks, Dec. 31	68,264	103,057	147,943	104,823	216,207	207,880

W Withheld to avoid disclosing company proprietary data; included with "Other."

Table 3.—Reported consumption of subacid grades of fluorspar in 1982, by end use and form

(Short tons)

End use or product	Containing not more than 97% CaF_2 Flotation concentrates	Containing not more than 97% CaF_2 Lump or gravel	Containing not more than 97% CaF_2 Briquets or pellets
Chemicals and allied products: Welding fluxes	1,435	--	--
Glass, ceramic, bricks:			
Glass	1,973	W	--
Other glass, clay products	1,071	W	--
Primary metals:			
Steel mills:			
Open-hearth furnaces	94	29,954	153
Basic oxygen furnaces	5,070	71,791	51,094
Electric furnaces	884	25,384	1,943
Iron and steel foundries	W	4,659	5,732
Other identified end uses	13	1,915	--
Total	10,540	133,703	58,922

W Withheld to avoid disclosing company proprietary data; included with "Other identified end uses."

Table 4.—Fluorspar (domestic and foreign) consumed in the United States, by State

(Short tons)

State	1981	1982
Alabama, Kentucky, Tennessee	78,637	63,371
Arizona, Colorado, Utah	23,473	9,677
Arkansas, Kansas, Louisiana, Missouri	133,696	48,806
California	22,833	4,380
Connecticut, Massachusetts, New York, Rhode Island	12,565	8,365
Illinois	31,147	10,585
Indiana	50,461	38,627
Michigan	12,286	6,252
New Jersey	19,525	13,396
Ohio	101,341	66,605
Oregon and Washington	516	190
Pennsylvania	104,462	51,955
Texas	275,806	167,568
West Virginia	38,772	29,648
Other[1]	27,335	11,140
Total	932,855	530,565

[1]Includes Iowa, Maryland, Virginia, and Wisconsin.

STOCKS

The 1982 yearend mine stocks of finished fluorspar totaled 10,800 tons, 16% lower than that at yearend 1981. Consumer stocks decreased from 216,200 tons in 1981 to 207,900 tons in 1982. Government stockpiles of fluorspar remained unchanged and included 896,000 tons of acid-grade fluorspar, of which 630 tons was considered nonstockpile grade, and 411,700 tons of metallurgical-grade fluorspar, of which 116,863 tons was nonstockpile grade.

PRICES

Prices of metallurgical-grade and acid-grade fluorspar reported in the Engineering & Mining Journal (E&MJ) by domestic producers and importers showed no significant changes in 1982. E&MJ yearend price quotations presented in table 5 serve as a general guide, but do not necessarily reflect actual transactions.

Yearend price quotations in the Chemical Marketing Reporter (CMR) were $72 per 100 pounds, f.o.b. plant, tank cars for anhydrous HF. For aqueous HF, 70% in 55-gallon tanks or 30-gallon drums, f.o.b. plant, prices were quoted as $56 per 100 pounds. CMR yearend prices for cryolite and AlF_3, at $550 per ton and $0.175 per pound, respectively, in bulk, ex-works, were unchanged from those of 1981. However, industry sources indicated that AlF_3 sold for as high as $0.50 per pound. The Bureau of Mines does not have information concerning actual contract prices.

Table 5.—Prices of domestic and imported fluorspar

(Dollars per short ton)

	1981	1982
Domestic, f.o.b. Illinois-Kentucky:		
Metallurgical: 70% effective CaF_2 briquets	110	110
Ceramic, variable calcite and silica:		
88% to 90% CaF_2	100	100
95% to 96% CaF_2	165	170
97% CaF_2	165-175	165-175
Acid, dry basis, 97% CaF_2:		
Carloads	171	180
88% effective CaF_2 briquets	179	179
European and South African:[1] Acid, term contracts	175-180	175-180
Mexican:[2]		
Metallurgical:		
70% effective CaF_2, f.o.b. vessel, Tampico	111.84	111.84
70% effective CaF_2, f.o.b. cars, Mexican border	107.40	107.40
Acid, bulk: 97+%, Mexican border	135.47-140.05	135.47-141.02

[1]C.i.f. east coast, Great Lakes, and Gulf ports.
[2]U.S. import duty, insurance, and freight not included.

Source: Engineering & Mining Journal, December 1981 and 1982.

FOREIGN TRADE

According to the Bureau of the Census data, U.S. fluorspar exports totaled 10,600 tons in 1982, about 700 tons less than exports in 1981. As U.S. exports are not reported by grade, they may include acid-, ceramic-, and metallurgical-grade fluorspar and briquets manufactured from domestic ore. Synthetic cryolite exports totaled 32,078 tons valued at $8.3 million in 1982.

U.S. imports of fluorspar declined 34% from those of 1981. Acid-grade imports were down 29%, while imports of subacid-grade material were down 47% compared with those of 1981. Imports from Mexico, the largest foreign supplier, were 37% of all 1982 U.S. fluorspar imports. The Republic of South Africa supplied 30%; China, 16%; Italy, 7%; Spain, 7%; and Morocco, 2%. Small quantities were also imported from Canada.

The origin of fluorspar imports was significantly different in 1982 compared with that of 1981 and previous years when Mexico held a much greater share of the U.S. market. In 1981, Mexico supplied 60% of U.S. fluorspar imports. Most of the lost Mexican share of the U.S. market went to China, which supplied only 3% of U.S. imports in 1981. Morocco did not export fluorspar to the United States in 1981.

U.S. imports of synthetic cryolite decreased 13% in 1982. Denmark, Canada, and Japan were the leading suppliers. Although imports of cryolite from most countries decreased 50% or more, imports from Japan increased 130%, and cryolite was imported from Sweden in 1982 but not in 1981. Imports of HF decreased 3% to 103,000 tons. Mexico and Canada continued to be the major suppliers of imported HF. Data on exports and imports of AlF_3 were not available.

Table 6.—U.S. exports of fluorspar

Country	1981		1982	
	Quantity (short tons)	Value	Quantity (short tons)	Value
Australia	49	$4,939	30	$2,990
Canada	10,078	995,400	9,702	973,449
Chile	118	11,766	104	10,434
Dominican Republic	447	81,589	224	32,334
Germany, Federal Republic of	23	2,266	105	10,450
Ghana	15	1,474	67	14,520
Japan	28	2,800	--	--
Malaysia	--	--	17	1,700
Mexico	6	534	--	--
Peru	166	55,862	--	--
Venezuela	331	36,870	324	37,678
Total	11,261	1,193,500	10,573	1,083,555

Table 7.—U.S. imports for consumption of fluorspar, by country and customs district

Country and customs district	1981			1982		
	Quantity (short tons)	Value (thousands)		Quantity (short tons)	Value (thousands)	
		Customs	C.i.f.		Customs	C.i.f.
CONTAINING MORE THAN 97% CALCIUM FLUORIDE (CaF_2)						
Canada:						
Buffalo	--	--	--	4	$1	$1
Laredo	664	$93	$93	--	--	--
Seattle	--	--	--	37	3	4
Total	664	93	93	41	4	5
China:						
Baltimore	--	--	--	220	27	46
Houston	--	--	--	6,216	636	683
Total	--	--	--	6,436	663	729
Italy:						
Galveston	33,826	4,381	5,178	--	--	--
Houston	--	--	--	40,481	5,135	5,811
Total	33,826	4,381	5,178	40,481	5,135	5,811
Mexico:						
Detroit	--	--	--	1,328	99	108
El Paso	85,219	11,396	11,484	65,733	8,827	8,827
Laredo	178,209	21,681	21,790	80,120	9,747	9,747
Philadelphia	10,978	1,424	1,479	--	--	--
Total	274,406	34,501	34,753	147,181	18,673	18,682
Morocco: New Orleans	--	--	--	13,393	1,991	2,132
South Africa, Republic of:						
Galveston	7,123	1,052	1,284	--	--	--
Houston	40,708	4,640	5,745	22,653	2,349	2,872
Laredo	15,273	1,535	1,916	10,194	1,151	1,376
New Orleans	163,101	20,151	24,008	112,663	12,846	16,075
Philadelphia	9,035	1,147	1,214	15,214	1,777	1,948
Total	235,240	28,525	34,167	160,724	18,123	22,271

Table 7.—U.S. imports for consumption of fluorspar, by country and customs district —Continued

Country and customs district	1981 Quantity (short tons)	1981 Value (thousands) Customs	1981 Value (thousands) C.i.f.	1982 Quantity (short tons)	1982 Value (thousands) Customs	1982 Value (thousands) C.i.f.
CONTAINING MORE THAN 97% CALCIUM FLUORIDE (CaF_2)—Continued						
Spain:						
Cleveland	19,211	$2,488	$2,793	33,282	$3,756	$4,365
Laredo	7,636	1,074	1,228	--	--	--
New Orleans	--	--	--	6,549	899	999
Total	26,847	3,562	4,021	39,831	4,655	5,364
Grand total	570,983	71,062	78,212	408,087	49,244	54,994
CONTAINING NOT MORE THAN 97% CALCIUM FLUORIDE (CaF_2)						
Canada:						
Buffalo	19	1	1	--	--	--
Detroit	85	6	8	--	--	--
Total	104	7	9	--	--	--
China:						
Baltimore	--	--	--	15,636	951	1,523
New Orleans	25,604	1,460	1,529	63,510	3,599	5,251
Total	25,604	1,460	1,529	79,146	4,550	6,774
Mexico:						
Baltimore	26,939	2,800	3,280	3,381	240	323
Buffalo	2,533	280	303	--	--	--
El Paso	28,234	2,578	2,758	14,128	1,253	1,253
Laredo	120,985	12,484	12,553	30,463	3,270	3,270
New Orleans	23,085	2,581	3,036	5,836	652	841
New York	445	48	48	--	--	--
Philadelphia	16,937	1,725	2,007	--	--	--
Total	219,158	22,496	23,985	53,808	5,415	5,687
South Africa, Republic of:						
Detroit	10,933	827	1,202	--	--	--
New Orleans	--	--	--	2,656	157	200
Total	10,933	827	1,202	2,656	157	200
Sweden: Houston	1	1	1	--	--	--
Italy: Los Angeles	--	--	--	26	8	10
Grand total	255,800	24,791	26,726	135,636	10,130	12,671

Table 8.—U.S. imports for consumption of 70% hydrofluoric acid

Country	1981 Quantity (short tons)	1981 Value, c.i.f. (thousands)	1982 Quantity (short tons)	1982 Value, c.i.f. (thousands)
Austria	17	$22	--	--
Belgium	--	--	1	(1)
Canada	39,929	40,915	34,259	$35,389
Germany, Federal Republic of	36	56	1	4
Japan	2,555	2,385	3,560	3,087
Mexico	63,086	68,121	65,132	63,192
United Kingdom	(1)	13	--	--
Total	105,623	111,512	102,953	101,672

[1]Less than 1/2 unit.

Table 9.—U.S. imports for consumption of cryolite[1]

Country	1981 Quantity (short tons)	1981 Value, c.i.f. (thousands)	1982 Quantity (short tons)	1982 Value, c.i.f. (thousands)
Canada	1,782	$1,043	892	$519
China	827	305	276	181
Denmark	2,595	1,853	1,082	925
Germany, Federal Republic of	91	67	49	36
Greenland	80	47	66	53
Japan	1,599	1,199	3,681	2,460
Netherlands	68	53	89	54
Sweden	--	--	61	28
Switzerland	6	1	--	--
United Kingdom	140	111	22	8
Total	7,188	4,679	6,218	[2]4,266

[1]Only the material from Denmark is natural cryolite; all other material is synthetic.
[2]Data do not add to total shown because of independent rounding.

WORLD REVIEW

World production of fluorspar decreased 10% in 1982 to 5.0 million tons. Mexico, with 16% of the world total, remained the world's leading producer, followed by, in descending order, Mongolia, the U.S.S.R., China, the Republic of South Africa, Spain, Thailand, and France. Fluorspar was produced commercially in more than 30 nations worldwide.

Canada.—Canada has had no fluorspar production since 1977. In British Columbia, Eaglet Mines, Ltd., continued planning and exploration work at its fluorite property near Quesnel Lake. Eaglet announced indicated minable reserves of 20.7 million metric tons containing 11.6% fluorspar.

China.— China exported acid-grade fluorspar to the United States for the first time in 1982. Metallurgical-grade exports to the United States more than tripled, primarily because the price of Chinese material was less than that of other major exporters.

Mexico.—Mexico retained its position as the world's largest fluorspar producer, but by a much smaller margin. Production of both acid- and metallurgical-grade material was down significantly. Cía. Minera Las Cuevas, S.A., operating the world's largest fluorspar mine, produced approximately 300,000 tons of fluorspar in 1982, compared with nearly 450,000 tons in 1981. Las Cuevas was expanding its mill capacity to 330,000 tons per year of acid-grade fluorspar, with an option to increase to 440,000 tons per year if required. Table 10 shows Mexican fluorspar sales, as reported by the Mexican Fluorspar Institute (Instituto Mexicano de la Florita), for 1978-82.

[1]Physical scientist, Division of Industrial Minerals.

Table 10.—Sales of Mexican fluorspar, by grade[1]

(Short tons)

Grade	1978	1979	1980	1981	1982
Submetallurgical	249,102	196,436	236,470	211,949	112,894
Metallurgical	327,937	306,494	312,218	250,647	124,110
Ceramic	49,726	85,523	96,167	100,620	27,259
Acid	540,259	588,572	564,608	533,987	339,443

[1]Courtesy of Instituto Mexicano de la Florita.

Table 11.—Fluorspar: World production, by country[1]

(Short tons)

Country[2] and grade[3]	1978	1979	1980	1981[p]	1982[e]
Argentina	29,482	41,972	17,050	22,878	20,000
Brazil:[4]					
Direct shipping ore, grade unspecified (sales)	513	[r]117	[e]110	[e]100	110
Beneficiated product (output):					
Acid grade	34,363	29,599	36,078	39,932	38,600
Metallurgical grade	33,247	28,161	24,956	19,184	18,700
Total	68,123	57,877	61,144	59,216	57,410
China:					
Acid grade[e]	[r]44,000	[r]66,000	[r]88,000	88,000	88,000
Metallurgical grade[e]	440,000	440,000	440,000	440,000	440,000
Total	[r]484,000	[r]506,000	528,000	528,000	528,000
Czechoslovakia[e]	106,000	106,000	106,000	106,000	106,000
Egypt, grade unspecified	2,464	730	1,931	[e]2,000	2,000
France:[5]					
Acid and ceramic grade	194,448	173,504	178,133	185,960	182,000
Metallurgical grade	107,433	112,218	106,814	96,452	96,000
Total	301,881	285,722	284,947	282,412	278,000
German Democratic Republic[e]	110,000	110,000	110,000	110,000	110,000
Germany, Federal Republic of (marketable)	83,469	69,635	86,148	79,155	79,300
Greece, grade unspecified	[r]671	397	[e]440	322	330
India:					
Acid grade	10,668	12,115	18,913	20,635	23,000
Metallurgical grade	4,794	7,021	4,463	4,613	7,700
Total	15,462	19,136	23,376	25,248	30,700
Italy:					
Acid grade	143,320	148,094	137,540	142,019	141,000
Ceramic grade	14,969	7,589	1,060	--	--
Metallurgical grade	30,314	45,809	28,912	39,018	39,000
Total	188,603	201,492	167,512	181,037	180,000
Kenya:					
Acid grade	103,278	[e]74,727	102,932	105,849	106,000
Metallurgical grade	14,189	[e]10,266	--	--	--
Total	117,467	84,993	102,932	105,849	106,000
Korea, North, metallurgical grade[e]	44,000	44,000	44,000	44,000	44,000
Korea, Republic of, metallurgical grade	12,531	9,315	7,619	7,125	7,700
Mexico (all grades)[6]	1,057,980	[r]964,759	1,010,218	1,230,542	800,000
Mongolia, metallurgical grade[e]	480,000	625,000	666,000	656,000	728,000
Morocco, acid grade	59,745	69,666	70,989	73,524	72,000
Pakistan, grade unspecified	369	461	1,305	220	220
Romania, metallurgical grade[e]	22,000	22,000	22,000	22,000	22,000
South Africa, Republic of:					
Acid grade	328,038	426,930	517,735	497,819	[7]323,882
Ceramic grade	16,432	9,344	9,798	6,744	[7]10,613
Metallurgical grade	89,042	60,991	48,664	42,758	[7]30,188
Total	433,512	497,265	576,197	547,321	[7]364,683
Spain:					
Acid grade	222,121	171,164	225,528	[e]300,400	236,000
Metallurgical grade	109,999	41,469	44,261	[e]44,300	52,000
Total	332,120	212,633	269,789	[e]344,700	288,000
Thailand:[8]					
Acid grade	60,627	62,362	66,258	60,827	93,000
Metallurgical grade	193,490	195,914	190,461	173,405	193,000
Total	254,117	258,276	256,719	234,232	286,000

See footnotes at end of table.

Table 11.—Fluorspar: World production, by country[1] —Continued

(Short tons)

Country[2] and grade[3]	1978	1979	1980	1981[p]	1982[e]
Tunisia, acid grade	36,661	37,267	43,487	38,409	38,600
Turkey, metallurgical grade	1,381	6,834	[e]2,200	2,189	2,200
United Kingdom:[9]					
Acid grade	143,300	114,640	151,016	110,000	NA
Metallurgical grade	17,637	13,228	11,023	11,000	NA
Unspecified	47,400	41,888	26,455	44,000	NA
Total	208,337	169,756	188,494	165,000	180,000
United States (shipments):					
Acid grade	74,880	W	W	W	W
Metallurgical grade	54,548	W	W	W	W
Total	129,428	109,299	92,635	115,404	77,017
Uruguay, grade unspecified	125	[e]85	[e]89	[e]89	88
U.S.S.R.[e]	562,000	573,000	573,000	585,000	595,000
Zambia, grade unspecified	84	--	--	--	--
Zimbabwe, metallurgical grade	344	--	--	--	--
Grand total	[r]5,142,356	[r]5,083,570	5,314,221	5,567,872	5,003,248

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data.

[1]Table includes data available through Apr. 18, 1983.

[2]In addition to the countries listed, Bulgaria is believed to have produced fluorspar, but production is not officially reported, and available information is inadequate for the formulation of reliable estimates of output levels.

[3]An effort has been made to subdivide production of all countries by grade (acid, ceramic, and/or metallurgical). Where this information is not available in official reports of the subject country, the data have been entered without qualifying notes; where a secondary source has been used to subdivide production by grade, the source for the basis of this subdivision has been identified by footnote. Where no basis for subdivision is available, the entry has been identified with the notation "grade unspecified.".

[4]Official Brazilian sources list crude ore mined as follows, in short tons: 1978—139,147; 1979—179,874; 1980—95,181 (revised); 1981—58,422; 1982—Not available.

[5]Figures for 1978-80 are reported marketed output. Total run-of-mine production was as follows, in short tons: 1978—590,067 (revised); 1979—557,438 (revised); 1980—583,342 (revised); 1981—577,726 (revised); 1982—562,178.

[6]Series revised to reflect actual total production of all grades of fluorspar; distribution of this number is not available.

[7]Reported figure.

[8]Acid-grade material listed for Thailand is beneficiated product resulting from processing of reported low-grade material; metallurgical—grade material is run-of-mine material reported under the term "high grade." Recorded production of low-grade material was as follows, in short tons: 1978—92,875; 1979—90,524; 1980—147,210; 1981—125,296; 1982—Not available.

[9]Includes material recovered from lead-zinc mine dumps.

Gallium

By Benjamin Petkof[1]

U.S. gallium consumption in 1982 was strong but showed a small decline from that of 1981. Domestically recovered gallium provided a significant portion of the U.S. gallium supply. Data on world production, consumption, and stocks were not available. The Bureau of Mines does not collect or publish domestic production data on gallium. Gallium in the form of metal or metallic compounds was used primarily in the production of solid-state electronic devices.

Table 1.—Salient gallium statistics in the United States

(Kilograms unless otherwise specified)

	1978	1979	1980	1981	1982
Production	NA	NA	NA	NA	NA
Imports for consumption	3,721	6,401	6,175	5,536	5,199
Consumption	8,908	9,461	10,460	9,560	9,411
Price per kilogram	$500-$600	$510	$510-$630	$630	$630

NA Not available.

DOMESTIC PRODUCTION

Only two domestic companies supplied gallium in 1982. The Aluminum Co. of America had gallium stocks that were recovered as a byproduct of its alumina production process at Bauxite, Ark., using proprietary technology. Eagle-Picher Industries, Inc., produced gallium metal, oxide, and trichloride from zinc production residues at its Quapaw, Okla., facility. Based on import and consumption data, the domestic gallium metal output was near that of 1981.

CONSUMPTION

General acceptance by industry and the public of electronic devices that use gallium-based components maintained the high demand for gallium. Continued use and development of items such as fiberoptic light transmission cables actuated by gallium-based light-emitting diodes and lasers, gallium-based electronic devices for computers, and ongoing research and development of gallium-based solid-state devices and systems were expected to maintain the high demand for gallium and gallium compounds.

Table 2.—U.S. consumption of gallium, by end use

(Kilograms)

End use	1980	1981	1982
Specialty alloys	14	2	27
Electronics[1]	9,635	8,865	8,748
Research and development	754	636	579
Unspecified	57	57	57
Total	10,460	9,560	9,411

[1]Light-emitting diodes, semiconductors, and other electronic devices.

Table 3.—Stocks, receipts, and consumption of gallium[1]

(Kilograms)

Purity	Beginning stocks	Receipts	Consumption	Ending stocks
1981:				
97.0%-99.9%	104	19	4	119
99.99%	3	16	15	4
99.999%	4	88	87	5
99.9999%-99.99999%	1,765	9,474	9,454	1,785
Total	1,876	9,597	9,560	1,913
1982:				
97.0%-99.9%	119	15	28	106
99.99%	4	14	14	4
99.999%	5	75	75	5
99.9999%-99.99999%	1,785	9,249	9,294	1,740
Total	1,913	9,353	9,411	1,855

[1]Consumers only.

PRICES

The American Metal Market quoted the price for 99.999%-pure metal at $630 per kilogram, in 100-kilogram lots, throughout the year. However, it was common knowledge in the marketplace that the metal price was discounted during the year.

FOREIGN TRADE

Data on gallium metal exports are not reported separately but are included in the export category "base metals and alloys, not elsewhere classified, wrought or unwrought, waste and scrap." Significant quantities of gallium and gallium compounds are exported as parts of manufactured electronic and electrical components and equipment.

U.S. gallium imports in 1982 were less than those of 1981 in quantity and value. About three-fourths of all imports were from Switzerland and the Federal Republic of Germany. The average value of imported gallium metal declined from $447 per kilogram in 1981 to $377 per kilogram in 1982.

Table 4.—U.S. imports for consumption of gallium (unwrought, waste and scrap), by country

Country	1981		1982	
	Kilograms	Value	Kilograms	Value
Belgium	200	$87,979	--	--
Canada	589	303,873	379	$177,074
China	916	403,185	--	--
France	386	134,964	480	170,066
Germany, Federal Republic of	585	272,941	1,448	669,406
India	10	5,714	--	--
Italy	98	16,632	--	--
Japan	--	--	48	16,267
Malaysia	2	1,250	--	--
Spain	--	--	148	21,402
Sweden	1	680	--	--
Switzerland	2,679	1,215,460	2,429	807,087
United Kingdom	70	29,418	267	97,129
Total	5,536	2,472,096	5,199	1,958,431

WORLD REVIEW

Gallium production and consumption data for the rest of the world were not available. However, gallium was consumed by nations with well-developed electronic and electrical industries. Minimum world gallium consumption was thought to be equal to twice that of the United States or at least 20,000 kilograms. World production was believed to be commensurate with world consumption.

TECHNOLOGY

The method of gallium recovery from zinc residues, at the Dowa Mining Co. Ltd. (Japan), was described. The residues were treated to concentrate the gallium and associated indium. Solvent extraction was used to separate the gallium from its associated solution. The company reportedly recovered about 180 kilograms of gallium per month.[2]

Advances in high-temperature gallium phosphide device applications were reviewed. The electronic properties of gallium phosphide were given and compared with silicon and gallium arsenide.[3]

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[1]Physical scientist, Division of Nonferrous Metals.

[2]Hideki, A. Recovery of Gallium and Indium From Zinc Refinery By-Product. Nippon Kogyo Kaishi, v. 98, No. 1133, July 1982, pp. 561-565.

[3]Zipperian, T. E., R. J. Chaffin, L. Dawson, and R. Sandia. Recent Advances in Gallium Phosphide Junction Devices for High-Temperature Electronic Applications. IEEE Trans. Ind. Electron, v. 1E-29, No. 2, May 1982, pp. 129-136.

Gem Stones

By J. W. Pressler[1]

The value of gem stones and mineral specimens produced in the United States during 1982 was estimated to be $7.2 million, a 5% decrease compared with that of 1981. During the year, turquoise production decreased while tourmaline, sapphire, and opal production increased. Amateur collectors accounted for much of the activity in many States. Commercial operators produced agate, jade, jasper, opal, sapphire, tourmaline, and turquoise, which they sold mainly to wholesale or retail outlets and also to jewelry manufacturers.

Domestic Data Coverage.—Domestic production data for gem stones are developed by the Bureau of Mines from the production of Gem Stones survey, a voluntary survey of U.S. operations. Of the 46 operations to which a survey request was sent, 26% responded, representing an estimated 25% of the total production indicated in the text. Production for the 34 nonrespondents was estimated using reported prior year production levels adjusted by trends in employment and other guidelines.

DOMESTIC PRODUCTION

Mines and collectors in 46 States produced gem materials with an estimated value of $1,000 or more in each State in 1982. Eleven States supplied 91% of the total value as follows: Arizona, $2.8 million; Nevada, $1.2 million; Maine and Oregon, $500,000 each; California and Wyoming, $250,000 each; Montana, $225,000; and Arkansas, New Mexico, Texas, and Washington, $200,000 each. In 1982, estimated production increased 125% in Montana and 20% in Nevada, but decreased 29% in Maine, 17% in California and Oregon, and 14% in Arizona.

Park authorities at the Crater of Diamonds Park in Pike County, Ark., reported that 84,600 people visited the park in 1982 and found 1,382 diamonds with a total weight of 263 carats. This was a slight increase compared with the 1,327 diamonds found in 1981. The largest was a 3.48-carat brown stone of undetermined value. The next four largest diamonds, one brown, two whites, and one yellow, ranged from 2.43 to 3.40 carats. The new concentrating and screening techniques that enabled diggers to recover more of the smaller (1- to 24-point) diamonds contributed substantially to the total diamonds recovered, which averaged 19 points compared with 33 points 2 years ago. The "dig for fee" operations remained popular.

Prospecting and evaluation of kimberlite in Michigan and Kansas continued during 1982. Commercial interest and evaluation of the Murfreesboro diamond-bearing kimberlite was active.

The Geological Survey of Wyoming continued its research and exploration activities in the southern Laramie Range. Cominco American, Inc., and Superior Minerals Co. prospected several regions in the Laramie Range and Medicine Bow Mountains. Cominco American and Superior were committed to testing of kimberlite diatremes for commercial diamond mineralization near the Wyoming-Colorado border, with a pilot plant located in Fort Collins, Colo.

In Pala, San Diego County, Calif., Pala Gem Mines produced tourmaline at its Stewart lithia mine. Other small mines, in the same county, continued to produce fine gem-quality and specimen tourmaline, kunzite, and morganite.

Montana continued to lead the other

States in the production of corundum, particularly gem-quality sapphire. Intergem Inc., of Denver, Colo., was conducting sampling and hydraulic testing in June 1982 on the Yogo Gulch Sapphire Mine in Fergus County, Mont. No sapphire production was reported for the year. Three pay-as-you-dig or fee placer operations were active: Eldorado Bar and Castle's Sapphire Mine near Helena, and Gem Mountain Sapphire near Philipsburg. Gem-quality rubies and sapphires were also found in the Cowee Valley near Franklin, N.C. The Cherokee Mine near Franklin, N.C., was active, with many visitors buying gravel by the bucket, followed by washing and sorting.

The American Gem Co. operated the Rist Emerald Mine near Hiddenite, Alexander County, N.C. The dig-for-fee mine had produced a single-crystal emerald weighing more than 1,000 carats in 1980, with an estimated value of $30,000.

One of the most popular gem-hunting areas in the United States was Emerald Creek in northern Idaho where gem-quality and asteriated garnet continued to be produced. The U.S. Forest Service administered the riverbed and gravel area in Benewah County, Idaho, and charged prospectors and rock hounds a daily fee.

CONSUMPTION

Domestic gem stone output went to amateur and commercial rock, mineral, and gem stone collections, objects of art, and jewelry. Apparent consumption (domestic production plus imports minus exports and reexports) in 1982 was valued at $1,643 million, 10% less than the revised value of $1,816 million for 1981.

PRICES

A sampling of prices that diamond dealers in various U.S. cities charged their customers in January 1983 is shown in table 1.

Table 1.—Prices of U.S. cut diamonds, by size and quality

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Price range per carat[3] 1982	Median price per carat[3] January 1982	Median price per carat[3] Early January 1983
0.04-0.08	G-I	VS_1	$400- $613	$532	$475
.04- .08	G-I	SI_1	365- 520	385	400
.09- .16	G-I	VS_1	450- 700	565	525
.09- .16	G-I	SI_1	400- 585	450	450
.17- .22	G-I	VS_1	600- 1,205	829	750
.17- .22	G-I	SI_1	490- 1,045	700	650
.23- .28	G-I	VS_1	675- 1,375	1,050	940
.23- .28	G-I	SI_1	580- 1,215	850	750
.29- .35	G-I	VS_1	690- 1,600	1,250	1,250
.29- .35	G-I	SI_1	600- 1,210	950	1,000
.46- .55	G-I	VS_1	1,200- 2,125	2,000	1,900
.46- .55	G-I	SI_1	885- 1,740	1,500	1,480
.69- .79	G-I	VS_1	1,500- 3,010	2,300	2,250
.69- .79	G-I	SI_1	1,000- 2,180	2,000	1,750
1.00-1.15[4]	D	FL	12,000-25,000	22,500	19,750
1.00-1.15	E	VVS_1	7,000- 7,500	12,500	7,300
1.00-1.15	G	VS_1	3,500- 4,500	5,350	3,900
1.00-1.15	H	VS_2	2,800- 4,050	4,400	3,200
1.00-1.15	I	SI_1	2,000- 3,000	2,775	2,600

[1]Gemological Institute of America color grades: D—colorless; E—rare white; G-I—traces of color.
[2]Clarity: FL—no blemishes; VVS_1—very, very slightly included; VS_1—very slightly included; VS_2—very slightly included, but more visible; SI_1—slightly included.
[3]Jewelers' Circular-Keystone, v. 154, No. 2, February 1983, p. 86. These figures represent a sampling of net prices that diamond dealers in various U.S. cities charged their customers during the month.
[4]The Diamond Registry Bulletin, v. 13, No. 1, Dec. 31, 1981, and v. 14, No. 1, Dec. 31, 1982.

Yearend domestic sales of commercial-grade gem diamonds and inexpensive commercial-grade stones up to 1 carat, had its traditional Christmas season surge. In 1982, total sales of gold jewelry, in which the value of the precious stone, principally diamond, was over 50% of the total value, decreased 3% compared with that of 1981.

The U.S. price of 1.0-carat, D-flawless, investment-grade diamond fluctuated during 1982 between $12,000 and $25,000 per carat, and at yearend 1982 was $19,750 per carat, a 12% decrease compared with that of 1981. However, investment diamond sales are only a very small percentage of the total diamond market, estimated at $100 million for the world, compared with total world diamond jewelry sales of $18.5 billion.

A sampling of prices that colored-stone dealers in various U.S. cities charged their customers during January 1983 is shown in table 2.

Colored stones languished during the year. Commercial gem materials were more popular although expensive, and fine-quality stones experienced poor sales. Average prices of some medium-quality stones—sapphire, Colombian emerald, and ruby—decreased 20% to 56%. The average price for medium-quality tsavorite garnet increased 27% because of its rarity and beauty.

Table 2.—Prices of U.S. cut colored gem stones, by size[1]

Gem stone	Carat weight	Price range per carat 1982	Median price per carat[1 2] January 1982	Median price per carat[1 2] Early January 1983
Amethyst	10	$10- $35	$18	$17
Aquamarine	5	40- 300	187	150
Citrine	10	6- 45	16	10
Emerald:				
Colombian	1	1,200-4,000	2,500	1,500
Zambian	1	NA	NA	1,400
Garnet, tsavorite	1	300-1,200	625	725
Opal, black	3	200- 900	250	NA
Opal, white	5	40- 130	80	NA
Peridot	5	40- 200	65	NA
Ruby:				
Medium to better	1	1,000-5,000	1,650	1,200
Commercial	1	500-3,000	700	NA
Sapphire:				
Medium to better	1	450-2,500	1,500	700
Commercial	1	225-1,000	750	NA
Star sapphire:				
Sky-blue	5	200-1,000	450	NA
Gray	5	30- 200	102	NA
Tanzanite	5	300-1,200	850	762
Topaz	5	75- 500	237	210
Tourmaline, green	5	40- 200	125	132
Tourmaline, pink	5	40- 250	125	137

NA Not available.
[1]Medium to better quality.
[2]Jewelers' Circular-Keystone, v. 153, No. 2, February 1982, p. 152; v. 154, No. 2, February 1983, p. 87. These figures represent a sampling of net prices that colored stone dealers in various U.S. cities charged their cash customers during the month.

FOREIGN TRADE

The declared customs value of U.S. imports of rough and polished natural diamonds, excluding industrial diamonds, was $1.9 billion in 1982, a 14% decrease compared with that of 1981. Total polished diamond imports, principally from Belgium (35%) and Israel (25%), were valued at $1.6 billion. Imports in the over-0.5-carat category, mostly from Belgium (40%), Israel (15%), and Switzerland (15%), decreased 17% in value to $633 million. Imports in the less-than-0.5-carat group, mostly from Belgium (32%), Israel (31%), and India (27%), decreased 3% in value to $1.01 billion. Imports of rough natural diamond, principally from the Republic of South Africa (65%), the United Kingdom (9%), and Belgium, (9%), decreased 5% in caratage and 32% in value in 1982 compared with that of 1981. The decrease in carat value from $430 in 1981 to $345 in 1982 for South African imports again indicated that De Beers Consolidated Mines Ltd. was withholding the better quality rough stones from the market.

The total value of emerald imports decreased 8% to $121 million in 1982. The total value of rubies and sapphires imported in 1982 decreased 27% to $129 million, compared with $177 million in 1981. Import caratage of ruby and sapphire were reported for the first time in 1982, and indicated an average carat value of $34 for ruby and $24.50 for sapphire.

Export value of all gem materials, other than diamond, amounted to $67.3 million.

Of this total, other precious and semiprecious stones, cut but unset, were valued at $29.6 million; other natural precious and semiprecious stones, not set or cut, $17.2 million; synthetic gem stones and materials for jewelry, cut, $7.7 million; pearls, natural, cultured, or synthetic, not strung or set, $1.3 million; and other, $11.5 million. Reexports of all gem materials, other than diamond, amounted to $43.1 million in value in categories as follows: pearls, $3.0 million; precious and semiprecious stones, cut but unset, $32.5 million; and other, $7.6 million.

Table 3.—U.S. exports and reexports of diamond (exclusive of industrial diamond), by country

Country	1981		1982	
	Quantity (carats)	Value (millions)	Quantity (carats)	Value (millions)
Exports:				
Belgium-Luxembourg	47,781	$49.4	40,655	$33.6
Canada	9,020	7.1	10,193	5.8
France	5,909	23.0	4,990	9.8
Germany, Federal Republic of	3,037	6.8	1,961	3.5
Hong Kong	47,802	134.8	47,395	100.0
Israel	16,253	11.8	20,353	5.6
Japan	31,415	66.8	27,411	52.0
Netherlands	371	4.3	1,052	2.5
Singapore	6,585	12.3	8,528	17.0
Switzerland	16,930	98.4	13,649	48.4
United Kingdom	5,278	18.3	4,180	9.1
Other	6,729	8.3	4,504	5.5
Total	197,110	441.3	184,871	292.8
Reexports:				
Belgium-Luxembourg	[1]1,973,297	142.0	[1]1,368,040	108.0
France	4,315	5.2	4,537	3.3
Hong Kong	55,118	44.9	112,431	54.8
India	323,785	7.2	370,863	7.2
Israel	386,840	79.3	338,034	66.7
Japan	79,813	19.5	77,687	26.8
Netherlands	41,324	3.2	27,824	4.6
Switzerland	28,182	58.5	43,727	39.3
United Kingdom	43,719	39.1	69,113	25.2
Other	81,484	13.9	85,922	9.8
Total	3,017,877	412.8	2,498,178	345.7

[1]Artificially inflated in 1981 by auction of 1,477,365 carats of U.S. Government stockpile industrial diamond stones with subsequent reexport as gem stones to Belgium-Luxembourg. In 1982, approximately 1.2 million carats were similarly auctioned and reexported to Belgium-Luxembourg.

Table 4.—U.S. imports of diamond for consumption, by kind and country

Kind and country	1981		1982	
	Quantity (carats)	Value (millions)	Quantity (carats)	Value (millions)
Rough or uncut, natural:[1]				
Belgium-Luxembourg	r28,237	$12.2	77,117	$25.3
Central African Republic	19,869	2.2	7,860	.5
Guinea	--	--	37,168	4.0
Israel	21,609	6.7	25,123	4.9
Liberia	r3,798	r3.2	4,407	4.7
Netherlands	--	--	6,581	4.4
Sierra Leone	37,872	23.3	1,953	.6
South Africa, Republic of	r656,444	282.5	579,815	199.8
Switzerland	r7,966	r4.2	6,955	6.8
United Kingdom	r80,236	56.9	77,818	19.3
Venezuela	67,351	6.0	38,156	2.8
Other	r11,726	r7.2	27,767	3.5
Total	r935,108	r404.4	890,720	276.6

See footnotes at end of table.

Table 4.—U.S. imports of diamond for consumption, by kind and country —Continued

Kind and country	1981 Quantity (carats)	1981 Value (millions)	1982 Quantity (carats)	1982 Value (millions)
Cut but unset, not over 0.5 carat:				
Belgium-Luxembourg	777,054	$319.9	954,156	$323.6
Hong Kong	19,370	10.0	27,196	11.0
India	1,120,122	246.0	1,229,187	271.4
Israel	958,153	383.3	832,168	315.4
South Africa, Republic of	45,150	27.9	49,611	24.2
Switzerland	29,660	13.8	44,734	15.4
United Kingdom	17,571	10.8	39,080	16.5
Other	68,851	25.5	87,427	30.4
Total	3,035,931	1,037.2	3,263,559	1,007.9
Cut but unset, over 0.5 carat:				
Belgium-Luxembourg	206,171	319.3	232,263	250.7
Hong Kong	5,899	26.2	9,177	28.4
India	11,409	6.3	27,299	7.6
Israel	138,107	146.7	111,084	95.7
Netherlands	8,288	16.0	12,322	16.5
South Africa, Republic of	26,463	48.2	36,045	51.7
Switzerland	18,688	125.6	14,539	91.8
United Kingdom	11,112	40.1	22,089	46.4
Other	11,927	31.4	15,717	44.3
Total	438,064	759.8	480,535	633.1

[r]Revised.
[1]Includes some natural advanced diamond.

Table 5.—U.S. imports of natural precious and semiprecious gem stones, other than diamond, by kind and country

Kind and country	1981 Quantity (carats)	1981 Value (millions)	1982 Quantity (carats)	1982 Value (millions)
Emerald:				
Belgium-Luxembourg	6,645	$3.2	5,392	$1.5
Brazil	48,977	5.8	328,976	5.7
Canada	18,788	1.2	10,351	.7
Colombia	121,708	40.2	116,272	37.6
France	9,759	2.2	12,963	2.9
Germany, Federal Republic of	41,795	4.6	19,167	2.2
Hong Kong	120,313	12.2	100,955	15.5
India	1,572,510	15.8	1.136,247	11.5
Israel	96,870	22.8	238,543	17.1
Pakistan	4,651	1.2	4,813	1.0
South Africa, Republic of	14,787	1.4	15,702	.4
Switzerland	49,721	1.1	76,377	14.5
Thailand	31,940	2.6	43,246	1.9
United Kingdom	7,097	4.6	18,442	3.9
Other	152,098	12.7	39,404	4.4
Total	2,297,659	131.6	2,166,850	120.8
Ruby:				
Austria	NA	.1	14,267	.2
Germany, Federal Republic of		3.1	35,994	1.3
Hong Kong		[r]9.1	203,379	9.1
India		4.7	303,205	4.7
Israel		.7	25,258	.7
Italy		.1	40,722	.1
Switzerland		12.0	45,876	16.4
Thailand		47.6	1,175,698	25.2
United Kingdom		4.7	47,395	3.6
Other		11.7	41,489	4.5
Total	NA	93.8	1,933,283	65.8

See footnotes at end of table.

Table 5.—U.S. imports of natural precious and semiprecious gem stones, other than diamond, by kind and country —Continued

Kind and country	1981 Quantity (carats)	1981 Value (millions)	1982 Quantity (carats)	1982 Value (millions)
Sapphire:				
Austria	NA	$.1	14,521	$0.2
Belgium	NA	1.4	10,922	1.4
Canada	NA	1.1	12,919	.4
France	NA	2.2	11,036	1.8
Germany, Federal Republic of	NA	2.4	40,381	1.6
Hong Kong	NA	8.4	179,616	8.0
India	NA	3.3	360,810	2.4
Israel	NA	.6	41,597	.6
Sri Lanka	NA	7.5	41,938	4.0
Switzerland	NA	11.1	66,575	13.4
Thailand	NA	34.8	1,749,651	22.3
United Kingdom	NA	5.1	25,800	3.0
Other	NA	5.0	25,184	4.2
Total	NA	83.0	2,580,950	63.3
Other:				
Rough, uncut:				
Australia	NA	1.2	NA	.9
Brazil	NA	3.2	NA	4.4
Colombia	NA	2.2	NA	3.4
South Africa, Republic of	NA	1.6	NA	.9
Switzerland	NA	.7	NA	2.9
Zambia	NA	2.5	NA	.9
Other	NA	6.3	NA	6.3
Total	NA	17.7	NA	19.7
Cut, set and unset:				
Brazil	NA	r37.1	NA	15.7
China	NA	3.6	NA	1.6
Germany, Federal Republic of	NA	r11.6	NA	10.0
Hong Kong	NA	r22.8	NA	19.7
India	NA	r4.0	NA	3.7
Japan	NA	96.6	NA	84.7
Switzerland	NA	r3.7	NA	3.4
Taiwan	NA	r3.5	NA	1.1
Thailand	NA	r2.9	NA	2.2
Other	NA	14.3	NA	16.8
Total	NA	r200.1	NA	158.9

rRevised. NA Not available.

Table 6.—Value of U.S. imports of synthetic and imitation gem stones, by country

(Million dollars)

Country	1981	1982
Synthetic, cut but unset:		
Austria	r1.8	1.0
France	1.2	1.3
Germany, Federal Republic of	r5.9	5.9
Korea, Republic of	8.2	11.1
Switzerland	r3.2	3.0
Other	r3.3	1.9
Total	r23.6	24.2
Imitation:		
Austria	7.7	7.2
Czechoslovakia	r.9	.8
Germany, Federal Republic of	r3.9	3.0
Other	r2.8	2.4
Total	r15.3	13.4

rRevised.

Table 7.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stones	1981 Quantity	1981 Value	1982 Quantity	1982 Value
Diamonds:				
Rough or uncut[1]	935	404,354	891	276,577
Cut but unset	3,474	1,796,908	3,745	1,641,035
Emeralds: Cut but unset	2,298	131,560	2,167	120,809
Coral: Cut but unset, and cameos suitable for use in jewelry	NA	3,630	NA	2,804
Rubies and sapphires: Cut but unset	NA	176,758	4,514	129,794
Marcasites	NA	498	NA	38
Pearls:				
Natural	NA	2,008	NA	3,003
Cultured	NA	105,942	NA	92,741
Imitation	NA	1,966	NA	1,458
Other precious and semiprecious stones:				
Rough, uncut	NA	17,697	NA	19,769
Cut, set and unset	NA	[r]87,990	NA	58,842
Synthetic:				
Cut but unset[2]	28,846	22,646	26,703	23,238
Other	NA	961	NA	896
Imitation gem stones	NA	13,332	NA	13,448
Total	XX	2,766,250	XX	2,384,452

[r]Revised. NA Not available. XX Not applicable.
[1]Includes 1,823 carats of other natural diamond, advanced, valued at $1.26 million in 1981, and 4,985 carats valued at $837,000 in 1982.
[2]Quantity in thousands of stones.

WORLD REVIEW

Angola.—In Angola, Companhia de Diamantes de Angola (Diamang) became the operating arm of the state-owned National Diamond Enterprise (Endiama). Endiama has the exclusive right to prospect, explore, and trade in Angolan diamonds. The Diamond Trading Co., owned by Anglo American Corp. of South Africa Ltd. and De Beers of the Republic of South Africa, provided essential managerial, technical, and marketing services, and owned a 2% interest in Diamang. Diamang was making significant progress in revitalizing Angola's diamond industry, the second most important mineral industry, following petroleum.[2]

Australia.—On November 1, 1982, Ashton Joint Venture (AJV) was restructured into two new joint ventures—Argyle Diamond Mines Joint Venture, with responsibility for the development, mining, and management of AJV's diamond interest in the Argyle and Ellendale areas of Western Australia, and Ashton Exploration Joint Venture, covering all exploration and evaluation activities in the remainder of the existing AJV area of diamond exploration in the Kimberley region.

Six small shafts on the kimberlite pipe AK-1 were completed in late 1982 to an average depth of 51 meters. Diamond recovery of 16 carats per metric ton from these shaft samples was much higher than cumulative averages to date. Total cumulative totals of bulk testing of the kimberlite pipe AK-1 gave a recovery of 408,392 carats from 62,846 tons, an average of 6.5 carats per ton. Testing of 120,650 tons of alluvial ore resulted in the recovery of 401,985 carats, an average of 3.33 carats per ton. Based on this information, diamond reserves were estimated to be about 500 million carats.[3]

AJV estimated that the average diamond quality from the AK-1 pipe comprised 5% gem, 25% cheap gem, and 70% industrial, with a total average value of $6.50 per carat. Average diamond quality for the alluvials comprised 10% gem, 35% cheap gem, and 55% industrial, with a total average value of $11.00 per carat.[4]

A 34.5-kilometer water supply pipeline from Lake Argyle was completed in November 1982 for the commercial alluvial operation and the large-scale kimberlite treatment plant. Work was continuing to double the capacity of the Argyle alluvial treatment plant to 4,000 tons per day by early 1983. This project will expand Argyle's diamond production capability to about 5 million carats per year. After the State government of Western Australia approved the mining and marketing proposals on December 21, 1982, commercial production of diamonds from the Upper Smoke Creek alluvial deposit was initiated at yearend.[5]

In the last 15 years, Australian production of opals and sapphires increased to over $66 million in value in 1982, with the principal production coming from small syndicate operations and individual producers. Precious opal mining came from long-established fields at Coober Pedy and Andamooka in South Australia, at Lightning Ridge and White Cliffs in New South Wales, and from smaller fields in Queensland.

Australia has become the major world supplier of rough gem-quality sapphires. The industry is centered in the placer gravels of the Glen Innes-Inverell district and in Queensland in the Anakie district.[6]

Belgium.—Antwerp's diamond industry had increased exports despite major price instability in the last few years, but local employment in diamond cutting had decreased sharply, principally because of increased competition from India and the U.S.S.R. The U.S.S.R. had become the largest source of imports of polished goods for Antwerp dealers, some of which were reexported to the United States. Antwerp was expected to remain a world center for trading, grading, and cutting by virtue of its skilled labor force and favorable business climate. Diamond exports in 1982 increased in value 0.7% to $3.1 billion, with the United States receiving $832 million, or 35%, of the total value.[7]

Botswana.—Botswana's diamond production was rapidly approaching that of the Republic of South Africa, with 7.8 million carats in 1982 compared with South African production of 9.2 million carats, and showed possibilities of becoming the leading producer of gem diamonds in the world. Botswana started its Jwaneng Mine in June, the third major diamond mine developed in recent years. Jwaneng produced about 2.6 million carats of medium-quality diamonds in 1982, and the yield was expected to reach 4.5 million carats by 1985. The other two mines, Orapa with a production of 4.5 million carats per year and Letlhakane with a production of 0.5 million carats per year, were operated by Debswana, a joint venture by De Beers and the Botswana Government. All diamond production was sold to the Central Selling Organization (CSO).[8]

Brazil.—Société d'Enterprise et d'Investissements S.A. (Sibeka), the Belgium-based diamond producer, was prospecting for diamonds in Brazil through its subsidiary, Sibinter, which had an 8.5% interest in Dinamin CA. Dinamin was carrying out an extensive drilling and dredging program over an area south of the Orinoco River.[9]

Central African Republic.—The Central African Republic's only active mining industry was gem diamond. In 1981, the International Development Association approved a $4 million technical assistance project for the Central African Republic, part of which included a study of the diamond sector. Central African diamond production decreased 10% in 1982 to about 277,000 carats, and remained far below the 1972 high of 524,000 carats.[10]

China.—A diamond weighing 96.94 carats was found in 1982 at the Chenjiafu diamond placer mine near Tancheng in Shandong Province. It was the third largest diamond found in the mining area, and followed finds of 159 carats in 1979 and 124 carats in 1981. The diamonds may come from deposits in the nearby Yi-Meg Mountain Range.[11]

Although several diamond mining areas have been reported in China, Changte in north Hunan Province is the only one confirmed. Changte has been known since 1955, and the recovery grade of the mine is about 0.25 carat per ton. Provinces where diamond deposits, individual stones, or kimberlite pipes have been discovered include Liaoning, Shandong, Guangxi, Guizhou, and Xizang. The Changte Mine produced principally industrial stones; production had been initiated in the early 1970's. China's diamond production was estimated to have been 15,000 carats in 1976, and by 1980, output had increased to 1.8 to 2.8 million carats, with about 20% gem-quality.

A diamond cutting industry has operated in Shanghai for about 50 years. A new diamond cutting plant was established in Beijing in 1981, financed by a Federal Republic of Germany company that previously had a marketing outlet for Chinese gold and silver jewelry. The new plant capacity was estimated at 60,000 carats per year of principally small stones. The first Chinese cut gem diamonds were introduced to the London market in 1980, and were pronounced of high-quality cut.[12]

Colombia.—Colombia, previous supplier of 90% of the world's high-quality emeralds, was facing strong competition from stones from Brazil, Zimbabwe, Mozambique, Tanzania, and especially Zambia. At yearend 1982, the median price of Zambian emeralds was almost the same as Colombian emeralds. However, the Bogota prices remained high, and because of their exceptional color and reputation, Colombian emeralds continued to dominate the market for investment gems.[13]

Ghana.—India contracted in 1982 to market Ghana's diamond production of over 800,000 carats per year. The Ghanaian Government had also asked the Indian Government to participate in a joint venture for diamond mining in Ghana.[14]

Guinea.—The Guinean $85 million joint venture, Société Mixte Aredor-Guinea, received at yearend 1982 a 7-year bank credit of $43 million as part of a $60 million financing package to develop and exploit diamond and gold deposits in the Baule Basin. Aredor-Guinea was a joint venture of Guinea, 50%; Bridge Oil Ltd. of Australia, 45%; Industrial Diamond Co., of London, 2.5%; and Simonius Vischer of Basel, Switzerland, 2.5%. The alluvial project was scheduled to come onstream in 1984 and was to mine 400,000 cubic meters of diamond-bearing gravels annually, with reserves sufficient for 15 years of operation. Exploration testing had indicated recovery of 20 carats per 100 tons, 80% gem quality, and average diamond value of $170 per carat. Guinea was the only African nation to sell its diamonds independently of the CSO.[15]

India.—The Geological Survey of India (GSI) explored the Ramkheria alluvial deposit adjacent to the famous Panna diamond district of India, and estimated the diamond reserves to be over 200,000 carats with a grade of 10 carats per 100 tons. GSI was also exploring many other diamond prospects including the famous Golconda Mines in Andhra Pradesh.

Emerald production in India's Rajasthan State was on the decline with only 6,600 carats produced in 1980 compared with 38,000 carats in 1975. Gem-quality garnet, agate, and jasper were also produced in Rajasthan, while Maharashtra State produced 80% of India's corundum and sapphire.[16]

The Indian Government continued to promote its diamond cutting and polishing industry to improve its export earnings, with over 200,000 artisans specializing in cutting small, inexpensive stones. Exports for the 1981-82 year were about $800 million, only a slight improvement over 1978-79. To ensure a long-term source of small gem diamond, India's Metals and Minerals Trading Corp. had offered to play a major role in the marketing of Ashton Joint Venture diamond production from Western Australia.[17]

Israel.—In September and October 1982, Israel's diamond imports increased considerably over the corresponding months in 1981, indicating that dealers were beginning to replenish their inventories that had depleted over the previous 2 years. For January and February 1983, exports of finished goods were $181 million, an 8% increase compared with that of the corresponding period of 1982.[18]

Ivory Coast.—Diamond mining in the Tortiya area had ceased in 1980, and prospecting programs were the major mining activity in the Ivory Coast. A diamond deposit was discovered in 1982 in the Tortiya area, 440 kilometers northwest of Abidjan. A Canadian company was contracted to follow up this initial discovery under the supervision of the state company, Société pour le Development Minier de la Cote d'Ivoire.[19]

Lesotho.—During May 1982, the Lesotho Government and De Beers agreed that the Letseng-la-Terai diamond mine was no longer economic, and the mine was closed. Stockpiled ore was treated through October 1982, and final cleanup operations were finished by yearend. Average recovery for 1982 was 2.95 carats per 100 tons.[20]

Liberia.—Exports of Liberian diamonds were valued at $23 million in 1981. About 75% of these exports were believed to originate from Guinea and Sierra Leone. Liberia exported diamonds to four countries in 1981: The United Kingdom (48%), Belgium (29%), the United States (21%), and Israel (2%).[21]

Namibia.—Production at De Beer's Consolidated Diamond Mines (Pty.) Ltd. beach-placer diamond mine at Oranjemund was reduced early in 1982 to achieve further economies because of the soft diamond market. This resulted in 19% less diamond production for 1982. Ten million tons of ore was treated during the year, with an average recovery of 10.13 carats per 100 tons. Ninety-five percent of the production was of gem quality.[22]

Pakistan.—The Pakistan Investment Promotion Bureau project for cutting, processing, finishing, and polishing diamond and precious stones, to be established in Karachi, was delayed for lack of approval and financing. This plan was reportedly similar to the plan of the Government of

India, which has been so successful.[23]

Three new emerald deposits were discovered by the country's Gemstone Corp., at Charbagh, Makad, and Gujar Killi in Swat.[24]

Sierra Leone.—Diamond production in Sierra Leone had consistently accounted for over one-half of its export earnings in recent years. The National Diamond Mining Co. (DIMINCO) was forced to layoff over 1,800 employees in 1982. The country's diamond production in 1982 was less than 300,000 carats, a decrease of about 5% from 1981 totals. Production had previously peaked at nearly 2 million carats in 1969. Production from the Alluvial Diamond Mining Scheme accounted for most of the shortfall and is expected to diminish further as alluvial deposits are depleted.[25]

DIMINCO had developed a $100 million project for the underground mining of a kimberlite pipe at Kono and negotiated during 1982 for international funding.[26]

South Africa, Republic of.—De Beer's CSO reported that diamond sales were higher in the second half of 1982 compared with the previous two half-years, reflecting a significant improvement in the demand for small sizes and cheaper qualities. Retail sales of diamond jewelry in 1982 was only 3% lower than in 1981, a record year. Despite all of De Beer's economy measures and cutbacks during 1982, its diamond stocks remained high at a value of $1.7 billion.

Operations at the De Beer's Koffiefontein Mine, a producer of high-quality diamonds, was suspended in June 1982, but its Finsch Mine, which produced smaller and lower quality stones, was restored to full capacity. Production at the Premier Mine increased 21% as a result of improved grade and recovery brought about by better mining and metallurgical controls. In Namaqualand, the Tweepad plant closed in mid-1981 and was reopened in September 1982; and the Annex Kleinzee plant was temporarily closed, resulting in an overall reduction of 22% in the Namaqualand Div. output. Active exploration continued during the year, with the sampling of the kimberlite pipes on the farm Venetia, and the testing of gravel along the north bank of the Orange River.[27]

Tanzania.—Diamond production in Tanzania comprised 99% of the country's value of mineral production, and 88% of mineral export revenues. Diamond production came from kimberlite and its associated alluvial deposits in the Shinyanga region. Williamson Diamonds Ltd. and Alamasi Ltd. operated two mines in the area.[28]

Thailand.—Thailand customs estimated that total gem export value in 1981 was over $220 million, principally sapphires and rubies. Over 200,000 miners, cutters, and polishers were employed in the country.[29]

U.S.S.R.—Diamond, after fossil fuels and precious metals, was one of the significant foreign-exchange-earning exports of the Soviet Union. Diamonds were cut in centers at Leningrad, Sverdlovsk, and Smolensk. A principal market was Antwerp, through a Soviet-Belgium diamond export organization, Almazyuvelierexport. Operating mines in Yakutia included the Mirnyy open pit with five concentrators, the Aykhal open pit and concentrator, the Udachnaya placer mine and concentrator, and the Irelyakh placer mine with two dredges. A small production came from the Vishera River region in Perm Oblast', where four dredges and two separation plants were operated at two deposits.[30]

Venezuela.—The Venezuelan Ministry of Energy and Mines enacted a new law during 1982 to improve mining techniques of small miners because an estimated 65% of their diamond production was smuggled out of the country.[31]

Sibeka, through its subsidiary, Sibinter, continued to prospect by drilling and dredging during the year in the large area south of the Orinoco.[32]

Zaire.—Zaire's state-owned Société Minière de Bakwanga (Miba) diamond mine produced about 6 million carats in 1982, valued at about $45 million. About 70% of this output was industrial-quality crushing bort, 25% was for cheap gem or high-quality industrial use such as setting stones, and the remaining 5% was gem stones. An estimated additional 6 million carats was produced by numerous small alluvial operators and illicit miners in the Tshikapa area. This artisanal production was supposed to have been sold to authorized buyers in Kinshasa. Instead, most of it was smuggled into the neighboring Congo and sold in Bujumbura, Brazzaville, and Europe. Congo has no diamond production of its own, but is a sizable exporter of gem-quality goods. Despite efforts of the Zairean Government to set up purchasing offices in several parts of the country in 1982 and to pay for the diamonds at black market exchange rates, the project was only marginally successful and may not continue. At yearend, the Zairean Depart-

Table 8.—Diamond (natural): World production, by country and type[1]

(Thousand carats)

Country	1978 Gem	1978 Industrial	1978 Total	1979 Gem	1979 Industrial	1979 Total	1980 Gem	1980 Industrial	1980 Total	1981[p] Gem	1981[p] Industrial	1981[p] Total	1982[e] Gem	1982[e] Industrial	1982[e] Total
Angola	488	162	650	630	211	841	1,110	370	1,480	1,050	350	1,400	1,000	400	1,400
Australia	--	--	--	--	--	--	--	48	48	21	184	205	70	487	[2]557
Botswana	420	2,379	2,799	659	3,735	4,394	765	4,336	5,101	744	4,217	4,961	1,165	6,604	[2]7,769
Brazil[3]	236	384	620	236	384	620	253	414	667	163	926	1,089	175	975	1,150
Central African Republic	199	85	284	205	110	315	227	115	342	209	103	312	186	91	[2]277
China[e]	NA	NA	NA	NA	NA	NA	360	1,440	1,800	380	1,520	1,900	400	1,600	2,000
Ghana	142	1,281	1,423	125	1,128	1,253	126	1,132	1,258	85	751	836	68	612	[2]680
Guinea[e]	25	55	80	27	58	85	12	26	38	12	26	38	13	27	40
Guyana	7	10	17	6	10	16	4	6	10	4	6	10	5	6	[2]11
India	14	2	16	14	2	16	12	2	14	14	2	16	12	2	14
Indonesia[e]	3	12	15	3	12	15	3	12	15	3	12	15	3	12	15
Ivory Coast	22	23	45	24	24	48	--	--	--	--	--	--	--	--	--
Lesotho	62	5	67	48	4	52	50	4	54	49	4	53	39	3	[2]42
Liberia	128	180	308	170	132	302	123	175	298	132	204	336	170	263	[2]433
Namibia	1,803	95	1,898	1,570	83	1,653	1,482	78	1,560	1,186	62	1,248	963	51	[2]1,014
Sierra Leone	353	426	779	[r]434	[r]451	[r]885	317	275	592	208	97	305	[2]203	[2]87	[2]290
South Africa, Republic of:															
Finsch Mine	403	2,227	2,630	465	2,120	2,585	465	2,442	2,907	1,002	3,463	4,465	847	3,003	3,850
Premier Mine	380	1,603	1,983	468	1,613	2,081	407	1,632	2,039	510	1,530	2,040	615	1,845	2,460
Other De Beers properties[4]	1,254	1,395	2,649	1,850	1,370	3,220	1,550	1,489	3,039	1,603	1,069	2,672	1,359	906	2,265
Other	320	145	465	403	95	498	390	145	535	314	35	349	521	58	579
Total	2,357	5,370	7,727	3,186	5,198	8,384	2,812	5,708	8,520	3,429	6,097	9,526	3,342	5,812	[2]9,154
Tanzania	141	141	282	157	157	314	137	137	274	110	107	217	100	120	220
U.S.S.R.[e]	2,150	8,400	10,550	2,200	8,500	10,700	2,250	8,600	10,850	2,100	8,500	10,600	2,100	8,500	10,600
Venezuela	271	549	820	247	556	803	238	483	721	102	388	490	100	400	500
Zaire	640	10,603	11,243	294	8,440	8,734	345	9,890	10,235	450	8,550	9,000	450	8,550	9,000
World total	9,461	30,162	39,623	[r]10,235	[r]29,195	[r]39,430	10,626	33,251	43,877	10,451	32,106	42,557	10,564	34,602	45,166

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.

[1]Table includes data available through June 3, 1983. Total diamond output (gem plus industrial) for each country is actually reported except where indicated by a footnote to be estimated. In contrast, the detailed separate production data for gem diamond and industrial diamond are Bureau of Mines estimates in the case of every country except Australia (1980-82), Central African Republic (1978-81), Liberia (1978-82), Sierra Leone (1978-82), the Republic of South Africa (1978-79), and Venezuela (1978-81), for which source publications give details on grade as well as totals. The estimated distribution of total output between gem and industrial diamond is conjectural, and for most countries, is based on the best available data at time of publication.

[2]Reported figure.

[3]Figures represent officially reported output plus official Brazilian estimates of output by nonreporting mines; officially reported output was as follows, in thousand carats: 1978—86, 1979—83, 1980—158, 1981-136.

[4]Other De Beers Group output from the Republic of South Africa includes Kimberley Pool, Koffiefontein Mine, and the Namaqualand Mines.

ment of Mines and Energy had established a list of approved private buyers of artisanally mined diamonds. These buyers will compete legally with the state marketing agency, Sozacom, which also has a diamond buying and marketing operation.[33] Miba had suffered declining grade and production of its alluvial deposits since 1961 and had been seeking a $40 million loan from the International Finance Corp. for the mining of its Massif I kimberlite pipe near Mbuji Mayi, with no progress at yearend 1982. Despite this, preparations continued for development of the new mine with increased capacity and modernization of its treatment plant.[34] Of the world's 15 largest diamond pipes, Zaire has two: Talala, covering 40 hectares, and Massif I, 18.6 hectares.

Zairean announcements during 1982 indicated satisfaction with its break in 1981 with CSO for the marketing of its Miba diamond production. Five-year contracts were signed with three buying concerns, Caddi Sprl and Glasol NV of Antwerp, Belgium, and Industrial Diamond Co. of London, England. Despite this apparent success, the Zairean Government announced on March 7, 1983, that it was once again returning to the CSO, and gave CSO exclusive purchase rights for Miba's diamond production with a floor price of $8.55 per carat. The prior system of three designated buyers was determined not to be as profitable to the Government as the new CSO arrangement was expected to be with a guaranteed minimum price.[35]

Zambia.—Extensive illegal mining of emerald occurred in Zambia during 1982. Estimated total value of emerald production for the year was $100 million. International Development and Construction Co. of Saudi Arabia and the Reserved Minerals Corp. of Zambia formed a joint venture for mining of emeralds in Zambia.[36]

TECHNOLOGY

Two methods were announced during 1982 to mark valuable gem diamonds with invisible identification marks. General Electric Co. developed an ion implanter to bombard the surface of a stone with a brand or secret pattern for use in positive identification.[37]

The Gemological Institute of America announced the development of a machine to inscribe an identification on the girdle of a stone using a laser device. The inscription will only be visible under 10-power magnification or better.[38]

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Gold

By J. M. Lucas[1]

The discovery of new sources of gold was again the principal objective of both corporate and national exploration firms worldwide. The world economic recession and the less-than-encouraging outlook for any immediate sustained growth in demand for most metals and fuels had a severe impact on exploration for many commodities; thus in 1982 gold became, for many, the only remaining target of interest. In the United States several substantial discoveries were made, mostly in Nevada and other Western States.

The impact of the economic recession on the 1982 domestic demand for gold in its role as a fabricated product was moderate when compared with the combined effect of soaring gold prices, record high interest rates, and economic uncertainty in recent years. Both domestically and internationally, the demand for newly fabricated gold products generally increased during 1982.

Table 1.—Salient gold statistics

	1978	1979	1980	1981	1982
United States:					
Mine production ----- thousand troy ounces--	999	964	970	r1,379	1,447
Value ---------------- thousands--	$193,324	$296,550	$594,050	r$633,918	$543,908
Ore (dry and siliceous) produced:					
Gold ore -------- thousand short tons--	4,292	7,046	9,893	r12,729	17,918
Gold-silver ore --------------do----	738	756	872	r1,041	1,213
Silver ore -----------------do----	992	962	1,925	r4,409	5,318
Percentage derived from:					
Dry and siliceous ores --------------	58	58	66	71	80
Base-metal ores -----------------	40	41	32	27	17
Placers ----------------------	2	1	2	2	3
Refinery production:					
Domestic ores ---- thousand troy ounces--	962	795	773	801	718
Secondary (old scrap) ----------do----	1,384	1,675	2,184	r1,610	1,421
Exports: Commercial -------------do----	5,509	16,499	6,119	6,437	2,970
Imports for consumption -----------do----	4,690	4,630	4,542	4,652	4,920
Gold contained in imported coins ------do----	3,736	2,790	3,081	2,612	2,908
U.S. Treasury gold medallion sales[1] ----do----	--	--	338	189	63
Net sales from foreign stocks in Federal Reserve Bank ---------------------do----	1,569	40	1,785	1,181	1,330
Stocks, Dec. 31:					
Monetary -------million troy ounces--	276.4	264.6	264.3	264.1	264.0
Industrial[2] ----- thousand troy ounces--	1,672	868	872	r635	776
Consumption in industry and the arts ---do----	4,738	4,785	3,215	r3,276	3,448
Price:[3] Average per troy ounce -----------	$193.55	$307.50	$612.56	$459.64	$375.91
World:					
Production, mine ---- thousand troy ounces--	r39,057	r38,807	39,197	p41,226	e42,713
Official reserves[4] ------million troy ounces--	r1,164.9	r1,145.1	r1,149.0	r1,148.3	1,143.2

eEstimated. pPreliminary. rRevised.
[1]Sales program began July 15, 1980.
[2]Unfabricated refined gold held by refiners, fabricators, and dealers.
[3]Engelhard Industries quotations.
[4]Held by market economy country central banks and Governments and international monetary organizations. Source: International Monetary Fund.

Table 2.—Volume of U.S. gold futures trading

(Million troy ounces)

Exchange	Location	1978	1979	1980	1981	1982
Commodity Exchange, Inc	New York	373.40	654.15	788.72	1,041.67	1,212.40
New York Mercantile Exchange	do	.85	.21	(1)	--	--
International Monetary Market	Chicago	281.30	355.87	254.35	251.82	153.35
Chicago Board of Trade	do	5.49	10.30	7.15	1.47	1.96
Mid-America Commodity Exchange	do	1.50	6.65	14.86	15.59	12.73
Total		662.54	1,027.18	1,065.08	1,310.55	1,380.44

[1]Less than 5,000 troy ounces. Trading in gold futures terminated in January 1980.

Domestic Data Coverage.—Domestic mine production data for gold are developed by the Bureau of Mines from four separate, voluntary surveys of U.S. operations. Typical of these surveys is the lode-mine production survey of gold, silver, copper, lead, and zinc mines. Of the 149 lode gold producers in operation in 1982 to which a survey request was sent, 52% responded, representing 91% of the total production shown in tables 3, 4, 6, and 8. Production for the 72 nonrespondents was estimated using reported prior year production levels, adjusted by trends in employment and other guidelines such as company annual reports, published news items, and State agency reports.

Legislation and Government Programs.—In June 1981, pursuant to legislation introduced in late 1980, the Congress established a Gold Commission to study U.S. policy with respect to the role of gold in the domestic and international monetary systems and to consider a return to a gold standard. Hearings were conducted in late 1981, and the Commission, which released its final report on March 31, 1982, concluded that no changes in the present role of gold were warranted. The Commission suggested, however, that the Government mint gold bullion coins in specific weights that would be exempt from capital gains taxes and sales taxes, but would not have a dollar denomination or legal tender status.[2]

The Commodity Futures Trading Commission voted on August 31, 1982, to extend approval to designated commodity exchanges to begin trading gold options, effective October 1, 1982. The program, which was later extended on a 3-year trial basis, allows trading in as many as six nonagricultural options such as gold and Treasury bills.

DOMESTIC PRODUCTION

For the third consecutive year Nevada was the leading gold-producing State as new gold mines developed in recent years produced at or near their full design capacity. In spite of continuing moderation of the gold price from its historic high in 1980, the search for new gold deposits, especially in the Western States, continued unabated at the rapid pace established in recent years. A few companies, formerly disinclined to include gold on their list of exploration objectives, redirected some of their efforts toward exploration for gold, especially in those geographical areas where previous investigations had been directed toward developing other minerals.

Approximately one-half of domestic gold mine output was accounted for by the first five leading mines listed in the table of leading producers (table 5). The 25 largest mines accounted for 93% of domestic production in 1982.

Gold production in 1982 was reported by 187 mines, of which 38 were placer mines, 130 were lode mines producing from precious metal ores or tailings, and 19 were lode byproduct producers. About 80% of the gold came from precious metal ores; most of the remainder came from base metal ores. The methods by which gold was extracted from its ores reflected the nature of the ores; thus, most of the gold was recovered by cyanidation of precious metal ores and by smelting of base metal ores, while minor quantities were recovered by amalgamation and by gravity methods (tables 7-9). The average recovery grade of gold ores mined in lode mines was 0.06 ounce[3] per ton,[4] while placer mines averaged 0.007 ounce per cubic yard of gravel washed. The volume of material washed for gold by placer operators was nearly 70% greater than in 1981.

Table 3.—Mine production of gold in the United States, by State

(Troy ounces)

State	1978	1979	1980	1981	1982
Alaska	18,652	6,675	12,881	r26,531	30,513
Arizona	92,989	101,840	79,631	100,339	61,050
California	7,480	5,010	4,078	6,271	10,547
Colorado	32,094	13,850	39,447	51,069	64,584
Idaho	20,492	24,140	W	W	W
Montana	19,967	24,050	48,366	54,267	75,171
Nevada	260,895	250,097	278,495	524,802	738,321
New Mexico	9,879	14,966	15,847	65,749	W
Oregon	340	W	W	2,830	W
South Carolina	--	--	--	W	--
South Dakota	285,512	245,912	267,642	278,162	185,038
Tennessee	W	--	--	W	--
Texas	W	--	--	--	--
Utah	235,929	260,916	179,538	227,706	174,940
Washington	W	W	W	W	W
Total	998,832	964,390	969,782	r1,379,161	1,446,905

rRevised. W Withheld to avoid disclosing company proprietary data; included in "Total."

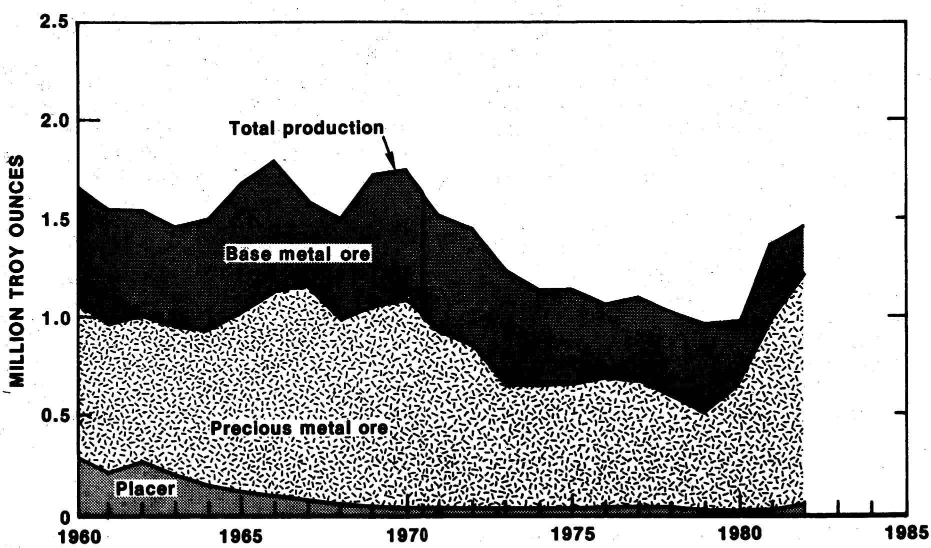

Figure 1.—Gold mined in the United States.

Alaska.—Although the number of mining claims staked in Alaska during 1982 declined from the record number of 1981, gold production activity and efforts to discover and develop new gold deposits continued at a brisk pace, albeit at a level somewhat below that of 1981. Blocks of mining claims staked in 1982 also tended to contain fewer acres than parcels assembled in 1981. Expenditures on all mineral exploration, estimated at close to $100 million in 1981, was probably lower in 1982, reflecting generally poorer prices for most minerals, including gold. The Fairbanks area and the eastern interior portion of the State accounted for about one-half of the major gold-mining activity and production. An informal field survey of Alaskan gold producers by the Alaska State Division of Geological and Geophysical Surveys indicated that nearly

175,000 ounces of gold was recovered from Alaskan gold deposits, mostly placer deposits, during 1982. This compared with 134,000 ounces in 1981, indicated by a similar survey. Active gold-mining operations in the State, including recreational placer mines, probably exceeded 500 during 1982. The much lower total reported on a voluntary basis by producers and tabulated in tables 3 and 6 reflects a seasonal reporting problem aggravated by the remote location of most of the mining operations.

Ranchers Exploration and Development Corp., of Albuquerque, N. Mex., again conducted sluicing operations at its mechanized placer mine located about 150 miles southeast of Fairbanks. Gold production for the short operating season (May-September) was about 6,100 ounces; production during the 1981 season was 5,091 ounces. The operation washes 250,000 to 300,000 cubic yards of gravel each year, depending upon the availability of water. Operations are generally confined to an area containing about 1.3 million cubic yards of gravel reserves having gold values of about $6 per yard at a gold price of $400 per ounce. Several companies, including Alaska Gold Co. and Northland Gold Co., operated large bucketline dredges near Nome and Nyak and along the Hog River drainage. At Canadian Barranca's mechanized placer, in the Chandalar district 200 miles north of Fairbanks, the company completed a 3,000-foot test drilling program; results indicated 1 million cubic yards of minable gravel containing 0.02 ounce of gold per cubic yard. By using open pit mining methods the company expects to triple gold production to about 3,000 ounces per year by 1983. Production will be from six separate open pits. Livengood Placers Inc. plans to begin full production in 1983, following successful 1982 sluicing tests that yielded 3,500 ounces of gold.

Alaska Apollo Gold Mines Ltd., formerly Catalina Energy & Resources Ltd., began a full-scale surface and underground drilling program at its Apollo and Sitka Mines located on Unga Island, in the Aleutian Islands, about 550 miles west of Anchorage. Just north of Fairbanks, on Ester Dome, Silverado Mines Ltd. continued surface and underground exploration and development at the Grant Mine; the company reported that exploration drilling on its other Ester Dome claims had yielded promising results. At the Ryan Lode on Ester Dome, St. Joe American Corp. completed trenching and sampling and a considerable footage of diamond drilling. These efforts, begun in 1979, confirmed the presence of a large reserve of gold-bearing ore. At the Greens Creek silver-gold-lead-zinc-copper project on Admiralty Island, Noranda Mining Inc. continued exploration, environmental assessment, and metallurgical testing. A decision on the final environmental impact statement for this potential underground mine is expected in early 1983. Exploration conducted by the Bureau of Mines in the Chugach National Forest east of Anchorage located areas of above-average potential for gold prospecting. Recoverable gold was detected in 26 of 107 placer samples collected in the 2.8-million-acre study area. Gold values ranged from 0.0001 to 0.028 ounce per cubic yard. Results of the 1981 sampling program were made available in 1982 as an open file report.[5]

Arizona.—The decline in gold production from Arizona in 1982 reflects the decline in copper production, a principal source of byproduct gold. The economic recession, which affected virtually every copper operation in the State, resulted in several mine closures and cutbacks in metal production. North of Phoenix, near Sun City, Ranchers Gold & Silver Exploration Program, a New Mexico limited partnership in which Ranchers Exploration and Development holds a 60% interest, continued geologic mapping, drilling, and surface sampling of the Mystic Claims. The results of the drilling and sampling were reportedly promising, and the company was actively seeking a joint venture partner to assist with further exploration. The Small Mines Div. of the Phelps Dodge Corp. did extensive sampling for precious metals in Arizona and other Western States, and two properties were acquired. An underground diamond drilling program for gold was conducted by Phelps Dodge at the old United Verde Extension or Little Daisy Mine in Jerome. The company reported that 2,800 ounces of gold and 131,000 ounces of silver were extracted from the Ash Peak property and from the old underground copper workings at Bisbee, which had been closed since 1975. Precious metals were also being pursued at or around Oatman and in the Black Mountains area southwest of Kingman; numerous claims have been staked there by domestic and international companies.

California.—Homestake Mining Co. proceeded with the development of its McLaughlin project located north of Knoxville at the juncture of Napa, Lake, and Yolo

Counties in northern California. From the results of test work and feasibility analyses, the company decided to construct a 3,000-ton-per-day open pit mine and processing plant. The crushing and grinding facility was to be constructed adjacent to the mine in Napa County. Pulverized ore was to be pumped from the mill to the main processing facility 5 miles away in Lake County. The water supply was expected to be provided from a storage reservoir in Yolo County. The plant was scheduled to produce about 200,000 ounces of gold per year at recoveries in excess of 90%. Construction at McLaughlin was expected to begin in the third quarter of 1983, with startup expected by the end of 1984. During 1982 the company's exploration group screened more than 1,400 properties and conducted more than 700 field examinations on precious metals prospects worldwide.

Placer Services Corp. (PSC), a subsidiary of the St. Joe Minerals Div. of the Fluor Corp., directed its principal efforts in 1982 at two California-based projects. Yuba Placer Gold Co., a joint venture in which PSC holds a two-thirds managing interest, completed mine development at its placer property near the Yuba River, east of Marysville, Calif. When operating at full capacity, the company's large floating dredge was expected to recover 20,000 to 25,000 ounces of gold annually. At the 2,200-acre San Juan Ridge placer property near North Columbia, PSC completed evaluation studies, prepared mining and reclamation plans, and undertook environmental studies. The property, once the site of hydraulic mining, was expected to yield up to 300,000 ounces of gold over an estimated life span of 8 years.

In Calaveras County, Mother Lode Gold Mines continued the development of the Royal Mountain King gold property. The property was scheduled to begin mining and milling in mid-1985 at a rate of about 2,000 tons per day. In October, near Happy Camp, Siskiyou County, Noranda Mining, a subsidiary of Noranda Mines Ltd., began surface mining at its Grey Eagle gold and silver mine. The design capacity of 500 tons per day was achieved in December.

A study of mineral locations in the Orleans Mountain area of northern California was conducted by the Bureau of Mines under the Roadless Area Resource Evaluation (RARE II) program of the U.S. Forest Service.[6] Seven properties were found to have mineral resource potential, including three large gold placers, one of which was described as having very high commercial potential.

Colorado.—In May, Houston Natural Gas Corp. and Cobb Resources Corp. of Albuquerque began shipping gold and silver concentrates from their London Mines in central Colorado. These old mines, which have been under restoration for several years, are located in Park County 10 miles west of Fairplay. Near Victor, in the old Cripple Creek district, Silver State Mining Corp. began production at the Ironclad property at a rate of about 1,000 tons per day. Cripple Creek and Victor Gold Mining Co., a joint venture of Texasgulf Inc. and Golden Cycle Corp., which had begun limited production at its Ajax and Cresson Mines in 1981, reduced operations in mid-1982 because of weak gold prices. Texasgulf was purchased in mid-1981 by Société National Elf Acquitane, a company in which the French Government owns a controlling interest. The lower gold prices also affected many other developing mines in Colorado; many that were scheduled to open during the year postponed further development or continued development or exploration on a limited basis only. In San Juan County, the State's largest gold producer, the Sunnyside Mine of Standard Metals Corp., following employment cutbacks in March, resumed full-scale operations in mid-September. Adoption of vertical crater retreat stoping in parts of the mine was successful in reducing costs. In midyear, the Franklin Mine of Franklin Consolidated Mining Co. Inc., near Idaho Springs, began limited production of gold and silver ore.

Idaho.—Near Stibnite, in Valley County, Idaho, Superior Mining Co., formerly Canadian Superior Mining (U.S.) Ltd., completed construction of five heap-leach pads and processed over 200,000 tons of ore at the West End gold mine. East of Stibnite, Thunder Mountain Gold Inc. completed an agreement with Phillips Petroleum Co. to explore gold claims and properties held by Thunder Mountain in and around the Payette National Forest; Superior Mining, which had optioned these properties in 1978, terminated its agreement with Thunder Mountain at the end of 1981. Further drilling was conducted by Ranchers Exploration and Development at the Yellow Pine gold and antimony property at Stibnite. Gold-bearing sulfides and oxides were tested, with the goal of determining the extent of the sulfides at depth and expanding the oxide reserves sufficiently to justify a gold recovery operation.

In the Yankee Fork Mining district of Custer County, Idaho, U.S. Antimony Corp. of Thompson Falls, Mont., leased a gold prospect near its newly completed gold and silver leaching plant at Yankee Fork. Exploration drilling and trenching have indicated two zones containing gold and silver mineralization. Center Star Gold Mines Inc. of Elk City relocated the main portal and working adit at the old Center Star Mine, and began stoping operations on the principal ore vein, which grades about 0.6 ounce of gold per ton. Renovation of the existing 50-ton-per-day mill was begun near yearend. In Shoshone County, Pacific Coast Mines, Inc., a subsidiary of U.S. Borax and Chemical Corp., began an exploration and drilling program on claims leased from Champion Gold and Silver Inc. of Coeur d'Alene. Placer gold was pursued by a number of firms throughout the State.

Montana.—In spite of the general decline in mineral exploration activity, the number of exploration licenses granted by Montana to explore for gold and other minerals increased from 140 in 1981 to 161 in 1982; during the same period corporate exploration licenses increased from 55 to 64. In the Little Rocky Mountains in Phillips County, Pegasus Gold Ltd. continued to improve the efficiency of the heap-leaching operations at Zortman and Landusky. The Zortman and Landusky Mining Co., operator of the combined project, recovered 67,000 ounces of gold and 146,000 ounces of silver from ore mined at the nearby Argo and Pegasus Mines. The company expected to increase gold production in 1983 to about 70,000 ounces.

In Jefferson County, Mont., northeast of Whitehall, Placer Amex Inc., the U.S. subsidiary of Placer Development Ltd. of Canada, completed the development of the new open pit Golden Sunlight Mine. Development of the mine was both under budget and well ahead of the mid-1983 startup date established earlier. In its initial years the company expected to process about 5,000 tons of ore per day for an annual yield of about 72,000 ounces. The mine has about 12 years of open pit ore reserves, and mining may proceed underground when the surface reserves are exhausted.

Placer mining, generally at small-scale operations, continued at a high level in western Montana. Many small lode mines produced gold throughout the year, again from operations located primarily in the western half of the State. Companies involved in gold exploration, development, and production in Montana ranged from local firms to multinational corporations.

Nevada.—Nevada was again the focal point of domestic gold development. Twelve mines in Nevada, including the largest domestic producer for 1982, were among the top 25 gold producers in the Nation during the year. Despite severe winter conditions, Freeport Gold Co.'s new Enfield Bell (Jerritt Canyon) mining and milling complex located 50 miles north of Elko produced nearly 200,000 ounces of gold, thus making it the largest gold producer in the Nation during 1982. Average gold recovery at the new facility, which is a joint venture between Freeport Gold (70%), a subsidiary of Freeport-McMoRan Oil & Gas Co., and FMC Gold Co. (30%), approached the design level of 87.5% of the contained gold. Freeport Gold sold nearly all of its 137,000-ounce share of the operation. Step-out drilling from the principal ore body at the new facility added reserves of 1,500,000 tons of gold ore with an average grade of about 0.15 ounce per ton. In spite of downward adjustments made in 1982 to the remaining reserves, proven and probable reserves carried at the beginning of 1983 stood at 11,614,000 tons containing 0.233 ounce per ton. This was expected to sustain operations at the property for 11 years or more.

In November Cortez Gold Mines announced plans to commence production, in mid-1983, at their Horse Canyon gold property located 4 miles from the company's mill at Cortez, in Lander County, 60 miles south of Elko. When fully operational, the 2,000-ton-per-day open pit operation was expected to yield about 40,000 ounces of gold per year. The company milled dump material from its nearby Gold Acres property in 1982. Work at Gold Acres was scheduled to be completed coincident with the opening of Horse Canyon.

Duval Corp., the mining subsidiary of Pennzoil Corp., continued premining stripping of the overburden at the new Fortitude gold and silver discovery. Stripping operations at the Lander County property, which is near the company's existing Battle Mountain Mine, were to continue through 1984, with mining expected to begin in 1985. Use of the Battle Mountain processing facilities was expected to help to minimize the capital expenditures required to bring the new mine onstream. With the Fortitude property producing, total gold production from Duval's Nevada properties was expected to be about 150,000 ounces per year, compared with about 71,000 ounces in 1982. Similarly, silver production was expected to increase from about 315,000 ounces in 1982 to about 1.5 million ounces.

At the Round Mountain Mine in Nye County, about 45 miles north of Tonopah, Louisiana Land & Exploration Co., through its Smokey Valley Mining Div., continued mining and expansion efforts aimed at developing fully both the old gold-silver deposit and the new adjacent gold-silver deposit. Preliminary stripping of the large new ore body, which began in late 1981, was completed during the first quarter of 1982. Plans to mine the new deposit were incomplete. The deposit reportedly contains an estimated 8.4 and 15.7 million ounces of gold and silver, respectively; it occurs as a large low-grade halo around a previously mined high-grade, vein-type deposit.

In Humboldt County the new Pinson Mine, 24 miles northeast of Golconda, marked its first full calendar year of production, exceeding its design capacity of 56,000 ounces of gold per year. Gold output in 1982 was about 66,000 ounces. The Pinson Mining Co., which operated the mine, was a joint venture between the Canadian-owned Lacana Mining Corp., Rayrock Resources Ltd., United Siscoe Mines, and several individuals. During the year the company increased the daily milling rate by nearly 40% to about 1, 500 tons per day, primarily through improvements in the crushing and grinding circuits. Carbon-in-pulp recovery methods were employed at the automated mill to produce a dore containing 975 parts of gold and 6 to 20 parts of silver per thousand. Construction of an asphalt pad was completed in April and tests were begun to evaluate the suitability of several heap-leaching techniques to various grades and types of ore present in the deposit. Reserves at the Pinson Mine were about 3.3 million tons grading 0.09 ounce per ton. The company also had a controlling interest in the Preble gold deposit, 12 miles to the south of the Pinson property, where 1.5 million tons of ore averaging 0.08 ounce per ton was indicated. Mining was not expected to begin at the Preble deposit before 1984. In early 1982, Rayrock announced that the Cordex IV Syndicate, an exploration venture between Rayrock, Lacana, and Dome Mines, Ltd., had discovered a new gold deposit near Elko. Engineering and metallurgical tests on the deposit, known as the Boulder Creek property, indicated about 2.5 million tons of ore grading 0.10 ounce per ton and minable by open pit methods. The syndicate expected to make a production decision in the near future.

The Alligator Ridge Mine, in White Pine County, completed its first full calendar year at its heap-leaching and gold recovery operations. With ore reserves estimated at about 5 million tons at the beginning of the year, exhaustion of the existing ore body was predicted to occur about 1988. The owner, Amselco Minerals, Inc., continued to direct considerable exploration effort and expense toward the discovery of additional gold reserves.

Amoco Minerals Co., a wholly owned subsidiary of Standard Oil Co. of Indiana, recovered 20,000 ounces of gold during the year from its Northumberland Mine near Northumberland Pass in Nye County. The new mine, which began operating in mid-1981, was developed in an ore body containing disseminated gold and silver, with an estimated ore reserve of 8 million tons. Ore mined from two open pits was treated using heap-leaching methods. The company expected to recover 35,000 ounces of gold in 1983.

West of Elko, at Newmont Mining Corp.'s Carlin Mine, feed for the Carlin mill was provided by the Maggie Creek, Blue Star, and main Carlin pits. Gold production from milled ore and heap-leached ore amounted to 145,100 ounces, up 8,500 ounces over the 1981 output. Though the quantity of ore milled in 1982 declined by 43,500 tons to 743,500 tons, the average grade of the ore milled increased from 0.185 ounce per ton in 1981 to 0.190 ounce per ton in 1982. Dump leaching at the inactive Bootstrap Mine continued for the fourth year. Metallurgical testing and prefeasibility engineering studies continued on the Gold Quarry ore body, a major gold deposit recently discovered near the Carlin Mine. In August, Newmont acquired additional mineral rights and properties surrounding the Carlin operations and negotiated a long-term lease on the Gold Quarry ore body.

Throughout Nevada, numerous mining firms were exploring, developing, and operating precious metals properties. Gold mine closures were few and generally limited to properties where ore reserves were exhausted or mining costs greatly exceeded the year's relatively lower gold prices.

New Mexico.—Gold Fields Mining Corp., in its first full year of production, ending

June 30th, announced the recovery of more than 50,000 ounces of gold from its Ortiz gold deposit in Santa Fe County. The new mine is located in the Ortiz Mountains at Cerrillos, the center of an old Spanish mining grant. Using heap-leaching recovery techniques, the company recovered 85% to 90% of the gold contained in the ore treated. An average of 820,000 tons of ore per year is mined from the open pit. Precious metals exploration and development in New Mexico during 1982 were generally concentrated around the many old gold-mining camps located throughout the State; several small mines began production.

Oregon.—Several placer mines and a few small lode mines produced gold in Oregon in 1982. Exploration activity around the State continued, but at a lower level than in 1981, with 30 out of 34 exploration companies reported by the State to be actively searching for gold in addition to other metals. The largest exploration project was that of Brooks Minerals Inc. at the North Pole Columbia Lode on Cracker Creek in Baker County. About 5,000 feet of old workings was rehabilitated and 3,000 feet of new work completed. Veta Grande Co. Inc.'s Mormon Basin Placer operated intermittently, as did several smaller placer operations. Numerous individuals using one-man floating suction dredges were active along gold-bearing drainages in southwestern Oregon. Also in southwestern Oregon a small quantity of gold ore was produced at the Greenback and Snowbird Mines. In eastern Oregon in the Baker mining district, the Pyx and the Thomason lode mines continued producing as did several small placers. The Iron Dyke Mine, which yielded gold-bearing sulfides in 1981, was idle during 1982.

South Dakota.—At Lead, in the Black Hills of South Dakota, a labor strike at the Homestake Mine, the Nation's largest underground gold mine, caused a decline in gold production from 277,962 ounces in 1981 to 185,039 ounces in 1982. The strike, the second and longest in the 106-year history of the mine, lasted from June 1 through September 26. The average cost per ounce of gold produced during the 8 months of operation was reduced to about $300 per ounce compared with $342 for the full year of 1981. Ore reserves at yearend were 17,518,000 tons grading 0.220 ounce per ton. Homestake intensified its exploration at the old open pit workings, located on the company's original mine claims site. All the permits required to conduct surface mining operations there were obtained, and development of the site may proceed if warranted by ongoing engineering studies. The company was also actively exploring for gold elsewhere in the Black Hills, as were several other companies including Anaconda Minerals Co. At Annie Creek, 3-1/2 miles southwest of Lead, Wharf Resources Ltd. of Calgary, Alberta, continued development of the Annie Creek gold claims. The company planned to begin heap-leaching operations at the site in 1983.

Utah.—In April, near the old ghost town of Mercur, Utah, about 25 miles south of Tooele, Getty Mining Co., formerly Getty Mineral Resources, a subsidiary of Getty Oil Co., began stripping overburden at its new open pit Mercur gold project. The $82 million mining and milling project, a joint venture between Getty and Gold Standard Inc. of Salt Lake City, was expected to begin gold production in mid-1983 at an annual rate of about 80,000 ounces of gold. At the Bingham Canyon Mine, the Utah Copper Div. of Kennecott Minerals Co., a subsidiary of Standard Oil Co. of Ohio, maintained full copper and byproduct gold production during the year despite cuts in the work force. The mine, the largest surface mine in the Nation, is located near Salt Lake City and is the company's lowest cost producer. In various recent years the mine has been the largest gold producer in the Nation. In Utah County, in the East Tintic mining district, Kennecott conducted an underground exploration drilling program to develop precious metals reserves at the Trixie Mine. The company closed the base metal mine in November.

Washington.—Originally discovered in about 1894, Washington State's old Lovitt or Gold King Mine was once again in the forefront of gold developments in the State. Exploration at the mine, located 3 miles south of Wenatchee, Chelan County, disclosed a minable ore deposit of about 1.5 million tons grading 0.12 ounce per ton contained in two mineralized zones. Preliminary test results were released in early 1983 of what appeared to be a third major new ore zone; of seven holes drilled, one contained 140 feet of ore with an average grade of 1.36 ounces per ton including a 50-foot section containing visible gold and assaying 2.98 ounces per ton. The two Canadian companies involved, Asamera Inc., of Calgary, Alberta, and Breakwater Resources Ltd. of Vancouver, British Columbia, reported encouraging prefeasibility studies and announced plans to construct a 1,000- to 2,000-ton-per-day mill at the mine, pending further favorable exploration results. At Hecla Mining Co.'s Knob Hill Mine at Republic in Ferry County, an underground exploration program was initiated to develop the gold and silver potential of the company's surrounding properties. According to the company's annual report, ore production at the mine, which has been in almost continuous operation since the early 1900's, amounted to nearly 57,000 tons in 1982, compared with 56,000 tons in 1981. Around Washington State, exploration activity for gold and silver continued at a high level. Of the total of 55 active companies, 50 firms reported they were seeking gold and silver. As in years past, the counties receiving the most attention were Stevens, Ferry, Okanogan, and Pend Oreille, with interest in Chelan County heightening toward year-end in response to developments around Wenatchee.

Wyoming.—Interest in Wyoming's gold potential, sparked by a 1981 announcement of gold discoveries by the Wyoming Geological Survey, led Timberline Minerals Inc. of Dubois to acquire 1,800 acres of land in the Seminoe Mountains of Carbon County. Preliminary investigation by the company indicated a gold resource assaying about 0.277 ounce per ton. Several companies were actively pursuing gold in and around the historic gold-mining district of Atlantic City-South Pass, at the southeast end of the Wind River Range south of Lander.

Other States.—Small quantities of disseminated gold were reported to have been detected in the Lower Cretaceous Comanchean Series of sediments in Erath and Comanche Counties of north-central Texas. Considerable interest was directed toward the gold potential of northern Minnesota, while in Marquette County, Mich., Callahan Mining Corp. completed preliminary feasibility studies, including an analysis of minable reserves, at the Ropes gold mine. Maine adopted a simplified permitting procedure for recreational and semicommercial placer operations.

Gold deposits were being evaluated or explored for in the Piedmont areas of Virginia, North Carolina, South Carolina, Georgia, and Alabama. Callahan conducted studies on gold opportunities in Virginia and on precious and other metals in North Carolina, Georgia, and Alabama. In Orange County, Va., near the old Melville and Vaucluse gold mines, Callahan, following leads established by earlier geological and geophysical work, completed the first phase of a diamond drilling program. To the south of Callahan's 714-acre tract, Walnut Creek Mining Co. began producing a limited tonnage of gold ore primarily for use in its nearby commercial panning center for tourists. Near Charlotte, N.C., a Canadian company was reported to have acquired an interest in an option to explore the old Howie Gold Mine, a former producer. Recreational panners and operators of small suction dredges were active throughout the Southeast.

Refinery production of gold recovered from foreign and domestic ores and old scrap declined about 11% from production reported in 1981. Gold recovered from new scrap showed an 8% increase during the same period.

Table 4.—Mine production of gold in the United States, by month

(Troy ounces)

Month	1978	1979	1980	1981	1982
January	82,304	71,827	77,922	98,887	106,956
February	89,695	68,850	78,301	93,385	109,407
March	87,198	75,567	87,040	115,200	138,066
April	89,196	75,222	89,477	110,366	136,010
May	81,305	76,153	93,054	108,291	141,384
June	84,701	76,500	83,279	r119,676	114,433
July	69,119	79,557	59,595	r126,675	112,421
August	83,502	92,974	57,130	r125,505	111,666
September	85,600	88,654	73,888	r124,629	107,032
October	94,090	92,331	84,161	123,201	124,545
November	80,506	85,370	83,366	119,386	126,266
December	71,616	81,385	102,569	113,960	118,719
Total	998,832	964,390	969,782	r1,379,161	1,446,905

rRevised.

Table 5.—Twenty-five leading gold-producing mines in the United States in 1982, in order of output

Rank	Mine	County and State	Operator	Source of gold
1	Enfield Bell (Jerritt Canyon)	Elko, Nev	Freeport Gold Co	Gold ore.
2	Homestake	Lawrence, S. Dak	Homestake Mining Co	Do.
3	Utah Copper (Bingham Canyon)	Salt Lake, Utah	Kennecott Copper Corp	Copper ore.
4	Carlin & Maggie Creek Pit	Eureka, Nev	Carlin Gold Mining Co	Gold ore.
5	Round Mountain	Nye, Nev	Copper Range Co	Do.
6	Battle Mountain	Lander, Nev	Duval Corp	Do.
7	Argo & Pegasus	Phillips, Mont	Zortman & Landusky Mining Co	Do.
8	Pinson	Humboldt, Nev	Pinson Mining Co	Do.
9	Alligator Ridge	White Pine, Nev	Amselco Minerals, Inc	Do.
10	Ortiz	Santa Fe, N. Mex	Gold Fields Operating Co	Do.
11	Sunnyside	San Juan, Colo	Standard Metals Corp	Do.
12	Borealis Project	Mineral, Nev	Houston International Minerals Corp	Do.
13	Delamar	Owyhee, Idaho	Earth Resources Co	Gold-silver ore.
14	Cortez	Lander, Nev	Cortez Gold Mines	Gold ore.
15	Northumberland	Nye, Nev	Cyprus-Northumberland Project	Do.
16	San Manuel	Pinal, Ariz	Magma Copper Co	Copper ore.
17	Knob Hill	Ferry, Wash	Hecla-Day Mines Corp	Gold ore.
18	Sterling	Nye, Nev	Saga Exploration Co	Do.
19	Morenci	Greenlee, Ariz	Phelps Dodge Corp	Copper ore.
20	Magma	Pinal, Ariz	Magma Copper Co	Do.
21	Leadville Unit	Lake, Colo	ASARCO Incorporated	Lead-zinc ore.
22	Atlanta	Lincoln, Nev	Standard Slag Co	Gold ore.
23	Bullion Monarch	Eureka, Nev	Universal Gas Co	Do.
24	Nome Unit	Seward Peninsula, Alaska	Alaska Gold Co	Placer.
25	West End	Valley, Idaho	The Superior Oil Co	Gold ore.

Table 6.—Gold produced in the United States, by State, type of mine, and class of ore

State	Placer (troy ounces of gold)	Lode: Gold ore, Short tons	Lode: Gold ore, Troy ounces of gold	Lode: Gold-silver ore, Short tons	Lode: Gold-silver ore, Troy ounces of gold	Lode: Silver ore, Short tons	Lode: Silver ore, Troy ounces of gold	Lode: Copper ore, Short tons	Lode: Copper ore, Troy ounces of gold
1980	16,968	9,892,599	599,506	872,019	33,428	1,924,939	5,472	197,292,230	272,665
1981	r28,927	r12,728,940	r921,930	r1,040,856	r40,514	r4,408,806	r15,254	r264,347,788	352,768
1982:									
Alaska	30,181	2,360	332	--	--	--	--	--	--
Arizona	--	W	W	W	W	W	W	W	W
California	7,798	38,244	2,733	59	16	--	--	--	--
Colorado	244	W	W	W	W	W	W	--	--
Idaho	W	W	W	W	W	W	W	--	--
Montana	--	3,882,855	67,924	12,292	538	W	W	W	W
Nevada	157	11,077,643	721,851	W	W	W	W	--	--
New Mexico	--	W	W	W	W	W	W	W	W
Oregon	W	--	--	--	--	--	--	--	--
South Dakota	--	1,167,886	185,038	--	--	--	--	--	--
Utah	--	--	--	W	W	W	W	W	W
Washington	W	W	W	--	--	--	--	--	--
Total[1]	38,463	17,918,046	1,105,447	1,213,247	37,697	5,318,490	13,539	162,286,553	233,093
Percent of total gold	3	XX	76	XX	3	XX	1	XX	16

State	Lode: Lead and zinc ores, Short tons	Lode: Lead and zinc ores, Troy ounces of gold	Lode: Copper-lead, lead-zinc, copper-zinc, and copper-lead-zinc ores, Short tons	Lode: Copper-lead, lead-zinc, copper-zinc, and copper-lead-zinc ores, Troy ounces of gold	Lode: Old tailings, etc., Short tons	Lode: Old tailings, etc., Troy ounces of gold	Total[1]: Short tons	Total[1]: Troy ounces of gold
1980	3,410,956	1,887	1,145,259	37,092	67,623	2,764	214,605,625	969,782
1981	638	30	3,152,611	11,582	361,588	8,156	r286,041,227	r1,379,161
1982:								
Alaska	--	--	--	--	--	--	2,360	30,513
Arizona	--	--	--	--	82,567	1,061	101,035,606	61,050
California	--	--	--	--	--	--	38,303	10,547
Colorado	--	--	W	W	--	--	884,882	64,584
Idaho	--	--	--	--	--	--	W	W

See footnotes at end of table.

Table 6.—Gold produced in the United States, by State, type of mine, and class of ore —Continued

State	Lode						Total[1]	
	Lead and zinc ores		Copper-lead, lead-zinc, copper-zinc, and copper-lead-zinc ores		Old tailings, etc.			
	Short tons	Troy ounces of gold	Short tons	Troy ounces of gold	Short tons	Troy ounces of gold	Short tons	Troy ounces of gold
1982 —Continued								
Montana	--	--	--	--	W	W	21,296,416	75,171
Nevada	--	--	--	--	130,516	[2]1,863	12,718,616	738,321
New Mexico	--	--	--	--	--	--	W	W
Oregon	--	--	--	--	--	--	W	W
South Dakota	--	--	--	--	--	--	1,167,886	185,038
Utah	--	--	--	--	W	W	37,190,361	174,940
Washington	--	--	--	--	--	--	W	W
Total[1]	--	--	([3])	([3])	[4]646,084	[5]18,666	187,382,420	1,446,905
Percent of total gold	XX	--	XX	([3])	XX	[5]1	XX	100

[r]Revised. W Withheld to avoid disclosing company proprietary data; included in "Total." XX Not applicable.
[1]Data may not add to totals because of items withheld to avoid disclosing company proprietary data.
[2]Includes byproduct gold recovered from molybdenum ore.
[3]Included in "Old tailings, etc." to avoid disclosing company proprietary data.
[4]Includes lead-zinc ore.
[5]Includes gold recovered from lead-zinc and molybdenum ores.

Table 7.—Gold produced in the United States from ore, old tailings, etc., by State

State	Total ore, old tailings, etc., treated[1] (thousand short tons)	Ore and old tailings to mills: Thousand short tons[1]	Recoverable in bullion: Amalgamation (troy ounces)	Recoverable in bullion: Cyanidation (troy ounces)	Concentrates smelted and recoverable metal: Concentrates (short tons)	Concentrates smelted and recoverable metal: Troy ounces	Crude ore, old tailings, etc., to smelters[1]: Thousand short tons	Crude ore, old tailings, etc., to smelters[1]: Troy ounces
1980	263,309	262,564	9,015	603,255	5,569,699	324,132	745	16,412
1981	[r]326,391	[r]326,316	14,945	912,742	6,233,314	404,750	675	[2]17,859
1982:								
Alaska	2	2	--	--	20	176	(3)	156
Arizona	136,204	135,894	--	1,116	2,495,992	56,629	309	3,305
California	[4 5]39	[4 5]38	60	1,017	1,047	1,238	2	434
Colorado	[4]974	[4]974	25,356	8,537	59,454	30,443	(3)	4
Idaho	W	W	--	W	W	W	W	W
Montana	[4]21,305	[4]21,292	--	67,582	247,285	7,275	14	314
Nevada	[4 5 6]12,722	[4 5 6]12,719	--	736,713	17,955	1,426	3	25
New Mexico	W	W	--	W	W	W	W	W
South Dakota	1,168	1,168	--	185,038	--	--	--	--
Utah	37,219	37,108	--	308	739,432	169,724	111	4,908
Washington	W	W	--	W	W	W	--	--
Total[7]	222,838	222,322	25,416	1,082,943	3,944,073	290,023	516	[2]10,143

[r]Revised. W Withheld to avoid disclosing company proprietary data; included in "Total."
[1]Includes some nongold-bearing ores not separable.
[2]Includes a small amount of placer production to avoid disclosing company proprietary data.
[3]Less than 1/2 unit.
[4]Includes tonnages from which gold was recovered by heap leaching.
[5]Includes tonnages from which gold was recovered by vat leaching.
[6]Excludes tonnages of molybdenum ore from which gold was recovered as a byproduct.
[7]Data may not add to totals shown because of items withheld to avoid disclosing company proprietary data.

Table 8.—Gold produced at amalgamation and cyanidation mills in the United States and percentage of gold recovered from all sources

Year	Bullion and precipitates recovered (troy ounces): Amalgamation	Bullion and precipitates recovered (troy ounces): Cyanidation	Gold recovered from all sources (percent): Amalgamation	Cyanidation	Smelting[1]	Placers
1978	2,254	532,670	0.2	53.3	44.3	2.2
1979	1,238	518,554	.1	53.8	45.1	1.0
1980	9,015	603,255	.9	62.2	35.1	1.8
1981	14,945	912,742	1.1	66.2	[r]30.6	[r]2.1
1982	25,416	1,082,943	1.8	74.8	20.7	2.7

[r]Revised.
[1]Crude ores and concentrates.

Table 9.—Gold produced at placer mines in the United States, by method of recovery

Method of recovery	Mines producing	Washing plants	Material washed (thousand cubic yards)	Gold recoverable: Thousand troy ounces	Value (thousands)	Average value per cubic yard
Bucketline dredging:						
1978	2	3	1,010	11	$2,187	$2.164
1979	2	3	475	3	977	2.056
1980	2	3	170	3	1,719	10.111
1981	3	5	[1]2,190	15	6,731	3.073
1982	6	8	4,702	22	8,130	1.729

See footnotes at end of table.

Table 9.—Gold produced at placer mines in the United States, by method of recovery —Continued

Method of recovery	Mines producing	Washing plants	Material washed (thousand cubic yards)	Gold recoverable: Thousand troy ounces	Gold recoverable: Value (thousands)	Gold recoverable: Average value per cubic yard
Dragline dredging:						
1978	3	9	[2]60	[3]3	$519	[4]$4.339
1979	3	10	[2]86	[3]4	1,110	[4]4.019
1980	3	11	[2]55	[3]6	3,379	[4]5.780
1981	1	7	[2]30	[3]3	1,200	[4]13.023
1982	3	14	[2]33	[3]3	1,186	[4]16.529
Hydraulicking:						
1978	10	10	233	4	784	3.367
1979	8	8	176	2	613	3.480
1980	14	14	453	4	2,657	5.869
1981	7	7	[r]113	1	526	[r]4.678
1982	4	4	17	([5])	139	8.026
Nonfloating washing plants:						
1978	9	11	[2]152	[3]4	812	[4]2.448
1979	7	8	[2]42	[3]1	225	[4]2.988
1980	7	10	[2]314	[3]4	2,605	[4]7.811
1981[r]	9	13	[2]894	[3]9	4,438	[4]4.869
1982	10	11	805	13	4,829	6.000
Underground placer, small-scale mechanical and hand methods, and suction dredge:						
1978	5	5	1	([5])	13	13.431
1979	3	3	4	([5])	5	1.281
1980	2	2	3	([5])	33	12.473
1981	6	7	108	1	401	3.728
1982	15	15	30	([5])	174	5.848
Total placers:[6]						
1978	29	38	[2]1,456	[3]22	4,314	[4]2.483
1979	23	32	[2]784	[3]10	2,930	[4]2.639
1980	28	40	[1 2]994	[3]17	10,394	[4]7.220
1981[r]	26	39	[1 2]3,335	[3]29	13,296	3.719
1982	38	52	[2]5,587	[3]38	14,458	[4]2.473

[r]Revised.
[1]Does not include platinum-bearing material from which byproduct gold was recovered.
[2]Excludes tonnage of material treated at commercial sand and gravel operations recovering byproduct gold.
[3]Includes gold recovered at commercial sand and gravel operations.
[4]Gold recovered as a byproduct at sand and gravel operations not used in calculating average value per cubic yard.
[5]Less than 1/2 unit.
[6]Data may not add to totals shown because of independent rounding.

Table 10.—U.S. refinery production of gold

(Thousand troy ounces)

Source	1978	1979	1980	1981	1982
Concentrates and ores:					
Domestic	962	795	773	801	718
Foreign	71	83	14	4	1
Old scrap[1]	1,384	1,675	2,184	[r]1,610	1,421
New scrap	1,701	1,208	1,640	[r]1,475	1,596
Total[2]	4,118	3,761	4,612	[r]3,890	3,737

[r]Revised.
[1]Excludes upgrading of U.S. Government-owned gold (mostly coin gold) by the U.S. Assay Office, amounting to 2,386,874 ounces in 1978, 3,000,068 ounces in 1979, 2,921,587 ounces in 1980, and 2,476,628 ounces in 1981. Refining activity suspended September 1981.
[2]Data may not add to totals shown because of independent rounding.

CONSUMPTION

Although total domestic consumption of refined gold, as measured by its conversion into fabricated and semifabricated forms, increased for the second consecutive year, it still remained far below that reported for 1979 (figure 2, table 11). Jewelry and arts usage in 1982 accounted for 58% of consumed gold, while industrial and dental usages accounted for 32% and 10%, respectively. The use of karat gold increased substantially in 1982, while the use of gold-filled and other forms increased only slightly; the use of fine gold for electroplating declined substantially. Sales of small items for investment continued to decline sharply from the higher levels achieved in earlier years; the increasing popularity and availability of various gold coins and medallions for investment purposes may have been responsible for some of the decline in the small-items category. In the 1981-82 period of moderating prices some substitution of gold by less expensive materials continued, but the broadening economic recession and reduced industrial output combined to hold down the demand for gold in many products.

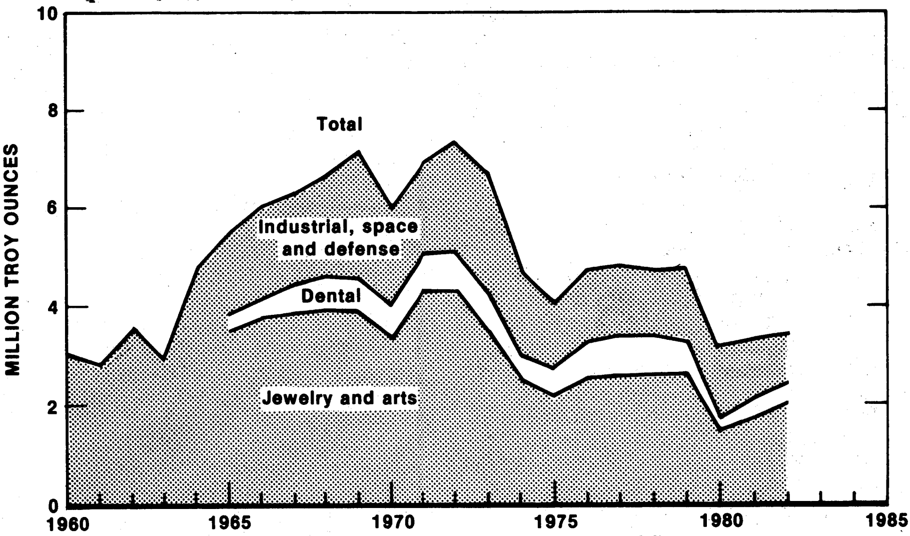

Figure 2.—Consumption of gold in the United States.

Table 11.—U.S. consumption of gold, by end use[1]

(Thousand troy ounces)

End use	1978	1979	1980	1981	1982
Jewelry and arts:					
Karat gold	2,224	2,276	1,249	r1,420	1,677
Fine gold for electroplating	42	32	30	24	17
Gold-filled and other	385	380	226	r286	301
Total	2,651	2,688	1,505	r1,730	[2]1,996
Dental	706	646	341	r314	358
Industrial:					
Karat gold	64	64	38	r50	64
Fine gold for electroplating	687	797	592	528	366
Gold-filled and other	562	545	657	r633	655
Total	1,313	1,406	1,287	r [2]1,210	1,085
Small items for investment[3]	68	45	82	22	9
Total consumption	4,738	4,785	3,215	r3,276	3,448

rRevised.
[1]Gold consumed in fabricated products only. Does not include monetary bullion.
[2]Data do not add to total shown because of independent rounding.
[3]Fabricated bars, medallions, coins, etc.

Although data are not reported on the purchase or "consumption" of gold bullion by the private sector, the quantities purchased annually are believed to be represented approximately by the sizable domestic supply surpluses that occurred each year between 1975, when the right of U.S. citizens to own gold bullion was reinstated, and 1979. In 1975 the supply surplus was 52,000 ounces, by 1979 it had grown to

4.1 million ounces. In 1980, however, this trend was temporarily reversed, and a deficit of about 0.8 million ounces of bullion was registered. In 1981 and 1982 the trend toward surplus supplies, though moderate in comparison with that of 1979, resumed and surpluses of 0.8 and 1.3 million ounces, respectively, were recorded. Also, the flow of gold coins, mostly "bullion coins," into the United States has been substantial since the purchase of nonnumismatic coins in quantity was authorized in 1974. Estimated imports of gold coins, in million ounces, follows: 1976, 1.3; 1977, 1.6; 1978, 3.7; 1979, 2.8; 1980, 3.1; 1981, 2.6; and 1982, 2.9. In mid-1980, the U.S. Department of the Treasury began public sales of gold medallions bearing the images of celebrated U.S. artists; a total of 577,000 ounces of gold in medallions was sold during 1980 and 1981 combined, but sales fell to 63,000 ounces in 1982.

STOCKS

Official.—There were no public bullion auctions by the U.S. Department of the Treasury during 1981 or 1982, but stocks of bullion held by the Department at yearend 1982 were 70,000 ounces less than stocks on hand at yearend 1981. The decline was attributed in part to the use of bullion stocks to satisfy the minting requirements of the Department's gold medallion sales program.

Official gold reserves of the market economy countries, including stocks held by the International Monetary Fund (IMF) and the Bank for International Settlements, totaled 1.143 billion ounces at yearend. IMF bullion stocks at yearend 1982 were essentially unchanged from stocks held at the close of 1980.

Commercial.—Industrial stocks of refined gold held by U.S. refiners, fabricators, and dealers were drawn down substantially during the first three quarters of 1982 but then surged upwards during the fourth quarter, apparently in response to the deepening economic recession. Futures exchange stocks, at 2.45 and 2.30 million ounces at yearend 1981 and 1982, respectively, were considerably less than those of yearend 1980 and more in line with levels posted in earlier years (table 12).

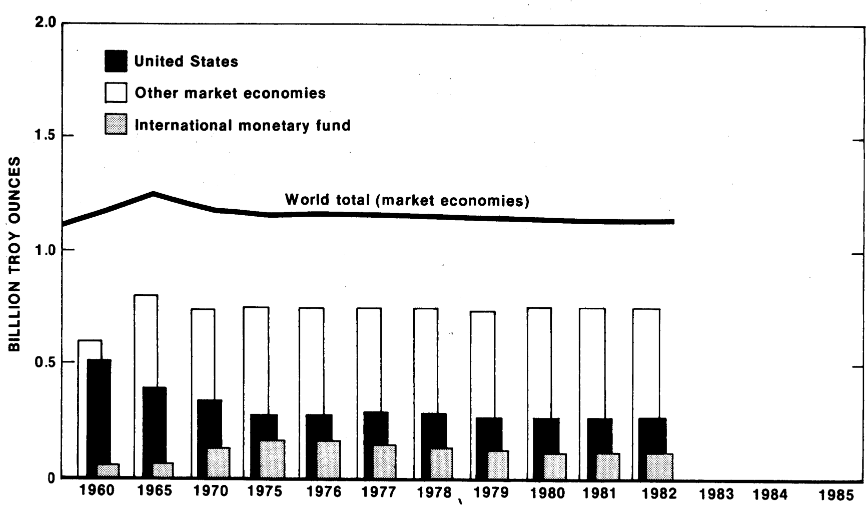

Figure 3.—World monetary gold stocks.

Table 12.—Stocks of gold in the United States, end of period

(Thousand troy ounces)

	1978	1979	1980	1981	1982
Treasury Department[1]	276,433	264,614	264,330	264,116	264,046
Industry	1,672	868	872	[r]635	776
Futures exchange	2,752	2,473	4,998	2,449	2,303
Earmarked gold[2]	366,248	359,285	354,453	350,640	348,555

[r]Revised.
[1]Includes gold in Exchange Stabilization Fund.
[2]Gold held for foreign and international official accounts at New York Federal Reserve Bank.

PRICES

The Engelhard Industries price of refined gold (figure 4, table 13), declined from an average of $384 per troy ounce in January 1982 to the year's low of $297 in June; the trend then reversed and moved upward to the year's high of $481 in September, closing the year at $461 on December 29. The average for the year was $375.91. Excluding the unusual years of 1980 and 1981, the 1982 average price follows the upward trend begun in 1976. Since 1979, nearly all of the industrialized nations have adopted market-related prices for valuation of their bullion reserves; in 1982, the United States was the only holder of large gold stocks still valuing its bullion at a fixed price ($42.22 per ounce).

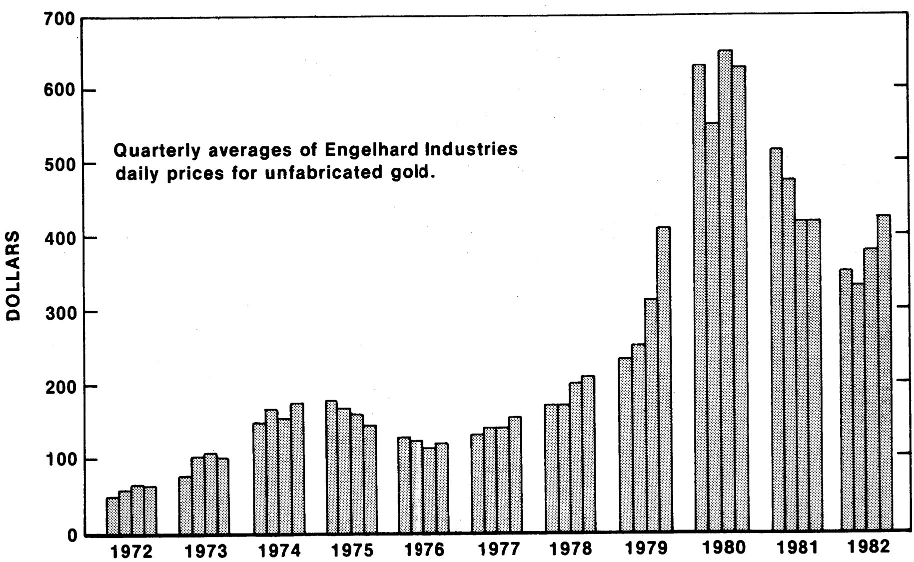

Figure 4.—U.S. gold prices.

Table 13.—U.S. monthly gold prices[1]

(Dollars per troy ounce)

Month	1981 Low	1981 High	1981 Average	1982 Low	1982 High	1982 Average
January	493.75	599.25	557.39	371.50	403.50	384.12
February	489.00	519.50	500.26	360.60	384.25	374.07
March	461.50	539.50	498.76	312.00	361.25	330.25
April	473.75	533.75	494.90	327.00	366.75	350.53
May	466.50	493.00	479.79	324.25	344.75	334.36
June	426.00	483.25	460.76	296.75	328.75	314.98
July	397.75	422.00	408.88	306.75	366.50	340.10
August	391.25	431.50	410.90	333.50	418.00	365.97
September	421.50	463.50	444.10	397.00	481.00	435.56
October	424.50	453.50	437.76	387.50	448.00	422.15
November	396.75	431.25	412.86	398.00	436.00	414.15
December	394.74	426.00	409.32	435.75	460.50	444.65
Year	391.25	599.25	459.64	276.75	481.00	375.91

[1]Engelhard Industries daily quotation.

FOREIGN TRADE

Exports of refined gold fell from the 5.3-million-ounce level of 1981 to 1.6 million ounces in 1982. The principal recipients of refined gold during 1982 were Canada with 61% of the total, the United Kingdom, 20%, and Switzerland, 9%. Of the gold in all forms imported into the United States in 1982, 60% came from Canada, followed by the United Kingdom and Switzerland with 8% and 6%, respectively. An estimated 2.9 million ounces of gold in coins was imported during the year; of this total, 36% came from Mexico, 32% from the Republic of South Africa, and 24% from Canada.

Table 14.—U.S. exports of gold in 1982, by country

Country	Ore, base bullion, and scrap: Troy ounces	Ore, base bullion, and scrap: Value (thousands)	Refined bullion: Troy ounces	Refined bullion: Value (thousands)	Total: Troy ounces	Total: Value (thousands)
Belgium-Luxembourg	102,561	$38,885	--	--	102,561	$38,885
Brazil	--	56	10,450	$4,311	10,450	4,367
Canada	791,878	294,283	996,510	360,526	1,788,388	654,809
France	13,412	5,536	551	181	13,963	5,717
Germany, Federal Republic of	25,185	9,093	760	257	25,945	9,350
Israel	--	--	12,507	4,903	12,507	4,903
Italy	97	31	1,370	485	1,467	516
Japan	4,051	1,745	301	113	4,352	1,858
Sweden	13,039	4,723	1,232	479	14,271	5,202
Switzerland	14,142	4,098	145,435	55,452	159,577	59,550
United Kingdom	365,707	138,796	326,785	115,696	692,492	254,492
Uruguay	--	--	131,656	45,591	131,656	45,591
Other	3,138	892	9,627	2,954	12,765	3,846
Total[1]	1,333,210	498,139	1,637,184	590,947	2,970,394	1,089,086

[1]Data may not add to totals shown because of independent rounding.

Table 15.—U.S. imports for consumption of gold in 1982, by country

Country	Ore, base bullion, and scrap		Refined bullion		Total[1]	
	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)
Argentina	4,878	$1,842	39,860	$16,120	44,738	$17,962
Belgium-Luxembourg	--	--	11,341	4,554	11,341	4,554
Bolivia	10,159	2,957	2,495	871	12,654	3,828
Brazil	1	2	119,770	50,510	119,771	50,512
Canada	250,641	91,514	2,724,811	1,032,360	2,975,452	1,123,874
Chile	133,359	44,063	121,242	43,197	254,601	87,259
Dominican Republic	141,886	52,210	--	--	141,886	52,210
Germany, Federal Republic of	10,876	4,008	5,590	1,959	16,466	5,967
Guyana	11,934	3,741	1,767	538	13,701	4,279
Hong Kong	4,723	1,624	12,163	5,568	16,886	7,192
Japan	1,644	671	46,445	18,287	48,089	18,958
Korea, Republic of	1,259	459	11,540	4,689	12,799	5,148
Liberia	2,768	868	101	34	2,869	903
Malaysia	6,542	2,324	--	--	6,542	2,324
Mexico	13,441	4,204	186,467	83,804	199,908	88,008
Netherlands	200	22	16,030	6,930	16,230	6,952
Panama	1,252	384	5,869	2,185	7,121	2,569
Peru	34,393	12,731	59,539	21,786	93,932	34,516
Philippines	25,302	9,922	--	--	25,302	9,922
Singapore	2,110	694	--	--	2,110	694
South Africa, Republic of	856	343	90,623	37,469	91,479	37,813
Switzerland	343	131	285,300	115,400	285,643	115,532
U.S.S.R	8,205	2,669	3,546	1,493	11,751	4,162
United Kingdom	6,417	2,629	46,175	16,241	52,592	18,869
Uruguay	2,374	1,014	396,075	167,915	398,449	168,928
Yugoslavia	--	--	32,666	11,396	32,666	11,396
Other	7,098	1,859	18,254	7,413	25,352	9,272
Total[1]	682,661	242,885	4,237,669	1,650,719	4,920,330	1,893,604

[1]Data may not add to totals shown because of independent rounding.

Table 16.—Value of U.S. gold trade

(Thousand dollars)

Year	Exports	Imports[1]
1978	1,113,794	903,024
1979	4,907,864	1,480,203
1980	3,647,932	2,750,120
1981	3,071,886	2,157,487
1982	1,089,086	1,893,604

[1]Values of imports for consumption for 1978-82; values of general imports were $921,504,188 (1978), $1,506,716,888 (1979), $2,795,549,207 (1980), $2,197,944,569 (1981 revised), and $1,940,356,813 (1982).

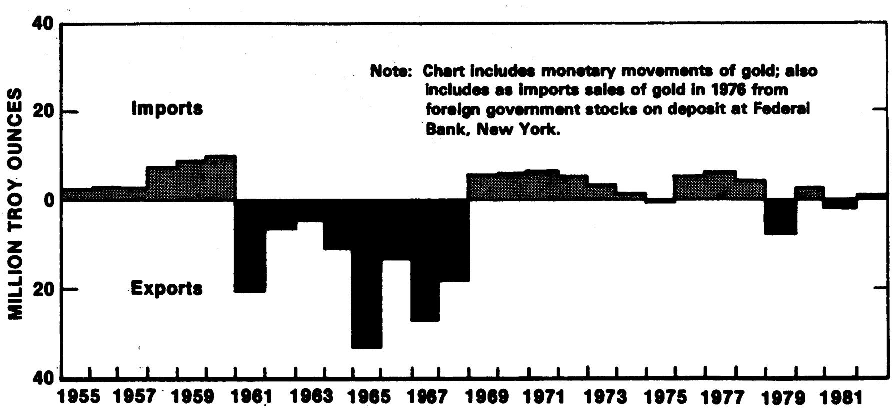

Figure 5.—Net U.S. trade in gold.

WORLD REVIEW

The pattern of world mine production established in recent years remained essentially unchanged, with the Republic of South Africa accounting for 50% of the world mine output, and the U.S.S.R., Canada, China, Brazil, the United States, and 56 other countries accounting for the remainder (figure 6, table 17).

As reported in Consolidated Gold Fields' annual summary, the supply of gold (excluding most secondary gold) available to official and commercial purchasers in the market economy countries in 1982 was about 39 million ounces;[7] of this total about 32.6 million ounces was mined in the market economy countries and 6.7 million ounces originated as net trade with the centrally controlled economy countries such as the U.S.S.R., China, and North Korea. When net purchases of gold for official or governmental financial purposes are excluded, the supply available to the commercial sectors of the market economy countries was about 36.1 million ounces, compared with about 31.3 million ounces in 1981. As in years past, most of the gold entering the market from the Republic of South Africa, the U.S.S.R., and several other producing countries continued to be traded through Switzerland, the United Kingdom, and other Western European countries.

According to Consolidated Gold Fields' report, the demand for gold in the commercial sector of the market economy countries during 1982 was about 34.4 million ounces, a 95% increase over estimated 1980 demand. Gold consumed in the developed and developing market economy countries combined was divided, in million troy ounces, between the following end use categories: jewelry, 23; electronics, 2.6; dental, 1.9; other industrial and decorative uses, 1.9; medallions and unofficial coins, 0.70; and official coins, 4.3. The totals for all categories combined were 34.4 million troy ounces, compared with 33.2 million troy ounces in 1981. Identified hoarding of gold bars for investment purposes during 1982 totaled 9.4 million ounces; 1982 was the second consecutive year in which bar hoarding reached record levels since the company's annual survey began in 1970. Identified bar hoarding was greatest in Saudi Arabia, Syria, and Yemen in the Middle East, and Indonesia in the Far East. Massive currency devaluations relative to the dollar occurred in several Latin American countries; this severely impacted established demand patterns in some countries and encouraged dishoarding of jewelry and investment items in others. The report further noted that, with the opening of gold futures exchanges in both London and Tokyo, in the spring of 1982, the gold market chain now extends around the world, allowing gold to be traded on a 24-hour basis, 7 days per week.

Table 17.—Gold: World mine production, by country[1]

(Troy ounces)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Argentina	5,600	10,140	10,622	14,757	15,000
Australia	647,579	596,910	547,591	567,813	[3]881,000
Bolivia	24,660	30,319	52,075	66,372	40,146
Brazil[4]	300,898	319,258	1,300,000	[e]1,200,000	1,447,000
Burundi	[e]450	133	130	[e]100	100
Cameroon	[e]200	147	72	316	150
Canada	1,735,077	1,644,265	1,627,477	1,672,893	2,008,023
Central African Republic	[e]965	2,181	2,000	1,386	1,400
Chile	102,287	111,405	219,773	400,479	546,562
China[5] [e]	150,000	200,000	225,000	1,700,000	1,800,000
Colombia	246,446	269,369	510,439	[e]535,000	404,400
Congo[e]	7,000	7,000	7,000	7,000	6,000
Costa Rica[e]	15,900	16,718	16,000	16,000	16,500
Dominican Republic	342,830	352,982	369,603	407,813	400,000
Ecuador	2,734	3,215	3,537	[e]3,700	258
El Salvador	3,619	2,720	2,492	[r] [e]2,000	2,000
Ethiopia	[e]8,000	[6]7,970	[e]9,000	11,930	13,000
Fiji	28,065	25,656	23,934	30,595	35,000
Finland	29,096	28,325	41,828	31,893	32,000
France	59,640	54,109	37,391	36,362	36,000
French Guiana[e]	5,000	5,000	4,000	4,000	3,500
Gabon	965	964	553	[e]550	550

See footnotes at end of table.

Table 17.—Gold: World mine production, by country[1] —Continued

(Troy ounces)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Germany, Federal Republic of	2,119	2,357	2,964	3,051	3,050
Ghana	402,034	362,000	353,000	[e]330,000	330,000
Guyana	15,404	10,593	11,003	19,263	8,643
Honduras	[e]2,500	1,501	2,027	1,579	[3]1,601
Hungary[e]	60,000	60,000	60,000	60,000	50,000
India[7]	89,186	84,781	78,834	[e]80,000	70,000
Indonesia[8]	66,166	57,452	59,877	51,821	50,000
Japan	145,240	127,626	102,339	99,242	[3]105,036
Kenya	205	[e]200	125	[e]100	100
Korea, North[e]	160,000	160,000	160,000	160,000	160,000
Korea, Republic of[7]	27,397	24,077	41,204	40,638	54,000
Liberia	NA	1,086	7,243	[9]16,864	[9]12,656
Madagascar	125	125	114	[e]110	100
Malaysia:					
Peninsular Malaysia	[r]6,252	[r]5,493	4,621	5,691	6,000
Sabah	64,377	55,292	60,905	69,915	70,000
Sarawak	971	[r]1,063	379	82	100
Mali[e]	965	1,000	1,500	1,500	1,500
Mauritania	8,000	--	--	--	--
Mexico	202,003	190,364	195,991	203,160	210,000
New Zealand	[r]7,043	6,998	6,419	6,166	6,000
Nicaragua	73,947	61,086	59,994	62,000	65,000
Papua New Guinea	751,265	630,496	451,707	540,325	[3]563,538
Peru	[r]112,656	[r]124,434	133,586	186,895	160,000
Philippines	586,531	535,166	643,805	753,452	778,000
Portugal	9,131	10,706	8,855	10,931	10,000
Romania[e]	65,000	65,000	65,000	65,000	65,000
Rwanda	1,125	472	944	1,204	1,400
Sierra Leone[10]	NA	NA	407	3,435	[3]8,729
Solomon Islands	[e]400	1,076	1,093	[e]1,050	1,100
South Africa, Republic of	22,648,558	22,617,179	21,669,468	21,121,157	[3]21,355,111
Spain	102,882	91,404	108,154	[e]105,000	100,000
Sudan[e]	300	300	300	300	400
Suriname	289	300	350	[e]380	300
Sweden	76,294	[e]70,000	[e]70,000	[e]70,000	70,000
Taiwan[7]	13,407	14,243	13,278	56,693	71,000
Tanzania	133	322	246	[e]250	250
United States	998,832	964,390	969,782	1,379,161	[3]1,446,905
U.S.S.R.[e]	8,000,000	8,160,000	8,300,000	8,425,000	8,550,000
Venezuela	13,384	14,989	16,519	[e]17,500	18,000
Yugoslavia[7]	142,556	138,987	106,226	115,164	122,000
Zaire	76,077	69,992	39,963	[e]70,000	65,000
Zambia	8,457	7,933	10,576	10,545	13,439
Zimbabwe	398,990	388,000	368,000	371,000	420,000
Total	[r]39,057,212	[r]38,807,269	39,197,315	41,226,583	42,712,547

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.
[1]Table includes data available through May 12, 1983.
[2]Gold is also produced in Bulgaria, Burma, Czechoslovakia, the German Democratic Republic, Guinea, Norway, Poland, Senegal, Thailand, and several other countries. However, available data are insufficient to make reliable output estimates.
[3]Reported figure.
[4]All figures except that for 1978 differ substantially from those appearing in latest available official Brazilian sources owing to the inclusion of estimates for unreported production by small mines (garimpos). Officially reported figures are as follows, in troy ounces; major mines: 1978—128,860; 1979—107,158; 1980—131,432 (revised); 1981—140,691; small mines (garimpos); 1978—172,038; 1979—36,234; 1980—310,704 (revised); 1981—414,744.
[5]Very conservative estimate of output 1978-80; total national production probably is much greater than these estimates, but no basis for quantification of the balance of output is available;1981 and 1982 estimate prepared by the Gold Institute, Washington, D.C.
[6]Data are for year ending July 6 of that stated.
[7]Refinery output.
[8]Excludes production from so-called people's mines.
[9]These figures are based on gold taxed for export and include gold entering Liberia undocumented from Sierra Leone and Guinea.
[10]Excludes estimates of gold produced in Sierra Leone, which is moved through undocumented channels for sale in Liberia.

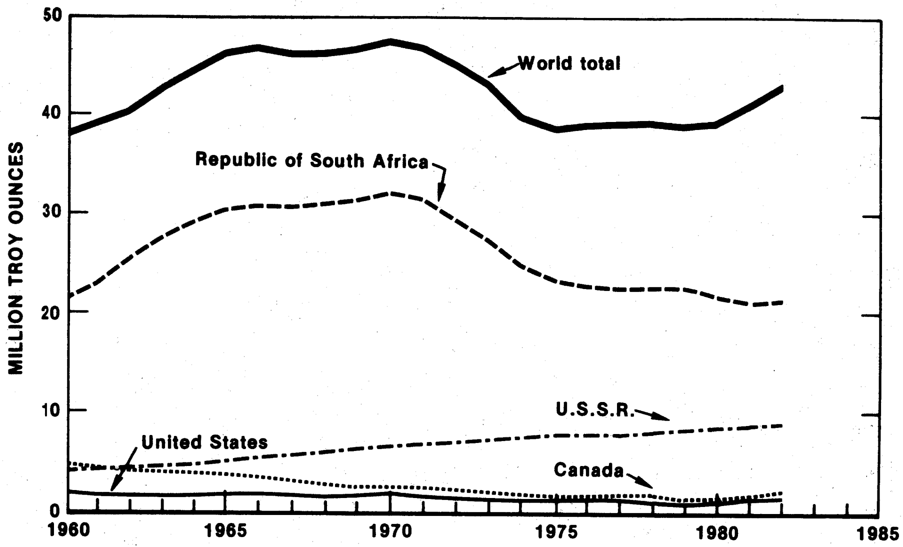

Figure 6.—World mine production of gold.

Australia.—Along the Golden Mile in Kalgoorlie, Western Australia, Kalgoorlie Mining Associates (KMA), Australia's largest gold producer, realized a substantial increase in gold production following the first full year of production at the recently rehabilitated Fimiston Mine. At KMA's Mount Charlotte Mine, sinking of the New Cassidy shaft continued; the new shaft, 21 feet in diameter and 3,800 feet deep, was scheduled to eventually replace the existing haulage and service shafts. The 500,000-ton-per-year carbon-in-pulp extraction plant of Western Mining Corp. Holdings Ltd. at Kambalda, south of Kalgoorlie, completed its first year of operation. Western Mining's 100% owned Great Boulder Holdings Ltd. reported substantially higher gold production from the Victor, Hunt, Sand King, Great Boulder, and Lancefield Mines. At Norseman, the Central Norseman gold mine continued full production and development, which included the opening of two additional shafts. Nearby, Australis Mining N.L. completed construction of a carbon-in-pulp treatment plant to recover gold values from Norseman area tailings dumps.

At Cowarna Downs Station near Karonie, on the Trans-Australia Railroad, 60 miles east of Kalgoorlie, Freeport of Australia Pty. Ltd., a subsidiary of Freeport-McMoRan announced the discovery of widespread gold mineralization in a number of drill holes completed on the Karonie project. The project is part of a worldwide effort by Freeport to locate disseminated gold deposits. At the Telfer gold mine, Newmont Pty. Ltd. and Dampier Mining Co. increased gold production by nearly 25% during 1982. Exploration for additional ore reserves was continued in the West Dome area of the Telfer open pit, which is situated in the East Pilbara area about 250 miles southeast of Port Hedland, Western Australia. At Meekatharra, Whim Creek Consolidated N.L. increased production at the Haveluck Mine and expanded the capacity of the treatment plant to 216,000 tons per year. The company processed ore from the Haveluck open pit as well as other nearby joint venture properties. Argosy Gold Mines Ltd. closed the Meekatharra carbon-in-pulp plant because of low gold prices. The company had been recovering gold from local tailings dumps.

In other developments in Western Australia, Gold Resources Pty. Ltd. continued underground rehabilitation and limited production at the Paringa Mine at Kalgoorlie; finished sections of the newly constructed treatment plant were also commissioned, with completion targeted for early 1983. At Copperfield-Mount Ida, about 100 miles northwest of Kalgoorlie, the old Mount Ida Mine, which had recently reopened, was placed on care and maintenance awaiting improved gold prices. East of Mount Ida, at Leonora, Carr Boyd Minerals Ltd., a joint venture team exploring the Harbour Lights prospect, encountered extensive, but as yet unproven, gold mineralization. At Paddington, to the south between Kalgoorlie and Broad Arrow, Pancontinental Mining Ltd. expanded its drilling program to further evaluate the potential of gold mineralization discovered earlier. Several companies exploring near Kalgoorlie reported encountering interesting gold values in rocks not previously known to host gold mineralization. Geochemical techniques, including the application of pathfinder elements, are becoming increasingly important tools in the search for gold in deeply lateritized and soil-covered terrain present throughout the gold fields of Western Australia.

In March, because of operating losses incurred by low metal prices, Peko-Wallsend Ltd. closed the Mount Chalmers Mine in the Northern Territory; the company also shifted mining operations at the Warrego copper-gold mine to areas containing higher recoverable gold values and directed gold exploration toward the occurrence of gold in the banded iron formations around Burrundie. Other companies exploring in the Northern Territory disclosed the discovery of several large low-grade gold deposits. In northeastern Queensland,, near Townsville, Placer Exploration Ltd. updated the 1981 feasibility study of the Kidston gold property to reflect current economic conditions and to prepare for a development decision. Engineering studies to combine the heap leaching of oxidized ore with the milling of sulfide ore may offer reduced capital expenditures. Measured and indicated ore in the Wise's Knob area of the property and its extensions amounted to nearly 51 million tons containing low-grade gold and silver mineralization. In the Croydon area of Queensland, Central Coast Exploration N.L. announced plans to install a heap-leaching operation central to its various gold prospects. In preparing for a gold tailings recovery operation at Mount Morgan, Peko-Wallsend commissioned a tailings dredge and completed construction of a treatment plant. The company also announced that further drilling at the Parkes, New South Wales, copper-gold prospect had encountered more mineralization that would warrant evaluation. In central Victoria, C.R.A. Exploration Pty. Ltd. was investigating the possible application of various solution-mining techniques for the recovery of gold from deeply buried alluvial gold deposits. Toward yearend, the company was preparing a technical report on deep alluvial gold for the Victorian Government while continuing to define the distribution and gold content of deep alluvial deposits targeted for possible study.

Brazil.—The quest for gold in the remote areas of northern Brazil continued at essentially the same level of intensity witnessed during the previous 2 years. Independent miners or garimpeiros continued to swarm into the rich Serra Pelada diggings in the State of Pará and into the placer camps along rivers in the States of Minas Gerais, Pará, Amazonas, Amapá, Rondônia, Mato Grosso, and elsewhere.

Outside the gold rush areas, exploration and development of both new and established gold mines by domestic as well as multinational companies continued at a rapid pace. The Anglo American Corp. do Brasil Ltda. (Ambras) reported that studies were in progress to double the capacity of the Mineração Morro Velho S.A. gold mines near Belo Horizonte, to process about 1.3 million tons of ore annually. At Ambras' new mine at Jacobina, in the State of Bahia, a new 265,000-ton-per-year treatment plant was commissioned near yearend; underground development and construction work also progressed satisfactorily. The company continued to explore for new gold reserves at Morro Velho as well as elsewhere in Brazil. The Government-controlled mineral and exploration companies, Cia. de Pesquisas de Recursos Minerais and Cia. Vale do Rio Doce, began to implement mechanization programs in the placer goldfields. The programs are aimed at both increasing Brazilian gold production and centralizing gold purchasing to reduce losses attributed to widespread smuggling of unreported production.

Canada.—Canadian gold mine production increased for the third consecutive year and exceeded the 2-million-ounce level for the first time since 1972. New mines coming onstream in late 1981 and 1982 contributed greatly to the increase. At the close of 1982 there were 39 lode gold mines in Canada operated by 30 companies. Only one major gold mine, the Lupin Mine in the Northwest Territories, began production in 1982, and only one major producer is likely to come onstream in 1983. Quebec became the leading gold-producing Province in 1982 with 37% of the total, followed by Ontario with 32%, British Columbia with 12%, and the Northwest Territories with 11%. Gold exploration declined, largely as a result of declining corporate earnings and falling metal prices. Erosion of the gold price generally hampered small gold exploration companies' efforts to raise funds through equity financing or through bank loans. A resurgence of the price and declining interest rates toward yearend rekindled hopes for increased exploration activity in the 1983 field season. A major claim staking and exploration rush was underway in late 1982 following the discovery of what appeared to be a major gold occurrence centered around the town of Hemlo, Ontario, near the north shore of Lake Superior; near yearend more than 16,000 claims had been staked by more than 65 companies.

Two grants were awarded under the Ontario Government's Board of Industrial Leadership and Development program to construct custom milling facilities. The purpose of this program was to stimulate exploration and development by making mills available to prospectors and small companies for testing small quantities of ore from their properties. Establishing the quality of the ore could facilitate raising the financing required to build their own mills. Details of the operations of individual mines and highlights of exploration and development were published in the Canadian Minerals Yearbook.

Chile.—Chilean gold production has grown more than fivefold since 1978, reflecting both the expansion of existing mines and the development of new gold-bearing properties. Near Coquimbo, St. Joe International Corp.'s new $200 million El Indio gold-silver-copper mine became fully operational during 1982. El Indio sold concentrates containing approximately 140,000 ounces of gold, 451,000 ounces of silver, and 8,350 tons of copper. Additionally, 229,000 ounces of gold was marketed in direct-shipping ore, which does not require onsite processing before shipping to smelters. El Indio's milling ore reserves were estimated at 4.7 million tons averaging 0.3 ounce per ton. The direct-shipping ore contains about 7.3 ounces per ton, and reserves were estimated at about 69,000 tons. The company reported encouraging results from exploration in progress on various prospects in the El Indio area. In late 1982, Empresa Nacional de Minería (ENAMI), the Chilean national agency for small- and medium-scale mines, opened the Andacollo copper-gold-silver deposit to international bidding. ENAMI's action on the 300-million-ton project resulted from the earlier collapse of a joint venture between ENAMI and Noranda Mines. Phelps Dodge acquired a majority interest in a Chilean company that owns and operates several small copper-gold mines and a mill in the Punta del Cobre mining district of northern Chile. The district appears to have a high potential for the discovery of additional ore deposits. C.R.A. Minera de Chile Ltda. reported that sampling of alluvial gravels at the Rio del Oro prospect indicated the presence of a significant volume of gold-bearing material. A bulk-sampling program was initiated to assess the prospect's potential for development.

China.—China has placed the highest priority on the development of its gold resources. Current Chinese Government policy is to expand geological exploration and encourage the development of both new and established gold mines by individuals, the "masses," Provincial governments, and units of the Chinese Army. Various news media reports originating from China during 1982 included the following items of interest: New gold deposits were discovered or expanded in a number of Provinces, and production targets were exceeded by many producers; large production increases at some mines were attributed to the implementation of team competition and economic incentives such as bonus rewards for productivity increases; in Shandong Province 12,000 persons are engaged in gold-mining; five dredges began work in one Province; Government gold procurement procedures are becoming overwhelmed by increasing production and will require streamlining; smuggling of gold and its purchase in volume by armed "unlawful elements" at prices greater than official rates is a problem; and enforcement of local controls over mining and training of the "masses" in gold-mining techniques and marketing procedures are lagging.

Costa Rica.—The operators of the Santa Clara gold mine, United Hearne Resources Ltd. of Vancouver, Canada, continued development and production at the mine, which is located in Puntenaras Province. During 1982, gold production at the open pit heap-leaching operation reached about 200 ounces per month. Gold production is expected to increase to about 2,000 ounces per month when construction of the additional leaching pads is completed. Canadian Barranca Corp. Ltd. of Edmonton, Alberta, owns a 40% interest in the mine. Toward yearend the Government of Costa Rica was considering the establishment of a national gold refinery to encourage and regulate gold production and reduce losses attributed to smuggling.

Dominican Republic.—The output of the Pueblo Viejo gold and silver mine, the sole gold producer in the country and one of the oldest producing gold mines in the world, was essentially unchanged from that of 1981. The mine, which has been state-owned since 1979, is managed under a contract with the Dominican Government by Rosario Dominicana, S.A. (a subsidiary of AMAX Inc.). At present, only dore, a mixture of gold and silver, is produced; however, by yearend 1982, the Government had nearly completed the construction of a new $4.8 million refinery to handle the output of the mine. The new facility is expected to reach full production in 1983. The company was reported to be expanding its exploration efforts to cover favorable areas outside the immediate vicinity of the mine. Joint exploration efforts by the Government of the Dominican Republic and the United Nations continued in the Miches area on the northeast coast, where some occurrences of placer gold have been located.

India.—As part of a 5-year program to expand the country's domestic gold production, the Government of India was planning the development of a new gold mine in the State of Andhra Pradesh. The new mine was expected to be in production by the end of 1984. Also during the year, the Geological Survey of India and State mineral agencies discovered several promising gold occurrences in the States of Andhra Pradesh and Uttar Pradesh.

Japan.—Japanese domestic mines produce only about 10% of the country's total primary gold production, the remainder being recovered from imported ores and concentrates. The Metal Mining Agency of Japan, which is responsible for basic metal exploration throughout the home islands, announced the discovery of two new gold deposits during 1982, on the Islands of Hokkaido and Honshu. In 1981 the agency announced that a new gold deposit had been located on Kyushu, the southern island of Japan, on lands owned by a subsidiary of the Sumitomo Metal Mining Co. Ltd. A 1982 company report on the property, designated as the Hishikari Mine, indicated that the deposit was estimated to contain about 4 million ounces of gold. Development of the property began in late 1982, and production, at about 160,000 ounces per year, was scheduled to begin in 1984.

Papua New Guinea.—Bougainville Copper Ltd., the largest gold producer in the islands, increased the production of copper-gold ore in 1982 by 11% over that of 1981. Gold production, at 563,538 ounces, was 4% greater than in 1981. Ore reserves at yearend were estimated at 838 million tons averaging 0.015 ounce per ton. A construction program to expand the capacity of the existing concentrator, to compensate for declining ore grades, continued through 1982. A gravity drainage tunnel nearly 4 miles long was completed; the tunnel was driven from the main pit to alleviate flooding problems associated with ground water and tropical rains. On the mainland of New Guinea, however, a 6-month drought delayed the planned 1984 startup of the new Ok Tedi gold-copper mine under construction in the Star Mountains near the border with Indonesia; the Fly River, along which supplies for the project are barged 800 miles from Port Moresby, ceased flowing, necessitating costly air delivery of essential items only.

At the Porgera gold property, near Mount Hagen in the Central Highlands of Western Enga Province, Placer (PNG) Pty. Ltd., a subsidiary of Placer Development Ltd., delineated six favorable zones of gold-silver mineralization, two of which were investigated for possible extraction by surface-mining methods. Nearby, geological mapping and surface prospecting resulted in the discovery of a new zone of better-than-average gold mineralization; initial drilling tests indicated gold values averaging 0.23 ounce per ton. Porgera is a joint venture between Placer, Consolidated Gold Fields of Australia Ltd., and Mount Isa Mines Ltd. Southeast of the New Guinea mainland, on Misima Island, Placer, in a joint venture with C.R.A. Exploration, continued detailed drilling of the Umuna, or principal, ore zone on their Misima Island gold-silver project. Preliminary metallurgical tests indicated a favorable potential for the recovery of both metals.

Peru.—Although a number of companies continued to seek gold deposits throughout Peru, and especially in the remote Province of Madre de Dios, budget cuts reflecting the general downturn in world economic activity, together with declines in the gold price during the year, caused a slowing down or indefinite postponement of many gold mine and prospect development plans formulated during the earlier boom years.

Philippines.—The operating profits of many Philippine copper producers, which also produce byproduct gold, were adversely affected by steeply declining copper prices as well as by weaker gold prices during 1982. A few producers were able to maintain economic headway by initiating gold hedging or future sales practices, the results of which, for some, more than offset losses incurred by mining. By reinstituting an existing gold subsidy program, the Government of the Philippines, through the Philippine Central Bank, provided loans to several producers during 1982. The loans were extended in the form of a repurchase agreement whereby the Central Bank purchased gold from producers whose production costs exceeded $370 per ounce; later, if the gold price increased, participating producers could repurchase the same quantity of gold sold earlier and resell it to gain a small profit. The Benguet Corp., the country's largest gold producer and one of the larger copper producers, completed the expansion of the Balatoc gold mill near Baguio on the island of Luzon. The expansion, the first since 1947, reduced the company's production costs by $100 per ounce. Although many Philippine companies reduced the scope of their operations or were forced to close because of declining commodity prices, exploration for new gold deposits was maintained at a relatively high level. A gold rush in the Province of Negros Occidental, in the west of Negros Island, began in early 1982, when gold was discovered in Sangke Creek, Hinobaan. In April, 20,000 to 30,000 prospectors were reported to be involved in the rush, and Government intervention was required to resolve conflicts arising over mining claims.

Saudi Arabia.—Feasibility studies and the initial drilling program at the gold deposit at Mahd adh Dhahab, 170 miles northeast of Jeddah, were completed in early 1982. Further development of the deposit, which has been mined for gold at various intervals for over 3,000 years, was to be under the management of Gold Fields Mahd adh Dhahab Ltd., a subsidiary of Consolidated Gold Fields, PLC. As part of a Government program to broaden the country's resource base, a number of mineral prospects were under investigation, especially in the Arabian shield area of western Saudi Arabia. Several of these were gold prospects, and a few were located in what were once ancient gold-mining centers.

South Africa, Republic of.—South African gold mine production during 1982, which amounted to 50% of world gold mine production, was up slightly from that of 1981. Inflation, weakening gold prices, and rising mining costs throughout much of 1982 placed considerable pressure on the South African rand, forcing its value relative to the dollar to the lowest point in several years. Consequently, to protect themselves against market and metal price declines, many producers allocated a percentage of their production to hedging operations on various international gold futures markets. In both 1981 and 1982 the Reserve Bank of South Africa engaged in gold swaps (the sale of official gold with an agreement for later repurchase) to increase the foreign exchange available to finance the country's balance-of-payments deficit. To meet anticipated declines in gold-mining tax revenue, the Government of South Africa included in its budget for fiscal 1982-83, which began April 1, an increase in the profit surcharge applied to gold and diamond mines from 5% to 15%. On June 1, 1983, the South African Chamber of Mines began marketing gold bullion bars of 99.99% purity; the 1-kilogram bars[8] and a limited quantity of 400-ounce bars were intended for markets in Asia and the United States, where the demand for higher purity bars, previously mostly of Soviet origin, has increased in recent years.

The 34 mines and 1 metallurgical recovery operation that were members of the Chamber of Mines accounted for 98.2% of all South African gold production. The total ore milled, including ore milled by producers of byproduct and coproduct uranium, amounted to 104.7 million tons, averaging 0.20 ounce of gold per ton; in 1981, 101.3 million tons averaging 0.22 ounce per ton was milled. Working costs for South African gold mines in 1982 averaged, in South African rands (R),[9] R209.98 (US$193.77) per ounce and ranged from R112.91 (US$104.19) per ounce at West Driefontein to R478.31 (US$441.38) per ounce at West Rand Consolidated. Production by the six major mining groups was as follows, in million ounces: Anglo American Corp. of South Africa, Ltd., 7.8; Gold Fields of South Africa, Ltd., 4.5; General Mining Union Corp., Ltd. (Gencor), 3.4; Rand Mines Ltd., 2.3; Johannesburg Consolidated Investment Co. Ltd. (J.C.I.), 1.4; and Anglo Transvaal Consolidated Investment Co. Ltd., 1.2.

The largest producing mines, in terms of millions of ounces of gold ouput, were Vaal

Reefs and Driefontein Consolidated, each with 2.4; Western Holdings, 1.3; Western Deep levels, 1.3; and Harmony, 1.0. Ten gold mines and one metallurgical recovery unit also produced uranium during 1982. Vaal Reefs was the largest uranium producer, with a yield of 1,898 tons of uranium oxide. Estimates of fully developed or blocked-out gold ore reserves reported by the Chamber of Mines at the close of 1982 totaled 520 million tons, containing an average of about 0.32 ounce of gold per ton.

At many of South Africa's gold mines, improvements in access, ventilation, and ore-hoisting facilities and expansions of existing processing plants were commissioned or well toward completion at yearend. These improvements, for the most part, were aimed at developing deeper and heretofore untapped ore reserves blocked out by earlier exploration. Inflation, mounting construction costs, and poor gold prices forced several mines to abandon or delay planned improvements. In early March, Gencor officially dedicated its New Beisa Mine in the Orange Free State. The new mine, principally a uranium producer, will produce gold as a byproduct. Ten miles to the southeast, the company is continuing the development of its new Beatrix gold mine, which is scheduled to begin production in 1984. Production at Gold Fields' Kloof Mine, on the Far West Rand, fell below expectations as several fires, rockbursts, and labor strikes interrupted milling operations. As in years past, exploration for new gold deposits continued; west of Johannesburg, near Fochville, Transvaal, for example, several companies, including Gold Fields and J.C.I., were conducting intensive exploration and drilling programs to locate likely extensions to existing gold deposits.

U.S.S.R.—Soviet gold production was estimated to have increased over estimated 1981 production. The net export of gold by centrally planned economy countries to market economy countries was estimated to have amounted to nearly 7 million ounces in 1982, compared with 2.9 million ounces in 1980 and 9 million ounces in 1981.

Nearly 12,000 ounces of refined and unrefined Soviet gold was imported into the United States during 1982, compared with nearly 40,000 ounces, mostly in the form of refined bullion in 1981.

TECHNOLOGY

Research aimed at developing improved methods of gold recovery from both primary and secondary sources was continued by the Bureau of Mines during 1982. A technique was developed by the Bureau to enhance the percolation rate of leaching solutions through crushed gold and silver ores containing very fine ore particles and clayey materials.[10] The technique, particle agglomeration pretreatment, consists of mixing the crushed ore with a small amount of portland cement as a binder and an appropriate amount of water. Following a brief curing period the ore is ready to be leached. The agglomeration process binds together very fine particles that would otherwise settle in the voids between coarser ore and impede the desired flow of leaching solutions.

In collaboration with a major rock drill manufacturing company, the Research Organization of the Chamber of Mines of the Republic of South Africa reached an advanced stage in the development of both large and small water-powered rock drills.[11] The use of water or hydraulic power to drive various other types of underground machinery such as pumps and conveyors was also being studied and may prove to be a practical adjunct to the use of chilled water and piped ice systems presently being refined to cool the workings of the Republic of South Africa's deep underground mines. The use of hydraulic power also has attractive safety aspects when compared with conventional power sources presently in use.

The Gold Bulletin, a quarterly journal of the International Gold Corp., contained a variety of articles and abstracts of patents on new or improved gold uses and technology.[12] Articles dealing with various historical aspects of gold technology were also presented.

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[1]Physical scientist, Division of Nonferrous Metals.

[2]U.S. Congress Gold Commission. Report to the Congress of the Commission on the Role of Gold in the Domestic and International Monetary System. 1982, v. 1, 226 pp.; v. 2, 567 pp. (distributed by the U.S. Government Printing Office, Washington, D.C.).

[3]Ounce means troy ounce.

[4]Short tons.

[5]Fechner, S. A., and M. P. Meyer. Placer Sampling and Related Bureau Activities in the Sound Study Area of the Chugach National Forest, Alaska. BuMines OFR MLA 62-82, 1982, 25 pp.

[6]Linne, J. M., and D. J.Barnes. Mineral Investigation of the Orleans Mountain RARE II Area (No. B5079), Humboldt and Siskiyou Counties, California. BuMines OFR MLA 67-82, 1982, 18 pp.

[7]DuBoulay, L. Gold 1983. Consolidated Gold Fields, PLC., London, May 1983, 55 pp.

[8]1 kilogram=32.1507 troy ounces.

[9]Values have been converted from South Africa rands (R) to U.S. dollars at the rate of R1=US$0.9228 for 1982, as shown in the International Financial Statistics, v. 36, No. 4, April 1983, p. 370.

[10]McClelland, G. E., and J. A. Eisele. Improvements in Heap Leaching To Recover Silver and Gold From Low-Grade Resources. BuMines RI 8612, 1982, 26 pp.

[11]Chamber of Mines of South Africa. Newsletter. November-December 1982, pp. 5-7.

[12]Gold Bulletin. V. 15, Nos 1-4, 1982 (pub. by the International Gold Corp., Box 61809, 2107 Marshalltown, South Africa).

Graphite

By Harold A. Taylor, Jr.[1]

Apparent consumption of natural graphite decreased 20% in 1982 to 46,000 short tons. An amorphous graphite was mined domestically for the first time in 23 years. All natural graphites, including crystalline flake, were in more than adequate supply as demand by industrial users dwindled along with the economy. Prices of imported graphites varied erratically during the year, although some prices began to drop around yearend.

Production of manufactured graphite in 1982 decreased 43% to 214,000 tons valued at $562 million. Production of graphite fibers increased 34% to 840 tons valued at $49 million.

Table 1.—Salient natural graphite statistics

	1978	1979	1980	1981	1982
United States:					
Production short tons	W	W	--	--	W
Apparent consumption[1] do	90,396	77,562	52,438	57,364	46,156
Exports do	9,595	8,623	8,880	11,344	10,335
Value thousands	$2,304	$3,741	$3,695	$4,433	$4,099
Imports for consumption[2] short tons	99,991	86,185	61,318	68,708	56,491
Value thousands	$11,700	$13,035	$15,765	$23,998	$20,712
World: Production short tons	[r]589,145	[r]689,522	672,056	[p]632,860	[e]606,732

[e]Estimated. [p]Preliminary. [r]Revised. W Withheld to avoid disclosing company proprietary data.
[1]Excludes domestic production, which was relatively small.
[2]Includes some artificial graphite; see table 9.

Domestic Data Coverage.—Domestic production data for synthetic graphite are developed by the Bureau of Mines from a voluntary survey of domestic producers, titled "Synthetic Graphite." Of the 39 operations to which a survey request was sent, 95% responded, representing 100% of the total production data shown in table 4. Production for the two nonrespondents was believed to be small and was not included.

Legislation and Government Programs.—National stockpile goals for strategic graphite, changed in 1980 to reflect specification revisions, were unchanged in 1982. Stockpile goals and inventories for each type of graphite are shown in table 2. There were no acquisitions or disposals of strategic graphite in 1982.

Table 2.—U.S. Government stockpile goals and yearend stocks of natural graphite in 1982, by type

(Short tons)

Type	Goal	National stockpile inventory
Madagascar crystalline flake	20,000	17,891
Sri Lanka amorphous lump	6,300	5,443
Crystalline, other than Madagascar and Sri Lanka	2,800	1,933
Nonstockpile-grade, all types	--	935

Source: General Services Administration. Inventory of Stockpile Materials as of Dec. 31, 1982.

DOMESTIC PRODUCTION

United Minerals Co. began, in 1982, producing sizable amounts of low-grade amorphous graphitic material by open pit mining from the claims of National Minerals Corp. near Townsend, Mont. Graphite Sales, Inc., marketed the material, which averaged 25% fixed carbon and was marketed to a variety of users. This was the first domestic production of amorphous graphite since the last mine in Rhode Island closed in 1959. The material was not beneficiated before sale, but merely dried, crushed, and sized. There is enough minable material to last indefinitely; reserves were estimated by the firm to be over 2 million tons. Other domestic deposits of graphite received little or no attention.

Output of manufactured graphite decreased 43% to about 214,000 tons in 1982, at 32 plants, with a likelihood of some unreported production for in-house use.

Production of all kinds of graphite fiber and cloth increased 34% to 840 tons in 1982.

The domestic graphite industry had a difficult time in 1982. The parent firm, Wickes Co., of one supplier of imported natural graphite, the Wickes Engineered Materials Div., filed for Chapter 11 bankruptcy on April 24, 1982. Another supplier of imported natural graphite and producer of crucibles and other manufactured graphite-using products, the Joseph Dixon Crucible Co., omitted its dividend in 1982, mostly because of the devaluation of the Mexican peso. The graphite electrode producers had layoffs, such as at the Union Carbide plants in Clarksburg, W. Va., and Yabucoa, P.R.

Domestic graphite fiber and foil capacity continued to expand. Union Carbide Corp. began production of polyacrylonitrile-based graphite fiber at its 450-ton-per-year capacity facility at Greenville, S.C., in April. Celanese Corp. announced expansion of its new plant at Rock Hill, S.C., to an annual capacity of 300 tons by yearend. Polycarbon, Inc., a subsidiary of Sigri Carbon Corp., announced plans to build a plant at Valencia, Calif., for the production of graphite cloth and low-modulus fibers as well as graphite foil, thus consolidating previously scattered operations.

Petroleum coke, the principal raw material for graphite electrodes and most other synthetic graphite products, is going to be in better supply in the future, although its quality is likely to get worse, according to a recent review.[2] The author indicated that total production of petroleum coke rose from 11.8 million tons in 1970 to 16.2 millions tons in 1981 and that capacity was expected to increase at a 4% to 5% annual rate for the next 5 years. However, the average quality was predicted to drop because of the greater portion of high-sulfur high-metals petroleum used. Union Oil Co. of California let a contract for construction of a 130,000-ton-capacity needle coke plant at Lemont, Ill.

The origin of lump or vein graphite was debated in 1982. One researcher proposed that the carbon source for lump graphite is inorganic magmatic or carbonate carbon, such as that found in basalt or limestone.[3] An earlier paper held that the source of carbon was organic Precambrian coal or anthraxolite, such as that found in northern Wisconsin, upper Michigan, and adjacent areas.[4] The discussion centered around the proportion of ^{13}C contained in lump graphite compared with the proportion of ^{13}C found in possible organic and inorganic source rocks, particularly the slaty Virginia Formation.[5]

Table 3.—Principal producers of manufactured graphite in 1982

Company	Plant location	Product[1]
Airco Carbon, a division of Airco, Inc	Niagara Falls, N.Y	Anodes, electrodes, crucibles, motor brushes, refractories, unmachined shapes, powder.
Do	Punxsutawney, Pa	
Do	St. Marys, Pa	
Avco Corp., Avco Specialty Materials Div	Lowell, Mass	High-modulus fibers.
The Carborundum Co., Graphite Products Div.	Sanborn, N.Y	Motor brushes, unmachined shapes, cloth.
Celanese Corp., Celanese Research Lab	Summit, N.J	High-modulus fibers.
Do	Rock Hill, S.C	
Fiber Materials, Inc	Biddeford, Maine	High-modulus fibers and cloth.
Fiber Technology Corp	Provo, Utah	--
BF Goodrich Co., Engineered Systems Div., Super Temp Operation.	Santa Fe Springs, Calif	Other.

See footnotes at end of table.

Table 3.—Principal producers of manufactured graphite in 1982 —Continued

Company	Plant location	Product[1]
Great Lakes Carbon Corp	Elizabethton, Tenn	Anodes, electrodes, powder, crucibles, cathodes, high-modulus fibers, unmachined shapes, other, powder.
Do	Morganton, N.C	
Do	Niagara Falls, N.Y	
Do	Ozark, Ark	
Do	Rosamond, Calif	
Hercules Inc	Salt Lake City, Utah	High-modulus fibers.
HITCO Materials Group, ARMCO Inc	Gardena, Calif	Cloth and high-modulus fibers.
Pfizer Minerals, Pigments & Metals Div	Easton, Pa	Other.
Ohio Carbon, Co	Cleveland, Ohio	Do.
Polycarbon, Inc	North Hollywood, Calif	Cloth.
Sigri Carbon Corp	Hickman, Ky	Electrodes and other.
The Stackpole Corp., Carbon Div	Lowell, Mass	High-modulus fibers, anodes, motor brushes, unmachined shapes.
Do	St. Marys, Pa	
Superior Graphite Co	Chicago, Ill	Powder and other.
Do	Hopkinsville, Ky	
Ultra Carbon Corp	Bay City, Mich	Other.
Union Carbide Corp., Carbon Products Div	Clarksburg, W. Va	Anodes, electrodes, unmachined shapes, motor brushes, powder, cloth, high-modulus fibers, other.
Do	Clarksville, Tenn	
Do	Columbia, Tenn	
Do	Fostoria, Ohio	
Do	Greenville, S.C	
Do	Niagara Falls, N.Y	
Do	Yabucoa, P.R	

[1]Cloth includes low-modulus fibers; electric motor brushes include machined shapes; crucibles include vessels.

Table 4.—Production of manufactured graphite in the United States, by use

Use	1981		1982	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Synthetic graphite products:				
Anodes	18,816	$42,445	8,147	$15,379
Cathodes	--	--	W	W
Cloth and fibers (low-modulus)	216	15,293	212	17,706
Crucibles, vessels, refractories	W	W	W	W
Electric motor brushes and machined shapes	W	W	W	W
Electrodes	257,938	641,709	138,960	358,186
Graphite articles	--	45,432	--	29,894
High-modulus fibers	r409	r21,759	628	31,491
Unmachined graphite shapes	17,508	32,931	14,346	41,991
Other	40,196	96,749	31,584	59,411
Total	r335,083	r896,318	193,877	554,058
Synthetic graphite powder and scrap	36,935	26,252	19,645	8,196
Grand total	r372,018	r922,570	213,522	562,254

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Other."

Table 5.—Production of graphite fibers in the United States

Year	Cloth and low-modulus fibers		High-modulus fibers		Total	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1972	56	$3,800	16	$1,820	72	$5,620
1973	r102	r6,300	46	4,750	r148	r11,050
1974	r153	r9,400	48	4,675	r201	r14,075
1975	r154	10,600	52	4,690	r206	15,290
1976	163	11,376	37	3,870	200	15,246
1977	136	8,800	49	4,330	185	13,130
1978	141	8,720	149	11,804	290	20,524
1979	169	10,089	194	13,031	363	23,120
1980	169	11,254	306	17,379	475	28,633
1981	216	15,293	r409	r21,759	r625	r37,052
1982	212	17,706	628	31,491	840	49,197

rRevised.

CONSUMPTION AND USES

Apparent consumption of natural graphite, excluding domestic production, decreased 20% to 46,000 tons. Reported consumption of natural graphite (table 6) decreased 25% in 1982 to about 36,600 tons. The three major uses of natural graphite—refractories, foundries, and steelmaking—accounted for 60% of reported consumption in 1982.

A two-part comprehensive article described the technology and costs of using different kinds of foundry mold coatings, including graphite. Graphite is suitable for use when casting iron, copper, aluminum, and also steel and magnesium under special conditions. New coating processes are under development, and the trend of the last 7 years toward ready-to-use coatings is likely to continue.[6]

Alumina-graphite was reported to be the optimal refractory material for use in a ladle shrouding system for use in continuous casting steel operations because it provides optimal thermal shock protection and erosion resistance.[7]

The use of natural graphite and graphite fiber in packings and gaskets is likely to grow, in large part because of a move by the manufacturers because of health concerns from asbestos to graphite and other materials, such as Teflon, Aramid, and fiberglass. The advantages of graphite are resistance to a wide range of pH and maintenance of strength at high temperatures.[8]

Two new developments suggested that usage of graphite fiber composites will continue to expand rapidly. The Department of Defense plans to extend its use of radar-masking stealth technology into other nonaerospace weapons; the graphite fiber composites absorb rather than reflect radar waves. Ford Motor Co. contracted with Polimotor Research Inc. for the development of a plastic engine, 90% of the components would be made of glass-fiber or graphite-fiber-reinforced composites, to be used in Ford's small cars to make them lighter and quieter.

Other new developments suggested that graphite fiber may encounter more competition in many important markets. Silicon carbide fiber and E. I. du Pont de Nemours & Co.'s Kevlar are both rapidly increasing in availability. Supermodularized metals, particularly low-cost aluminum alloys with a 30% to 50% greater rigidity, would be more capable of competing with graphite fiber composites, especially in aircraft, as could some amorphous (glassy) metals now being developed.

Table 6.—Consumption of natural graphite in the United States, by use

Use	Crystalline		Amorphous[1]		Total[2]	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1981[3]						
Batteries	W	W	W	W	1,471	$2,465
Brake linings	775	$778	2,163	$1,787	2,938	2,565
Carbon products[4]	287	545	253	453	540	998
Crucibles, retorts, stoppers, sleeves, nozzles	5,307	3,594	--	--	5,307	3,594
Foundries[5]	501	348	4,528	2,230	5,029	2,578
Lubricants[6]	1,194	1,353	2,452	1,841	3,646	3,194
Pencils	1,853	2,336	632	292	2,485	2,628
Powdered metals	331	470	130	258	461	728
Refractories	W	W	W	W	11,610	3,222
Rubber	59	77	221	95	280	172
Steelmaking	391	166	10,728	2,793	11,119	2,959
Other[7]	3,471	1,594	351	457	3,822	2,051
Withheld uses	462	855	12,620	4,832	--	--
Total[2]	14,631	12,116	34,078	15,038	48,708	27,154
1982						
Batteries	W	W	W	W	1,669	2,920
Brake linings	770	869	1,860	1,381	2,630	2,250
Carbon products[4]	201	378	204	432	405	810
Crucibles, retorts, stoppers, sleeves, nozzles	2,625	2,470	--	--	2,625	2,470
Foundries[5]	348	508	4,401	2,170	4,749	2,678
Lubricants[6]	923	1,028	1,869	1,455	2,792	2,483
Pencils	1,366	1,850	301	187	1,667	2,037
Powdered metals	269	405	150	300	419	705
Refractories	W	W	W	W	7,667	2,119

See footnotes at end of table.

Table 6.—Consumption of natural graphite in the United States, by use—Continued

Use	Crystalline Quantity (short tons)	Crystalline Value (thousands)	Amorphous[1] Quantity (short tons)	Amorphous[1] Value (thousands)	Total[2] Quantity (short tons)	Total[2] Value (thousands)
1982 —Continued						
Rubber	146	$187	120	$65	266	$252
Steelmaking	288	139	9,368	2,709	9,656	2,848
Other[7]	1,733	1,104	327	403	2,060	1,507
Withheld uses	564	1,041	8,771	3,998	--	--
Total[2]	9,233	9,979	27,371	13,100	36,604	23,078

W Withheld to avoid disclosing company proprietary data; included with "Withheld uses."
[1]Includes mixtures of natural and manufactured graphite.
[2]Data may not add to totals shown because of independent rounding.
[3]Includes revisions for 1981.
[4]Includes bearings and carbon brushes.
[5]Includes foundry facings.
[6]Includes ammunition, packings, and seed coating.
[7]Includes paints and polishes, antiknock and other compounds, soldering and/or weld, electrical and electronic products, mechanical products, magnetic tape, and small packages.

PRICES

Actual graphite prices are often negotiated between the buyer and seller, and published price quotations are given as a range of prices, such as those shown in table 7. Another source of information for imported graphite is the average customs value per ton of the different classes of imports, which can be derived from table 9. However, these imports mainly represent shipments of unprocessed graphite.

Average prices of graphite imports were little changed in 1982. Prices for crystalline flake rose from $641 per ton in 1981 to $655 per ton in 1982, up slightly. Prices for Mexican amorphous graphite rose from $45 per ton in 1981 to $54 per ton in 1982, or by 20%. Prices for all types of Sri Lankan lump graphite rose from $1,509 per ton in 1981 to $1,512 per ton in 1982, up slightly. Prices for other natural graphite (mostly fine crystalline flake and dust) dropped from $520 per ton in 1981 to $496 per ton in 1982, or by 5%.

Table 7.—Representative yearend graphite prices[1]

(Per short ton)

	1981	1982
Flake and crystalline graphite, bags:		
China	$272-$1,542	$272-$1,542
Germany, Federal Republic of	318- 2,540	318- 2,722
Madagascar	227- 635	249- 726
Norway	354- 635	272- 816
Sri Lanka	816- 2,268	544- 1,814
Amorphous, nonflake, cryptocrystalline graphite (80% to 85% carbon):		
Korea, Republic of (bags)	71- 82	82- 109
Mexico (bulk)	59- 91	77- 109

[1]F.o.b. foreign port or border.

Source: Engineering and Mining Journal. V. 183, No. 12, December 1982, p. 19.

FOREIGN TRADE

Exports of both natural and artificial graphite in 1982 decreased. Exports to Western Europe decreased while those to Venezuela increased.

Imports of natural graphite decreased 19% to 53,150 tons in 1982. China's exports of total natural and artificial graphite gained significantly, up 53% to 10,091 tons, while Canada's lost precipitously, down 78% to 996 tons in 1982.

Exports of graphite electrodes in 1982 totaled 56,054 tons valued at $103.9 million, of which 12,206 tons ($27.5 million) went to Venezuela; 6,953 tons ($17.4 million), to Argentina; 3,644 tons ($6.1 million), to Brazil; 3,026 tons ($6.5 million), to Canada; and the balance, to other destinations.

Table 8.—U.S. exports of natural and artificial graphite, by country

Country	Natural[1]		Artificial		Total	
	Quantity (short tons)	Value	Quantity (short tons)	Value	Quantity (short tons)	Value
1981:						
Canada	6,764	$2,009,707	1,456	$393,174	8,220	$2,402,881
Germany, Federal Republic of	775	614,943	823	471,391	1,598	1,086,334
Italy	766	282,952	406	169,480	1,172	452,432
Japan	167	197,743	846	614,981	1,013	812,724
Mexico	848	321,476	633	195,562	1,481	517,038
Netherlands	13	15,730	796	325,566	809	341,296
United Kingdom	360	145,473	314	151,513	674	296,986
Venezuela	554	309,369	20	53,509	574	362,878
Other[2]	1,097	535,444	1,973	1,096,227	3,070	1,631,671
Total	11,344	4,432,837	7,267	3,471,403	18,611	7,904,240
1982:						
Canada	5,284	1,605,612	1,465	237,284	6,749	1,842,896
Germany, Federal Republic of	254	167,653	630	249,142	884	416,795
Italy	76	31,156	53	27,564	129	58,720
Japan	490	448,907	481	592,525	971	1,041,432
Mexico	1,080	374,829	347	145,537	1,427	520,366
Netherlands	12	3,629	5	5,093	17	8,722
United Kingdom	386	208,950	208	148,491	594	357,441
Venezuela	1,723	631,109	42	27,361	1,765	658,470
Other[2]	1,030	626,902	2,416	1,077,739	3,446	1,704,641
Total	10,335	4,098,747	5,647	2,510,736	15,982	6,609,483

[1]Amorphous, crystalline flake, lump or chip, and natural, not elsewhere classified.
[2]Includes 41 other recipient countries to which varying, but lesser, tonnages of natural and/or artificial graphite were exported.

Table 9.—U.S. imports for consumption of natural and artificial graphite, by country

Country	Natural						Artificial[2]		Total[3]	
	Crystalline flake		Crystalline lump, chip, or dust		Other natural crude and refined[1]					
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1980	7,188	$4,203	99	$48	50,343	$6,728	3,688	$4,787	61,318	$15,765
1981:										
Australia	--	--	--	--	12	6	(4)	2	12	8
Austria	--	--	--	--	17	72	--	--	17	72
Belgium-Luxembourg	18	8	--	--	--	--	--	--	18	8
Brazil	4,606	3,159	--	--	1,755	1,170	232	161	6,593	4,490
Canada	1,126	427	--	--	3,124	1,239	347	98	4,597	1,764
China	1,536	796	--	--	5,042	2,371	--	--	6,578	3,167
Comoros	40	23	--	--	--	--	--	--	40	23
Dominican Republic	--	--	--	--	--	--	5	52	5	52
France	537	286	--	--	166	84	--	--	703	370
Germany, Federal Republic of	68	81	(4)	1	1,005	673	82	126	1,155	881
India	386	232	--	--	118	108	--	--	504	340
Japan	14	12	--	--	317	337	210	1,414	541	1,763
Madagascar	1,955	1,561	--	--	1,133	592	--	--	3,088	2,153
Mexico	287	206	--	--	39,184	2,576	--	--	39,471	2,782
Netherlands	--	--	--	--	(4)	1	(4)	1	(4)	2
New Zealand	--	--	--	--	--	--	(4)	4	(4)	4
Norway	36	15	--	--	563	289	--	--	599	304
South Africa, Republic of	81	44	--	--	161	82	--	--	242	126
Sri Lanka	304	421	--	--	1,167	1,799	--	--	1,471	2,220
Switzerland	--	--	--	--	4	7	2,173	3,049	2,177	3,056
Taiwan	--	--	--	--	401	205	--	--	401	205
U.S.S.R	--	--	--	--	341	132	--	--	341	132
United Kingdom	--	--	--	--	159	78	--	--	159	78
Total[3]	10,991	7,274	(4)	1	54,668	11,819	3,049	4,905	68,708	23,998

See footnotes at end of table.

Table 9.—U.S. imports for consumption of natural and artificial graphite, by country —Continued

Country	Natural						Artificial[2]		Total[3]	
	Crystalline flake		Crystalline lump, chip, or dust		Other natural crude and refined[1]					
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1982:										
Australia	--	--	--	--	(4)	$1	(4)	$3	(4)	$4
Austria	--	--	--	--	9	5	--	--	9	5
Brazil	3,794	$2,918	--	--	1,033	677	--	--	4,827	3,595
Canada	2	3	--	--	276	27	718	233	996	263
China	4,003	2,243	--	--	5,470	2,153	618	217	10,091	4,613
Denmark	--	--	--	--	(4)	(4)	--	--	(4)	(4)
Finland	--	--	--	--	18	10	--	--	18	10
France	55	23	--	--	46	30	--	--	101	53
Germany, Federal Republic of	109	202	--	--	814	682	22	137	945	1,021
Hong Kong	--	--	--	--	551	210	--	--	551	210
India	211	130	40	$41	161	161	--	--	412	332
Italy	--	--	--	--	1	3	--	--	1	3
Japan	130	125	--	--	69	156	286	1,997	485	2,278
Madagascar	2,467	1,412	--	--	1,229	579	--	--	3,696	1,991
Mexico	--	--	--	--	31,289	2,356	(4)	(4)	31,289	2,356
Netherlands	--	--	--	--	10	8	23	58	33	66
Norway	--	--	--	--	72	44	--	--	72	44
Singapore	--	--	--	--	--	--	19	29	19	29
South Africa, Republic of	--	--	--	--	223	99	--	--	233	99
Sri Lanka	--	--	--	--	727	1,099	--	--	727	1,099
Sweden	--	--	--	--	63	135	--	--	63	135
Switzerland	--	--	--	--	(4)	1	1,653	2,360	1,653	2,361
Taiwan	--	--	--	--	151	91	--	--	151	91
United Kingdom	--	--	--	--	(4)	1	(4)	2	(4)	3
Zimbabwe	--	--	--	--	116	49	--	--	116	49
Total[3]	10,771	7,056	40	41	42,339	8,579	3,341	5,036	56,491	20,712

[1]Includes lump graphite from Sri Lanka, and 38,110 tons of amorphous graphite worth $1.72 million in 1981 and 30,340 tons of the same worth $1.64 million in 1982 from Mexico. The balance of Mexico and the remaining countries were fine crystalline flake and dust.
[2]Includes only that received in raw material form; excludes products made of graphite.
[3]Data may not add to totals shown because of independent rounding.
[4]Less than 1/2 unit.

Table 10.—U.S. imports for consumption of graphite electrodes, by country

Country	1981		1982	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Canada	5,981	$2,200	3,578	$2,129
China	--	--	730	1,048
Germany, Federal Republic of	6,158	5,600	3,100	3,187
Italy	6,387	7,400	3,686	4,174
Japan	21,421	42,100	18,462	39,405
Other	6,404	7,500	806	1,250
Total	46,351	64,800	30,362	51,193

WORLD REVIEW

World production of natural graphite decreased slightly. Markets for graphite weakened throughout the year while competition among sellers grew stronger. In addition to the activity in the following countries, some minor mining activity may have occurred in Australia and Spain.

Brazil.—Some 1979 statistics for graphite became available. Measured graphite reserves totaled about 20 million tons, and indicated and inferred reserves totaled about 16 million tons each. These reserves, averaging 17.74% carbon, are almost all located at Pedra Azul in Minas Gerais

State. About two-thirds of Brazilian graphite production was consumed domestically, 54% in steelmaking, 18% in refractories, 18% in foundry mold washes and pencils, and the balance in other uses.

Canada.—Orrwell Energy Corp., Ltd., completed more drilling at its Mont Laurier, Quebec, property, for a total of 67 holes with a total footage of 15,596 feet, and stated that its ore reserves were about 1 million tons. Several other deposits were nearby, some of which may be a higher grade and with coarser flake. Orrwell sold $400,000 worth of its shares in a private placement to National Resources Trading, Inc., of New York, which will manage any operations and market and sell any product. Metallurgical test work showed 88% recovery of a 92% carbon product by standard flotation methods. Orrwell contracted with the Ontario Research Foundation for an innovative flowsheet using air separation followed by electrostatic cleaning of the concentrate.

Two private groups located adjacent crystalline flake graphite deposits in Ryerson Township, near Huntsville, Ontario. Geophysical work and six drill holes revealed several thousand feet of mineralization along the strike that is often several hundred feet wide. Arrangements have been made for bulk sampling and the preparation of a beneficiation flowsheet.

China.—The Chinese announced the discovery of a graphite deposit near Jixi City in Heilongjiang Province. Said to be the largest graphite deposit of the 14 discovered so far in the Province, reserves were estimated to be over 300 million tons of high-grade ore. The Ministry of Foreign Economic Relations and Trade announced a 5,000-ton expansion of capacity of a graphite mine near Hohhot, located in another important graphite-producing Province, Inner Mongolia.

The authorities in Gansu Province were reported to be seeking foreign markets for graphite electrodes they had in oversupply.

France.—Union Carbide withdrew from its joint venture with Société Nationale Elf Aquitaine and Toray Industries, Inc., to build a graphite-fiber plant that was to come onstream in late 1984. The other two firms decided to go ahead, in spite of concern about an oversupply increased by another joint venture that had scheduled a French plant to come onstream at the same time.[9]

Japan.—The graphite-using refractory industry had been expanding rapidly in the last several years; for example, carbon-magnesia shaped refractories grew from 43,000 tons in 1980 to 67,000 tons in 1981. The application of new steelmaking technology, such as continuous casting, has required more efficient use of refractories and led to the production of new refractories that can withstand more extreme conditions. This is likely to continue, and some new graphite-bearing refractories now being developed are likely to be used.[10]

Korea, Republic of.—A large decline in output of crystalline flake graphite in 1981 was caused by a great reduction in output of the Pyung-Taek Mine. Domestic consumption of crystalline flake graphite was 1,008 tons in 1981, up from 355 tons in 1980. Domestic consumption of amorphous graphite was 3,960 tons in 1981, down from 16,370 tons in 1980.

Mexico.—The reserves of the crystalline flake graphite mine of Grafito de México S.A. de C.V. totaled 4.4 million tons averaging 4% graphite, or about a 60-year supply of ore at present rates of production; other resources are minor. About one-quarter of their product was a medium-to-coarse flake graphite "Type A" containing 82% to 85% carbon with 63% of the product being retained on a 48-mesh screen, and 4% on a 200-mesh screen. The balance of the product was a fine flake graphite "Type B" containing 93% to 95% carbon with 3% of the product being retained on a 48-mesh screen, 27% on a 100-mesh screen, 38% on a 200-mesh screen, and the remainder on finer screens.

Reserves of the amorphous graphite mines in Sonora are reported as follows: Lourdes Mine, 2.2 million tons; Moraguirre-Superior Mines, 1.1 million tons; and the new prospects and/or mines near Tonichi, 2.2 million tons. Resources are immense and are scattered all over southern Sonora. The Sonoran mines are probably easily capable of doubling their 1981-82 production, given the demand. The Lourdes Mine of Grafitos Mexicanos, S.A., is the largest and is capable of producing more than one-half of the total Mexican graphite production. The concentration of graphite production into a small area near the Lourdes Mine, 50 miles south and east of Hermosillo, has been broken by the paving of the road beyond Tonichi. This allowed Grafitos Mexicanos to open two medium-size mines 15 miles east of Tonichi near Onavas and truck the graphite to its plant at Torres; it also opened a small mine near Cuidad Obregon. All the mines have very rich ore and very little waste is produced. No methane or explosive dust problems exist.

Recent Mexican internal consumption of amorphous graphite has totaled 7,200 tons to 9,600 tons per year, mostly for carbon raising in steel. Good potential was evident for future expansion of this amount.

Pakistan.—Large graphite deposits with total reserves of at least 1.6 million tons were discovered along the Neelam River in northern Pakistan. The Pakistan Council of Scientific and Industrial Research set up a graphite pilot plant at Lahore and produced concentrates containing 95% carbon and suitable for use in foundries. A commercial-scale plant producing 5.5 tons per day of refined graphite was scheduled to come onstream at Kel in late 1983, at a cost of $385,000.[11]

Sweden.—Kema Nord Industrial Chemicals formed a joint venture with Superior Graphite Co. to produce Superior's Desulco, a synthetic graphite powder used as a carbon raiser in iron and steel, in Sweden, for the European market.

Taiwan.—Formosa Plastics Corp. decided to build a graphite-fiber plant at its Jen-Wu plant complex near Kaohsiung, following successful production of its precursor raw material, acrylic fiber.[12]

Yugoslavia.—The Tvornica electrode and ferroalloy works was constructing a 3,000-ton-per-year-capacity graphitizing plant for electrodes at Sibenik in Croatia.[13]

Table 11.—Graphite: World production, by country[1]

(Short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Argentina	9	11	6	2	2
Austria	44,645	44,664	40,454	26,243	26,500
Brazil (marketable)[3]	11,417	[r]11,979	23,473	19,289	16,500
Burma[4]	309	295	482	1,568	250
China[e]	88,000	[r]200,000	176,000	176,000	176,000
Czechoslovakia[e]	49,600	49,600	49,600	49,600	49,600
Germany, Federal Republic of[5]	7,034	4,047	6,270	9,024	8,800
India (mine)[6]	70,310	58,225	60,391	62,004	48,500
Italy	4,528	4,522	4,362	3,897	3,850
Korea, North[e]	22,000	28,000	28,000	28,000	28,000
Korea, Republic of:					
Amorphous	59,288	59,789	65,209	37,533	38,600
Crystalline flake	2,793	2,704	1,575	928	880
Madagascar	18,326	15,699	13,506	11,104	11,000
Mexico:					
Amorphous	57,611	56,086	48,289	46,268	37,500
Crystalline flake	--	--	[e]150	[e]350	500
Norway	12,292	13,109	11,471	9,552	8,200
Romania	[r e]12,500	13,670	13,800	[r e]13,800	13,800
Sri Lanka	11,581	10,364	8,591	8,348	8,400
South Africa, Republic of	643	434	--	--	--
Thailand	25	--	2,286	1,984	1,650
U.S.S.R.[e]	110,000	110,000	110,000	115,000	115,000
United States	W	W	--	--	W
Zimbabwe	[r e]6,234	6,324	8,141	12,366	13,200
Total	[r]589,145	[r]689,522	672,056	632,860	606,732

[e]Estimated. [p]Preliminary. [r]Revised. W Withheld to avoid disclosing company proprietary data.
[1]Table includes data available through May 5, 1983.
[2]In addition to the countries listed, Namibia may have produced graphite during the period covered by this table, but output is unreported, and available general information is inadequate for formulation of reliable estimates of output levels.
[3]Does not include the following quantities sold directly without beneficiation, in short tons: 1978—947; 1979—93,840; 1980—6,600; 1981—17,988; 1982—not available.
[4]Data are for fiscal year beginning Apr. 1 of that stated.
[5]Data presented represent estimated marketable product derived from raw graphite mined indigenously, assuming that marketable output equals one-half of officially reported raw graphite production.
[6]Indian marketable production is about 30% of mine production.

TECHNOLOGY

The Bureau of Mines was actively considering the initiation of a research project to remove supply constraints on natural crystalline flake graphite. In addition to considering the possibility of developing a process to synthesize coarse crystalline flake graphite from other carbon materials, it was considering working on establishing the parameters for substitution using various combinations of coarse crystalline flake, fine crystalline flake and dust, graphite fiber, and synthetic graphite powder, for use in steel-related refractories. The physical and chemical properties of samples of these graphite materials are now being determined.

A recent study on the use of crystalline flake graphite in refractories recommended that the characterization of flake graphites should be improved, the rôle of differing flake morphologies be delineated, the understanding of the graphite-oxide phase bonding be increased, and the mode of attack on graphite by fluxes and slags be explored. Graphite is used in refractories to resist slag attack, to impart electrical conductivity when desired, and to greatly improve thermal shock resistance, while other components increase resistance to attack by metal and air. These properties of crystalline flake graphite, particularly its almost unique thermal shock resistance, make it desirable to use in spite of the difficulties encountered in manufacturing the refractories caused by incompatibility in chemical bond type and morphological differences between graphite and the other materials.[14]

Recent research on carbyne, a reported polymorph of carbon in addition to graphite and diamond, has indicated that it may not exist. The electron diffraction patterns characteristic of carbyne given in earlier works could have been caused by minor quantities of sheet silicate minerals such as nontronite clay and muscovite mica. In some instances, poorly ordered graphite may have been misidentified as a carbyne.[15]

A recent symposium on intercalated graphite compounds disclosed that the structure of graphite-bromine compounds was becoming better understood, new classes of copper nitrate-graphite and zinc nitrate-graphite compounds were being discovered, and the use of intercalated graphite in lubricants, catalysts, and batteries was increasing. Matsushita Electric Co. of Japan has begun manufacturing a lithium anode-graphite intercalation compound cathode storage battery. A self-lubricating nozzle and mold for extruding stainless steel rods in continuous casting processes that uses an intercalated graphite fluoride compound as lubricant was reported to be quite efficient and practical.[16]

The lubrication-related properties and high temperature stability of composites made with graphite materials and a partially fluorinated polyimide were tested. The best properties were found in composites made with graphite fibers, then ones made with (ungraphitized) carbon fiber, and finally ones made with powdered graphite fluoride. The composites tested contained 50% by weight of the fibers and 10% by weight of the graphite fluoride powder.[17]

A preliminary study of environmental concerns that might arise from the utilization, recycling, and combustion of composite materials such as graphite fiber composite was made for the Environmental Protection Agency (EPA). The study was expected to allow EPA to plan further work, if any, on environmental concerns associated with composites.[18]

It was demonstrated in a report that substantial energy savings can result from substituting fiber-reinforced composites, including graphite fiber composites, for aluminum and steel in automobiles. The energy savings derive from the lesser amounts of materials needed to make the vehicle and the lesser amounts of fuel needed to power it. Total calculated energy requirements to build and operate the automobile were 211.6 x 10^3 British thermal units (Btu) for steel, 174.3 x 10^3 Btu for aluminum, and only 126.7 x 10^3 Btu for fiber composites.[19]

A Japanese researcher announced the development of a cheap method of making graphite fiber from benzene. The process involves heating benzene to 1,100° C, driving off hydrogen and depositing carbon on a metal catalyst in highly ordered strands, and then heat-treating and graphitizing the strands at temperatures as high as 3,000° C. Showa Denko Co. is reportedly planning to produce and market these fibers soon.[20]

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Gypsum

By J. W . Pressler[1]

The gypsum industry, impacted by the 3-year recession and downtrend in housing demand, with only 1.1 million housing (public and private) unit starts in 1982, ended the year with the lowest shipments of gypsum wallboard since 1975, 13.1 billion square feet, a decrease of 5% compared with 1981 shipments. Output of crude gypsum and calcined gypsum also decreased. Sales of gypsum products in 1982 decreased 8% to 17.4 million short tons valued at $1.1 billion. Imports of crude gypsum decreased 12% in 1982 to 6.7 million tons. Total value of gypsum exports decreased 17% to $30.0 million.

Domestic Data Coverage.—Domestic production data for gypsum are developed by the Bureau of Mines from a survey of U.S. gypsum operations. Of the 131 operations to which the annual survey request was sent, 100% responded, representing 100% of the total production shown in tables 1 and 2.

Table 1.—Salient gypsum statistics

(Thousand short tons and thousand dollars)

	1978	1979	1980	1981	1982
United States:					
Active mines and plants[1]	116	113	114	113	109
Crude:					
Mined	14,891	14,630	12,376	11,497	10,538
Value	$92,726	$99,868	$103,059	$98,101	$89,131
Imports for consumption	8,308	7,773	7,365	7,593	6,718
Byproduct gypsum sales	669	828	663	696	697
Calcined:					
Produced	14,041	14,543	11,848	11,687	11,243
Value	$387,010	$442,157	$270,324	$243,140	$196,488
Products sold (value)	$1,248,013	$1,391,993	$1,241,949	$1,196,236	$1,121,775
Exports (value)	$19,804	$22,388	$27,222	$35,434	$29,550
Imports for consumption (value)	$63,882	$65,079	$51,880	$51,720	$53,646
World: Production	[r]85,759	[r]88,537	85,283	[p]84,076	[e]80,616

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Each mine, calcining plant, or combination mine and plant is counted as one establishment; includes plants that sold byproduct gypsum.

DOMESTIC PRODUCTION

The United States remained the world's leading producer of gypsum, accounting for 13% of the total world output.

In 1982, 44 companies mined crude gypsum at 70 mines in 22 States. Production decreased 8% compared with that of 1981. Leading producing States were Texas, Oklahoma, Iowa, and California. These four States produced more than 1 million tons each and together accounted for 52% of total domestic production. Stocks of crude ore at mines and plants at yearend 1982 were 4.0 million tons.

Leading companies in 1982 were United States Gypsum Co., 12 mines; National Gypsum Co., 7 mines; Georgia-Pacific Corp., 6 mines; Celotex Div. of Jim Walter Corp., and Genstar Building Materials Co., 3 mines each; and Weyerhaeuser Co., 1 mine. These 6 companies, operating 32 mines, produced 78% of the total crude gypsum in 1982.

Leading individual mines in 1982 were United States Gypsum's Sweetwater Mine, Nolan County, Tex.; United States Gypsum's Plaster City Mine, Imperial County, Calif.; United States Gypsum's Shoals Mine, Martin County, Ind.; Georgia-Pacific's Acme Mine, Hardeman County, Tex.; Weyerhaeuser's Briar Mine, Howard County, Ark.; United States Gypsum's Southard Mine, Blaine County, Okla.; and National Gypsum's Shoals Mine, Martin County, Ind. These seven mines accounted for 35% of the national total. Average output per mine in 1982 for the 70 U.S. mines decreased 8% to 150,500 tons.

In 1982, 13 companies calcined gypsum at 69 plants in 29 States. Output decreased 4% in tonnage and 19% in value and was the lowest since 1976. Leading States were Texas, California, Iowa, and New York. These 4 States, with 21 plants, accounted for 37% of the national output.

Leading companies were United States Gypsum, 21 plants; National Gypsum, 18 plants; Georgia-Pacific, 9 plants; Genstar, 6 plants; and Celotex Div. of Jim Walter, 4 plants. These 5 companies, operating 58 plants, accounted for 86% of the national output in 1982.

Leading individual plants were United States Gypsum's Plaster City plant, Imperial County, Calif.; United States Gypsum's Sweetwater plant, Nolan County, Tex.; United States Gypsum's Shoals plant, Martin County, Ind.; Weyerhaeuser's Briar plant, Howard County, Ark.; United States Gypsum's Jacksonville plant, Duval County, Fla.; United States Gypsum's Stony Point plant, Rockland County, N.Y.; Georgia-Pacific's Acme plant, Hardeman County, Tex.; United States Gypsum's Baltimore plant, Baltimore County, Md.; United States Gypsum's Fort Dodge plant, Webster County, Iowa; and National Gypsum's Shoals plant, Martin County, Ind. These 10 plants accounted for 32% of the national production. Average calcine production for the 69 U.S. plants in 1982 was 162,900 tons, virtually the same as the 162,300 tons per plant in 1981.

In 1982, the following companies sold a total of 697,000 tons of byproduct gypsum, valued at $5.5 million, for agricultural use and gypsum wallboard manufacturing: Occidental Petroleum Corp., Allied Chemical Corp., and J. R. Simplot Co., all in California; Occidental Petroleum in Florida; American Cyanamid Co. in Georgia; Glidden Pigments Div. of SCM Corp. in Maryland; and Texasgulf Inc. in North Carolina. For the first time in the United States, byproduct gypsum was mixed with natural gypsum and commercially used in the manufacture of wallboard. United States Gypsum's Baltimore, Md., plant used substantial quantities of byproduct gypsum obtained from Glidden Pigments' plant in Baltimore.

One new gypsumboard plant and several plant expansions and improvements increased the national production capacity an additional 360 million square feet per year, but several plants were closed during the year. Consequently, the immediately available yearend capacity of operating gypsumboard plants in the United States was reduced 3% to 18.5 billion square feet per year. Total 1982 gypsumboard production in the United States was 13.1 billion square feet, indicating a 71% utilization of operating capacity.

National Gypsum opened its new Harper open pit gypsum mine in Kimble County, Tex. Most of the gypsum rock was used in its Rotan wallboard plant, with some sold to cement companies for use as a set retarder.

Windsor Gypsum Co. was installing a new gypsum wallboard plant in McQueeney, Guadelupe County, Tex., with a capacity of 500 million square feet per year. It was estimated to be onstream by May 1983.

In 1982, several gypsum wallboard plants were closed or operated part time because of depressed housing demand and the recession. National Gypsum closed its Waukegan, Ill., and Clarence Center, N.Y., plants. United States Gypsum closed and mothballed its plant in Philadelphia, Pa., and closed its gypsum plant in Ottawa County, Ohio. Genstar closed its Fremont, Calif., and Camden, N.J., plants. At yearend, United States Gypsum bought the Fremont plant from Genstar, intending to reopen it when market demand improved. Domtar Gypsum America Inc., which had established a new wallboard plant in Tacoma, Wash., in 1981, closed the plant in 1982 because of poor demand. Western Gypsum Co. of Santa Fe, N. Mex., closed its Rosario Mine and wallboard plant part of the year.

The Grand Rapids, Mich., mine and wallboard plant, purchased by Domtar Construction Materials Div. of Domtar Inc., Montreal, Canada, remained dormant during the year. The Longworth Mine and wallboard plant of Southwest Gypsum Co., formerly Three Rivers Gypsum Inc., in Fisher County, Tex., was dormant during the year and up for sale.

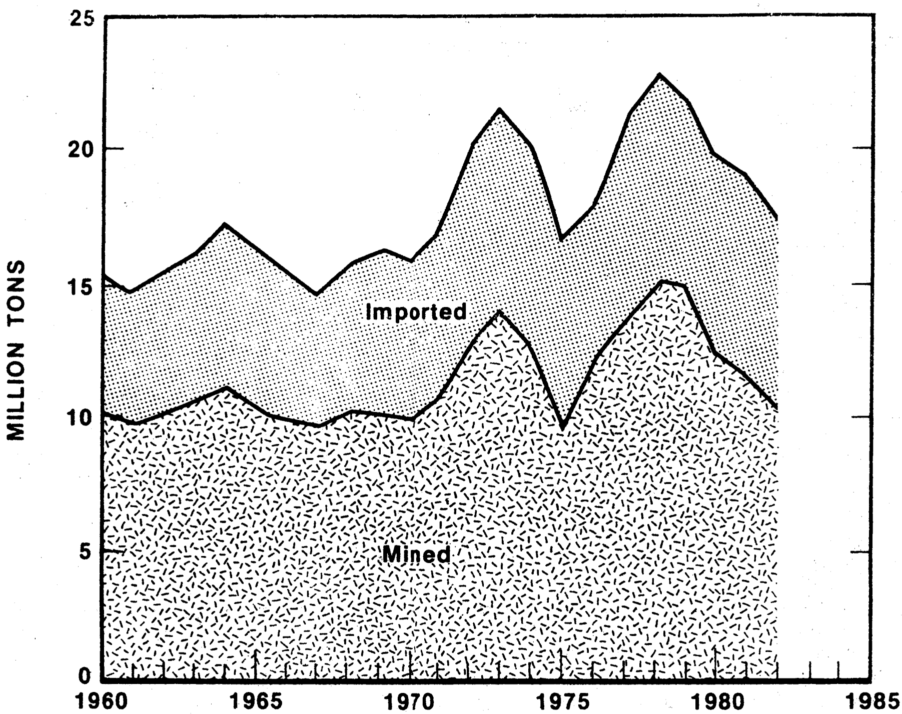

Figure 1.—Supply of crude gypsum in the United States.

Table 2.—Crude gypsum mined in the United States, by State

State	1981			1982		
	Active mines	Quantity (thousand short tons)	Value (thousands)	Active mines	Quantity (thousand short tons)	Value (thousands)
Arizona	4	213	$2,594	4	175	$1,205
Arkansas, Kansas, Louisiana	5	1,059	7,090	5	1,085	8,152
California	8	1,456	13,948	10	1,088	10,614
Colorado	6	203	2,346	5	184	1,571
Idaho, Montana, South Dakota, Washington	5	97	915	5	80	810
Indiana, New York, Virginia	4	1,371	10,904	4	1,382	11,601
Iowa	6	1,383	12,706	6	1,177	11,345
Michigan	4	1,066	6,762	4	682	5,150
Nevada	4	778	6,914	4	656	4,523
New Mexico	3	166	2,256	3	198	887
Ohio	1	148	1,566	1	109	1,335
Oklahoma	5	1,177	9,870	5	1,254	10,089
Texas	7	1,783	14,900	7	1,954	16,681
Utah	5	300	2,705	4	231	2,363
Wyoming	3	299	2,625	3	283	2,805
Total	70	[1]11,497	98,101	70	10,538	89,131

[1]Data do not add to total shown because of independent rounding.

Table 3.—Calcined gypsum produced in the United States, by State

State	1981 Active plants	1981 Quantity (thousand short tons)	1981 Value (thousands)	1982 Active plants	1982 Quantity (thousand short tons)	1982 Value (thousands)
Arizona, Colorado, New Mexico, Utah	6	470	$9,847	6	513	$7,383
Arkansas, Illinois, Indiana, Kansas, Louisiana, Oklahoma	12	2,277	45,337	12	2,226	35,787
California	7	1,331	29,719	7	1,172	22,667
Delaware, Maryland, North Carolina, Virginia	6	1,192	25,624	6	1,182	20,857
Florida	3	637	13,627	3	717	14,231
Georgia	3	613	13,612	3	539	11,363
Iowa	5	932	18,167	5	847	13,475
Massachusetts, New Hampshire, New Jersey	5	658	14,267	4	576	11,399
Michigan	3	321	6,248	3	245	3,915
Montana, Washington, Wyoming	5	358	7,844	5	347	8,997
Nevada	3	518	9,846	3	499	7,491
New York	5	839	18,777	4	840	13,480
Ohio	3	288	6,030	3	213	5,128
Texas	6	1,254	24,197	5	1,326	20,318
Total[1]	72	11,687	243,140	69	11,243	196,488

[1]Data may not add to totals shown because of independent rounding.

CONSUMPTION AND USES

Apparent consumption, production plus net imports, of crude gypsum in 1982 decreased 10% to 17.1 million tons. Net imports provided 38% of the crude gypsum consumed. Apparent consumption of calcined gypsum decreased 4% to 11.1 million tons.

Yearend stocks of crude gypsum at mines and calcining plants were 4.0 million tons. Of this, 63% was at calcining plants in coastal States.

Of the total gypsum products sold or used in 1982, 4.5 million tons, 26%, was uncalcined. Of the total uncalcined gypsum, 68% was used for portland cement and 29% was used in agriculture. Leading sales regions for gypsum used in cement were the West South-Central, South Atlantic, and West North-Central; these three regions accounted for 56% of the total. For agricultural gypsum, the Pacific region accounted for 63% of total sales.

Of the total calcined gypsum in 1982, 95% was used for prefabricated products and 5% for industrial and building plasters. Of the prefabricated products, based upon surface square feet, 69% was regular wallboard, 21% was fire-resistant Type X wallboard, and 7% was lath, veneer base, sheathing, and predecorated wallboard. Of the regular wallboard, 81% was 1/2 inch and 11% was 5/8 inch. The leading sales regions for prefabricated products were the South Atlantic, West South-Central, and Pacific, accounting for 54% of the total.

Table 4.—Gypsum products (made from domestic, imported, and byproduct gypsum) sold or used in the United States, by use

(Thousand short tons and thousand dollars)

Use	1981 Quantity	1981 Value	1982 Quantity	1982 Value
Uncalcined:				
Portland cement	3,634	41,530	3,067	35,685
Agriculture[1]	1,525	20,736	1,301	16,951
Fillers and miscellaneous	113	4,891	123	5,768
Total[2]	5,273	67,157	4,491	58,404
Calcined:				
Industrial plaster	360	29,689	358	30,953
Building plaster:				
Regular base coat	238	16,984	187	15,512
Poured gypsum cement and concrete	60	4,303	51	4,347
Veneer plaster	75	8,706	66	8,628
Gaging plaster and Keene's cement	26	2,730	25	2,826
Other	(3)	40	(3)	34
Total[2]	398	32,764	329	31,347
Prefabricated products[4]	12,927	1,066,626	12,222	1,001,071
Total calcined[2]	13,686	1,129,078	12,909	1,063,371
Grand total[2]	18,958	1,196,236	17,400	1,121,775

[1]Includes 696,245 tons of byproduct gypsum in 1981 and most of 697,201 tons in 1982.
[2]Data may not add to totals shown because of independent rounding.
[3]Less than 1/2 unit.
[4]Includes weight of paper, metal, or other materials, and some byproduct gypsum in 1982.

Table 5.—Prefabricated gypsum products sold or used in the United States

Product	1981 Thousand square feet	1981 Thousand short tons[1]	1981 Value (thousands)	1982 Thousand square feet	1982 Thousand short tons[1]	1982 Value (thousands)
Lath:						
3/8 inch	56,980	44	$4,978	37,377	29	$3,360
1/2 inch	14,970	14	1,178	2,105	2	174
Total	71,950	58	6,156	39,482	31	3,534
Veneer base	328,213	339	24,607	285,045	291	21,299
Sheathing	199,405	184	18,844	265,128	247	25,654
Regular gypsumboard:						
3/8 inch	651,596	531	46,024	560,921	459	38,627
1/2 inch	8,171,442	7,269	570,657	7,346,516	6,522	496,846
5/8 inch	963,834	873	83,832	1,020,294	925	83,158
1 inch	53,672	85	7,889	21,177	23	3,115
Other[2]	118,527	121	9,561	128,348	131	10,148
Total[3]	9,959,071	8,879	717,962	9,077,256	8,061	631,893
Type X gypsumboard	2,778,482	3,107	238,086	2,810,491	3,077	233,377
Predecorated wallboard	133,040	126	34,915	161,070	152	45,400
5/16-inch mobile home board	269,213	220	22,981	436,298	352	37,868
Other	14,880	15	3,073	11,131	11	2,048
Grand total[3]	13,754,254	12,927	1,066,626	13,085,901	12,222	1,001,071

[1]Includes weight of paper, metal, or other material.
[2]Includes 1/4-, 7/16-, and 3/4-inch gypsumboard.
[3]Data may not add to totals shown because of independent rounding.

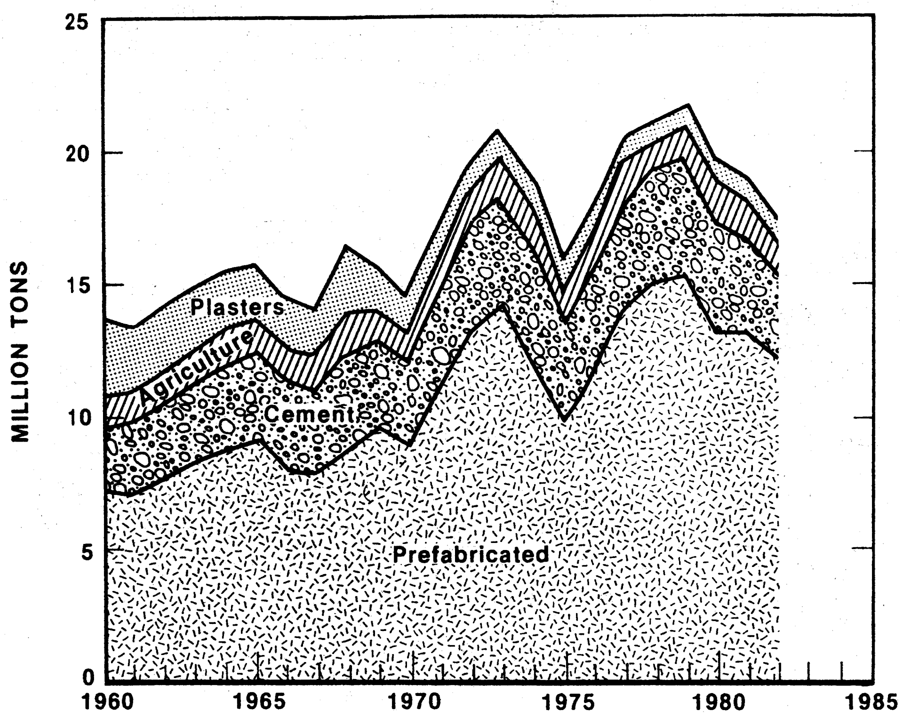

Figure 2.—Sales of gypsum products, by use.

ENERGY

Although the gypsum industry's national operational capacity remained low, 71% for 1982, efficient production scheduling, superior insulation, and energy-saving processing equipment such as one-step drying and calcining continued to approximate the same utilization of energy per unit of wallboard as in the past few years. In 1982, British thermal unit consumption per thousand square feet of gypsum wallboard sales was 2.63 million, the same as that of 1981.

As reported by the Gypsum Association, fuel sources for the gypsum industry in 1982 were natural gas, 81.2%; electricity, 6.3%; propane, 1.0%; No. 2 fuel oil, 4.3%; No. 4 and No. 6 fuel oil, 3.6%; and coal, 3.6%.

PRICES

The average value of crude gypsum decreased 1% to $8.46 in 1982. The average value of calcined gypsum decreased significantly, 16%, to $17.48. The average value of byproduct gypsum sold decreased 17% to $7.90 in 1982.

The average value of gypsum products sold or used decreased 1% to $64.47 per ton in 1982. In 1982, prefabricated products were valued at $81.91 per ton, industrial plasters at $86.46 per ton, building plaster at $95.28 per ton, and uncalcined products at $13.00 per ton.

Quoted prices for gypsum products were published monthly in Engineering News-Record. Prices at yearend 1982 showed a wide range, based on truck lots delivered to the job. Regular 1/2-inch wallboard prices ranged from $79 per thousand square feet at Dallas to $170 at Boston. Average price at yearend for 19 cities was $120.70 per thousand square feet, with some minor discounts for prompt settlement. Prices for building plaster in 1982 ranged from $120 per ton at Los Angeles to $183 at New York.

FOREIGN TRADE

In 1982, the gypsum industry continued to rely on imports of crude gypsum rock for a significant fraction, 38%, of apparent consumption. Imports of crude gypsum were principally from Canada, 79%; Mexico, 17%; and Spain, 4%. Imports decreased 12% compared with that of 1981 to 6.7 million tons. Most of the imported crude gypsum was mined by subsidiaries of U.S. companies in Canada and Mexico. For 1982, total value of gypsum and gypsum products imported was $53.6 million, an increase of 4% compared with that of 1981. In 1982, 168 million square feet of wallboard was imported from Canada, 45% more than in 1981. Total value of gypsum product exports to all countries was $30 million in 1982, a 17% decrease compared with the 1981 value.

Table 6.—U.S. exports of gypsum and gypsum products

(Thousand short tons and thousand dollars)

Year	Crude, crushed, or calcined		Other manufactures, n.e.c. (value)[1]	Total value
	Quantity	Value		
1980	88	11,774	15,448	27,222
1981	157	14,590	20,844	35,434
1982	123	13,319	16,231	29,550

[1]Includes gypsum or plaster building boards and lath (TSUSA 245.7000) and articles, n.s.p.f., of plaster of Paris (TSUSA 512.4500).

Table 7.—U.S. imports for consumption of gypsum and gypsum products

(Thousand short tons and thousand dollars)

Year	Crude		Ground or calcined		Alabaster manufactures[1] (value)	Plasterboard[2] (value)	Other manufactures, n.s.p.f.[3] (value)	Total value
	Quantity	Value	Quantity	Value				
1980	7,365	35,664	2	231	1,959	10,958	3,068	51,880
1981	7,593	39,266	2	339	1,169	8,419	2,527	51,720
1982	6,718	35,981	2	304	1,120	13,556	2,685	53,646

[1]Includes imports of jet manufactures, which are believed to be negligible.
[2]Includes gypsum or plaster building boards and lath (TSUSA 245.7000).
[3]Comprised of "articles, n.s.p.f., of plaster of Paris, with or without reinforcement" (TSUSA 512.3100, 512.3500, 512.4100, and 512.4400).

Table 8.—U.S. imports for consumption of crude gypsum, by country

(Thousand short tons and thousand dollars)

Country	1981		1982	
	Quantity	Value	Quantity	Value
Canada[1]	5,436	27,497	5,283	28,887
Dominican Republic	83	918	28	350
Ghana	12	55	--	--
Jamaica	66	847	14	163
Mexico	1,696	8,112	1,124	4,842
Spain	300	1,818	269	1,716
Other	(2)	19	(2)	23
Total	7,593	39,266	6,718	35,981

[1]Includes anhydrite.
[2]Less than 1/2 unit.

WORLD REVIEW

The principal world market for gypsum and anhydrite was in the construction industry, which has been severely influenced by the last 3 recessionary years of 1980-82. Much of the gypsum industry has been consolidating and awaiting improved economic times. Some parts of the world were showing growth because of industrialization. Gypsum was more common than anhydrite in commercial utilization. Its chemical properties permit the calcination and rehydration required in the production of wallboard, plaster, and plaster products. Gypsum occurs widely in surface outcrops as an altered and hydrated product of its underlying associated anhydrite.

Production from small deposits in the developing countries has been intermittent and often unreported. Total world production figures might be somewhat low because, in many countries, significant mine production was consumed captively in integrated industrial plants producing wallboard, plaster, and plaster products and was unreported.[2]

Belgium.—Gyproc Benelux of Wijnegem, Belgium, awarded a contract to NEI International Combustion Ltd. of England for the supply of a Lopulco LM 16/2 table and roller mill and associated air plant to grind gypsum for wallboard manufacturing. An important feature of the mill was the capability to recover heat from the calcining process to assist in the drying of the gypsum rock feed material within the mill.[3]

Canada.—Canada became the third leading producer of crude gypsum in 1982, accounting for 8% of the world total with shipments of 6.3 million tons, an 18% decrease compared with that of 1981. In 1981, 71% of the crude gypsum was shipped from Nova Scotia, followed by British Columbia, Ontario, and Newfoundland, 9% each; the remaining 2% was from Manitoba and New Brunswick. Almost 70% of the crude gypsum produced in Canada's principal gypsum-producing region in Atlantic Canada was shipped to company wallboard plants in the Eastern United States as subsidiary operations. The remainder was shipped up the St. Lawrence River to wallboard and cement plants. Imports of 158,000 tons of crude gypsum in 1981, principally from Mexico, were used by wallboard and cement producers in British Columbia.[4]

Gypsum deposits in Alberta remained undeveloped because of their remote or restricted location or difficult accessibility. The Peace Point and Fort McMurray deposits have the best development potential. The Peace Point deposit has excellent quality, with average grade running 95% gypsum over thicknesses of 15 to 30 feet, and estimated reserves in the order of 1 billion tons. Development of either deposit likely would have to wait the industrialization of the region along with further oil sands development.[5]

Domtar's new wallboard plant at Caledonia, Ontario, began production during 1980. The new plant incorporated an energy- and labor-saving, one-step, grinding and calcining technique to produce calcine. Domtar's long-term plan included development of a new underground mine at Caledonia. In March 1982, Domtar announced that it had suspended production indefinitely at its gypsum wallboard plant in Montreal because of declining demand in eastern Canada.[6] All Canadian gypsum wallboard manufacturers were members of the Gypsum Association in the United States, which announced that Canadian wallboard capacity as of yearend 1982 was 3.57 billion surface square feet, a 2% decrease compared with that of 1981.

China.—Gypsum was produced throughout China except for the northeast. Recent detailed geological examination indicated that all Chinese gypsum resources are in Triassic and Tertiary geological formations. The fine-quality Yingcheng gypsum from Hubei Province has a long history of production. A large gypsum deposit was found between Triassic horizons in Shansi Province.[7]

Dominican Republic.—In March 1982, the Government of the Dominican Republic announced a new mining policy, which sought to revitalize the mining industry by encouraging private sector participation in exploration and mining, and by redefining of the state role.[8] Exports of gypsum rock to the United States reached a high of 230,000 tons in 1974 and then fell to a 1979-82 average of 64,000 tons per year, with only 28,000 tons in 1982.

Egypt.—With the return of the Sinai in April 1982 to full Egyptian sovereignty, the Egyptian Government had hoped to proceed with development of one or more of the Sinai's mineral resources. One of these was the Ras Malaab gypsum reserves of 250 billion tons. The Sinai Manganese Co. was seeking a foreign partner for a joint venture to provide financing for a gypsum quarry and processing plant at Ras Malaab for an annual production of about 300,000 tons per year for the Egyptian market.[9]

Laos.—Laos had an agreement with Vietnam for assistance in mining gypsum. The gypsum deposit was in Savannakhet Province and had produced 14,000 tons recently.[10]

Mauritania.—Mauritania was reported to have deposits of 98% pure gypsum, with resources estimated in the magnitude of 1 billion tons. In recent years, 15,000 tons had been mined outside of Nouakchott and exported to Senegal. Mining stopped in early 1981.[11]

Pakistan.—Pakistan's total gypsum reserves were estimated to be 400 million tons, with large deposits in Mianwali, Jhelum, and Dera Ghazi Khan in Punjab Province, Quetta and Sibi in Baluchistan Province and Kohat in Northwest Frontier Province. A new plant was to be established in Burikhel, Mianwali district, Punjab Province, with a capacity of 90,000 tons per year of gypsum plaster and 28,000 tons per year of gypsum for fertilizer use. The project was expected to cost $4.2 million, including a foreign exchange component of $2.5 million for importation of plant and equipment. The National Fertilizer Corp. intended to improve its production of gypsum in the Mianwali district with a $5.7 million project to increase its annual production of gypsum from 265,000 tons to 715,000 tons.[12]

The State Cement Corp. of Pakistan was installing a cement plant in the Dera Ghazi Khan district of Punjab Province. Reserves were estimated to be 200 million tons of limestone, 70 million tons of gypsum, and 30 million tons of fuller's earth.[13]

Romania.—The Eocene gypsum deposits in the Transylvanian Basin form thick horizontal strata, sometimes with alabaster interbeds, unlike those of the exterior of the Carpathians, which are strongly tectonized and contain marly beds. Gypsum was mined only from open pit operations for the production of plaster and as a set retarder in cement manufacturing. The ores contained 62% to 87% gypsum and 1.5% to 23% anhydrite. Some deposits from the Transylvanian Basin also contained alabaster, which was separated and used for carving and decorative objects.[14]

Saudi Arabia.—The National Gypsum Co. of Saudi Arabia awarded a construction contract in 1982 to Babcock-BSH AG of Bad Hersfeld, Federal Republic of Germany for a gypsum wallboard plant to be constructed in Riyadh. This turnkey plant, with a capacity of 14,000 surface square feet per hour, was scheduled to go onstream in late 1983.[15]

South Africa, Republic of.—In July 1981, Gypsum Industries Ltd., South Africa's leading producer of gypsum, with two large plants, increased prices 12% as a result of increasing demand. Domestic sales increased by almost 20% in 1982, caused by the building boom, particularly in low-cost housing areas.

In 1981, Gypsum Industries invested $3.5 million in capital expenditures, a large portion of which was for the development of a type of water-resistant exterior cladding that could be utilized in the construction of timber and metal frame houses. With this cladding, such houses could be built virtually entirely of gypsum, reportedly with a significant cost advantage over alternate building methods and materials.[16]

Spain.—Spain has large resources of gypsum, principally in the eastern part of the peninsula and in the Balearic Islands. In 1980, 242 mines in 32 Provinces produced 5.8 million tons and provided employment for 873 workers. Principal producing areas were the Central region, 33 mines; Andalusia, 42 mines; Catalonia, 22 mines; Levant, 33 mines; and the Iberian Ranges, 24 mines. End uses were for the manufacture of calcined gypsum products, 85%; cement set retarding, 14%; ornamental rocks, 1%; and loading of paper, 0.14%. Exports were substantial, principally to the Scandinavian countries.[17]

United Kingdom.—Gypsum is widely distributed throughout England, principally in rocks of Permian and Triassic Age, and to a lesser extent in Upper Jurassic strata. British Gypsum Ltd., the largest gypsum mining company in England, operated 10 mines in Cumbria, Yorkshire, Staffordshire, Nottinghamshire, and East Sussex. All were underground mines, except the Newark Mine in Nottinghamshire. The Fauld Mine in Staffordshire was the only source of ornamental alabaster in the United Kingdom, which was sorted as a coproduct. Underground mining access was gained by drifts, and conventional room-and-pillar mining techniques were used, with extractions ranging from 56% to 79%. Recovery was limited by depth of workings and the seam strength characteristics.

Mine-run gypsum was generally screened

to remove mudstone and shale fines; at the Fauld and Robertsbridge operations, heavy-media sink-float separation was used to remove additional impurities. In addition to the traditional uses of gypsum, products included explosion-proof stoppings, cavity fillings, and an anhydrite-based product for gateside packing in coal mines.[18]

Table 9.—Gypsum: World production, by country[1]

(Thousand short tons)

Country	1978	1979	1980	1981[p]	1982[e]
Afghanistan	7	--	--	--	3
Algeria[e]	190	210	220	220	220
Angola[e]	28	28	28	22	20
Argentina	674	648	1,028	739	[2]673
Australia	1,045	1,356	1,443	1,897	1,907
Austria[3]	844	880	919	882	920
Belgium[3]	202	212	192	170	180
Bolivia	[e]1	[e]1	1	1	[2]1
Brazil[4]	[r]512	[r]515	601	659	770
Bulgaria	375	341	343	386	390
Burma[5]	39	42	41	34	30
Canada[3 6]	8,901	8,927	7,947	7,744	[2]6,312
Chile	192	179	218	262	250
China	1,700	4,000	3,700	3,800	3,900
Colombia	281	283	289	298	300
Cuba[e]	105	100	134	145	140
Cyprus	67	51	48	69	61
Czechoslovakia	768	809	834	845	830
Dominican Republic	[r]188	193	259	[e]225	230
Ecuador	38	[r]7	7	2	2
Egypt	880	877	1,036	1,047	1,026
El Salvador	8	8	10	7	5
Ethiopia	1	1	1	5	5
France[3]	6,692	[r]6,754	6,491	6,839	6,800
German Democratic Republic	385	397	397	397	400
Germany, Federal Republic of (marketable)[3]	2,467	2,481	[r e]2,480	2,480	2,500
Greece	601	666	[e]500	551	550
Guatemala	42	28	37	32	30
Honduras[e]	25	25	25	20	20
India	974	[r]967	944	1,053	1,100
Iran	[e]8,800	7,700	7,700	6,600	5,500
Iraq[e]	180	180	190	190	190
Ireland	432	460	421	397	400
Israel	220	80	[e]90	46	55
Italy	[r]1,747	[r]1,630	1,820	1,702	1,800
Jamaica	148	[r]52	116	206	200
Japan[7]	6,387	6,915	6,730	6,765	7,000
Jordan	40	40	[e]50	58	[2]44
Kenya[3]	33	33	33	33	30
Korea, Republic of[e 7]	680	680	700	700	800
Lebanon	12	11	11	10	10
Libya	[r]198	200	198	198	190
Luxembourg	1	1	1	1	1
Mauritania	15	18	13	2	6
Mexico	1,938	2,228	1,884	2,076	[2]1,700
Mongolia[e]	31	31	30	30	35
Nicaragua[e]	40	40	44	33	[2]22
Niger	3	3	[e]3	3	3
Pakistan	279	378	626	433	440
Paraguay	10	12	13	11	11
Peru	186	239	309	[e]385	400
Philippines[7]	123	121	121	122	121
Poland[e 4]	1,488	1,500	1,430	1,430	1,400
Portugal	230	265	261	268	300
Romania	1,957	2,061	1,776	1,800	1,800
Saudi Arabia	231	331	331	386	400
South Africa, Republic of	429	416	499	612	[2]590
Spain	5,918	5,815	5,757	5,829	5,800
Sudan[3]	[e]22	[r]11	11	31	30
Switzerland[e]	77	77	88	95	90
Syrian Arab Republic	[e]95	70	87	88	90
Taiwan[7]	4	3	9	7	[2]2
Tanzania	22	10	12	13	13
Thailand	310	388	454	596	830
Tunisia	44	66	83	83	80
Turkey	67	[e]70	80	100	100
U.S.S.R.[e 7]	5,800	6,000	6,000	6,000	6,000

See footnotes at end of table.

Table 9.—Gypsum: World production, by country[1] —Continued

(Thousand short tons)

Country	1978	1979	1980	1981^p	1982^e
United Kingdom[3]	3,662	3,858	3,800	3,289	3,000
United States[8]	14,891	14,630	12,376	11,497	[2]10,538
Venezuela	206	287	129	241	175
Vietnam^e	15	15	17	17	20
Yugoslavia	554	626	682	737	700
Zaire	--	--	125	125	125
Zambia	2	([9])	--	--	--
Total	^r85,759	^r88,537	85,283	84,076	80,616

^e Estimated. ^p Preliminary. ^r Revised.
[1]Table includes data available through June 29, 1983.
[2]Reported figure.
[3]Includes anhydrite.
[4]Series revised to represent sum of (1) mine output without beneficiation and (2) output of concentrates.
[5]Data are for years beginning Apr. 1 of that stated.
[6]Shipments.
[7]Includes byproduct gypsum. In Japan byproduct gypsum was virtually all gypsum consumed during 1977-82.
[8]Excludes byproduct gypsum.
[9]Less than 1/2 unit.

TECHNOLOGY

Anhydrite does not combine or react with water. When accelerators such as soluble sulfates are added, it hydrates to form a cementing material which, on curing under high humidity, develops high strength and density and resistance to moisture attack and cracking. It can be used to make ornamental plaster and imitation marble. A research study carried out by the Central Building Research Institute of Roorhee, India, concluded that anhydrite plaster can be manufactured from waste phosphogypsum with the help of suitable accelerators to produce a new type of high-strength material. The plaster gives a hard smooth finish and can be used in environments that are not continually damp.[19]

A one-step gypsum grinding-calcining plant, designed to conserve heat by recycling a portion of the hot exit gas through the hot gas producer, was described. Recycling of the gas reduced fuel consumption, and the small amount of exit gas enabled the utilization of a smaller dust collecting system. Higher water vapor content improved the precipitation efficiency in the electrostatic precipitator. The effects of gas recycling upon the calcined gypsum properties were described.[20]

[1]Physical scientist, Division of Industrial Minerals.
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[20]Freimuth, C. von. Effect of Exit Gas Recycling in Gypsum Grinding and Calcining Plant Upon Heat Consumption and Gypsum Properties. Zement, Kalk, Gips (Wiesbaden), Ed. B, No. 7, July 1982, pp. 362-364.

Helium

By Philip C. Tully[1]

Grade-A helium (99.995% or better) sales volume in the United States by private industry and the Bureau of Mines was 867 million cubic feet (MMcf) in 1982.[2] Grade-A helium exports by private producers were 378 MMcf for total sales of 1,245 MMcf of U.S. helium. The Bureau's price, f.o.b. plant, for Grade-A helium was increased from $35 to $37.50 per thousand cubic feet (Mcf) effective October 1, 1982, the first helium price increase in more than 20 years. The price of Grade-A helium gas sold by private producers was about $34 per Mcf at the end of the year, and the price of liquid helium averaged $52 per Mcf gaseous equivalent with some producers posting surcharges to these prices.

Domestic Data Coverage.—Domestic production data for helium are developed by the Bureau of Mines from records of its own operations as well as the High Purity Helium survey, a single, voluntary canvass of private U.S. operations. Of the seven operations to which a survey request was sent, 100% responded, and that data plus data from the Bureau's operations represent 100% of the total production shown in table 2.

Legislation and Government Programs.—The Government's program for storage of private crude helium in the Government's helium storage facilities at Cliffside Field near Amarillo, Tex., was critical in reducing a shortage of private helium during the last half of 1982. Private helium previously stored under contract with the Government was delivered back to the owners for purification.

DOMESTIC PRODUCTION

In 1982, there were 10 privately owned domestic helium plants, which were operated by 9 companies. One new plant, Air Products and Chemicals, Inc., was started (table 1). Seven privately owned plants and one Bureau plant extracted helium from natural gas. Private and Bureau plants use cryogenic extraction processes. The Bureau and five of the six private plants that produce and liquefy Grade-A helium are Air Products and Chemicals, Hansford County, Tex.; Cities Service Cryogenics, Inc., Ulysses, Kans.; Kansas Refined Helium Co., Otis, Kans.; Phillips Petroleum Co., now owned and operated by Helium Sales, Inc., Elkhart, Kans.; and Union Carbide Corp., Linde Div., Bushton, Kans. Air Products and Chemicals started its 250-MMcf-per-year helium purification and liquefaction plant in Hansford County, Tex.

The volume of crude (a gas mixture containing about 50% to 80% helium) and Grade-A helium recovered from natural gas for 1978-82 is summarized in table 2, and the volumes recovered and sold are plotted in figure 1. The sharp reduction in the volume of helium recovered from natural gas was caused by the temporary shutdown of two private crude helium plants because of the lack of natural gas liquids markets for these multiproduct plants. Most of the natural gas processed for helium extraction came from the gasfields shown in figure 2. Supply and disposal of helium for 1980-82 at the Bureau's helium plants are summarized in table 3.

The Bureau awarded a contract for a pressure swing adsorption helium purification unit in 1979. The unit was installed at the Masterson, Tex., (Exell) plant during 1980, accepted in 1981, and operated successfully in 1982. A new cryogenic helium purification unit and helium liquefier, also purchased under contract, were installed at the Bureau's Exell plant. The liquefier was accepted in 1981 and operated throughout 1982. Performance tests on the purifier were in progress at the end of 1982.

Table 1.—Ownership and location of helium extraction plants in the United States, in 1982

Category and owner or operator	Location	Product purity
Government-owned:		
Bureau of Mines	Masterson, Tex	Crude and Grade-A helium.[1]
Do	Keyes, Okla	Helium tank car maintenance only.
Private industry:		
Air Products and Chemicals, Inc	Hansford County, Tex	Grade-A helium.[1]
Cities Service Cryogenics, Inc	Scott City, Kans	Crude helium.[2]
Do	Ulysses, Kans	Grade-A helium.[1]
Cities Service Helex, Inc	do	Crude helium.
Kansas Refined Helium Co	Otis, Kans	Grade-A helium.[1]
Navajo Refined Helium Co	Shiprock, N. Mex	Grade-A helium.
Northern Helex Co	Bushton, Kans	Crude helium.
Phillips Petroleum Co.[3]	Elkhart, Kans	Grade-A helium.[1]
Do	Hansford County, Tex	Crude helium.
Union Carbide Corp., Linde Div	Bushton, Kans	Grade-A helium.[1]

[1]Including liquefaction.
[2]Output is piped to Cities Service Cryogenics, Inc., plant at Ulysses, Kans., for purification.
[3]Grade-A helium facility sold to Helium Sales, Inc., Sept. 30, 1982.

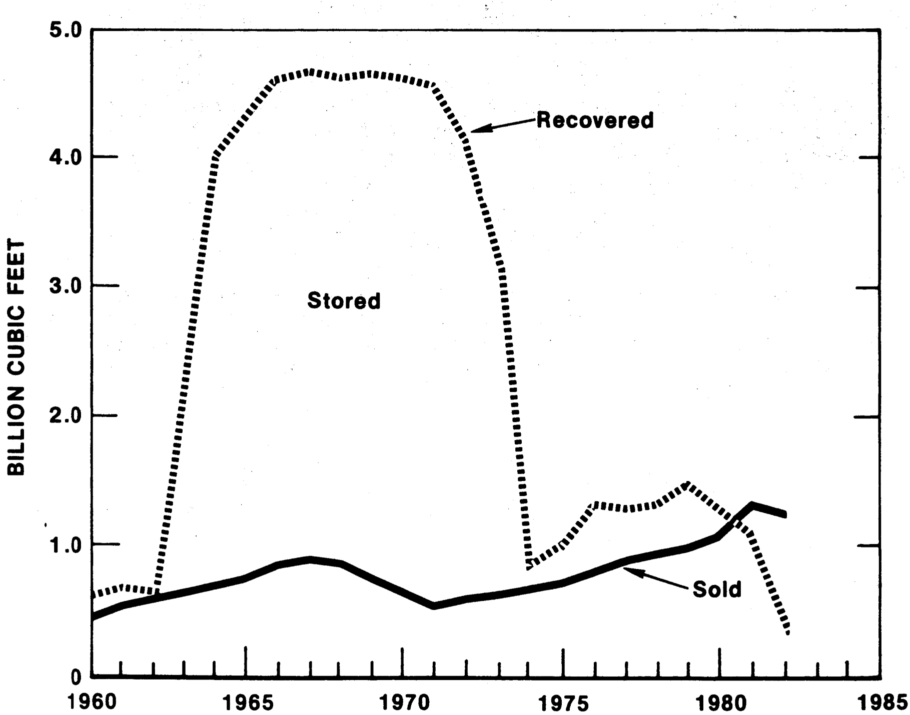

Figure 1.—Helium recovery in the United States, 1960-82.

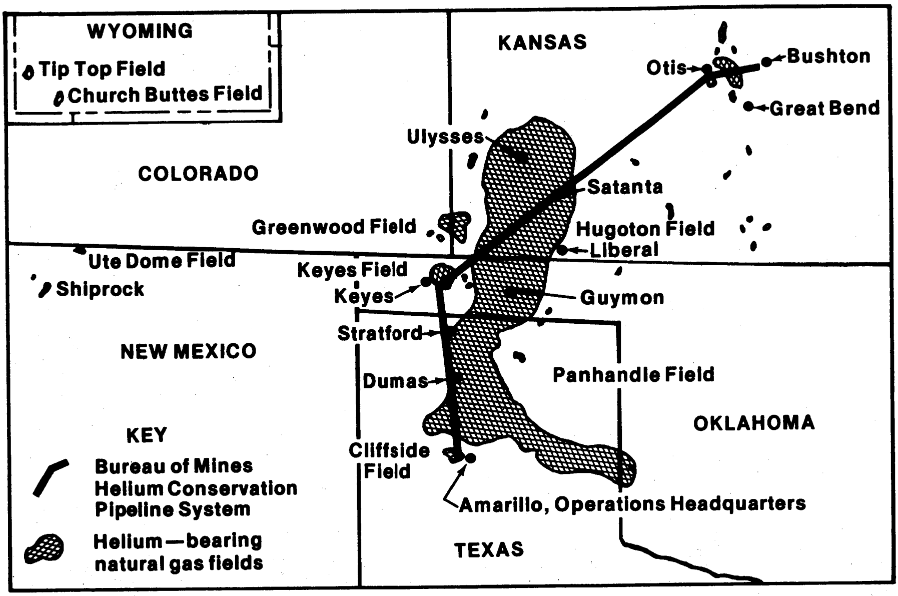

Figure 2.—Major U.S. helium-bearing natural gasfields.

Table 2.—Helium recovery in the United States[1]

(Thousand cubic feet)

	1978	1979	1980	1981	1982
Crude helium:					
Bureau of Mines:					
Total storage	42,483	34,868	22,887	-257,799	-350,221
Private industry:					
Stored by Bureau of Mines	723,788	787,123	633,956	452,880	113,261
Withdrawn	-157,716	-180,840	-266,898	-304,987	-724,113
Total private industry storage	566,072	606,283	367,058	147,893	-610,852
Total crude helium	608,555	641,151	389,945	-109,906	-961,073
Stored private crude helium withdrawn from storage and purified by the Bureau of Mines for redelivery to industry	-229,512	-222,320	-200,612	-80,208	-51,234
Grade-A helium:					
Bureau of Mines sold	208,252	209,680	187,735	240,880	305,071
Private industry sold	779,434	890,160	986,601	1,014,543	939,496
Total sold	987,686	1,099,840	1,174,336	1,255,423	1,244,567
Total stored	379,043	418,831	189,333	-190,114	-1,012,307
Grand total recovery	1,366,729	1,518,671	1,363,669	1,065,309	232,260

[1]Negative numbers denote net withdrawal from the Government's underground helium storage facility, a partially depleted natural gas reservoir in Cliffside Field near Amarillo, Tex.

Table 3.—Summary of Bureau of Mines helium plant operations

(Thousand cubic feet)

	1980	1981	1982
Supply:			
Inventory at beginning of period[1]	16,326	14,510	14,375
Helium recovered:			
Exell plant: Grade-A	35,063	[2]237,719	[2]362,298
Keyes plant:			
Crude	93,162	22,375	
Grade-A[3]	348,912	49,346	
Total	442,074	71,721	
Total recovered	[r]477,137	[r]309,440	362,298
Helium returned in containers (net)	2,556	33,888	
Total supply	[r]496,019	[r]357,838	376,673
Disposal:			
Sales of Grade-A helium	187,735	240,880	305,071
Redelivered to private producers	200,612	80,208	51,234
Net deliveries to helium conservation system	[r]93,162	[r]22,375	
Inventory at end of period[1]	14,510	14,375	20,368
Total	[r]496,019	[r]357,838	376,673

[r]Revised.
[1]At Amarillo and Exell helium plants.
[2]Includes 67,591 Mcf purified for private industry in 1981 and 51,234 Mcf in 1982.
[3]Includes 200,612 Mcf purified for private industry in 1980, and 12,617 Mcf in 1981. Gas processing shut down September 1981.

CONSUMPTION AND USES

The major domestic end uses of helium in 1982 were cryogenics, welding, and pressurizing and purging, as shown in figure 3. Minor uses included synthetic breathing mixtures, chromatography, leak detection, lifting gas, heat transfer, and controlled atmospheres. Annual helium sales volumes for 1978-82 are shown in table 4. The Pacific and Gulf Coast States were the principal areas for helium demand.

Federal agencies purchase their major helium requirements from the Bureau. Direct helium purchases by the Department of Energy, the Department of Defense, the National Aeronautics and Space Administration, and the National Weather Service constituted most of the Bureau's Grade-A helium sales (table 5). All of the remaining sales to Federal agencies were through private helium distributors, which purchased equivalent volumes of Bureau helium under contracts described in the Code of Federal Regulations (30 CFR 602). Some of the private distributors also have General Services Administration helium supply contracts. These contracts make relatively small volumes of helium readily available to Federal installations at reduced freight charges.

The Bureau of Mines price, f.o.b. plant, for Grade-A helium was increased from $35 to $37.50 per Mcf effective October 1, 1982, the first helium price increase in over 20 years. Private producers' price for Grade-A helium gas was about $34 per Mcf at the end of the year. The price of liquid helium averaged $52 per Mcf gaseous equivalent, plus possible surcharges.

All Grade-A gaseous helium sold by the Bureau was shipped in cylinders, special railway tank cars, or highway tube semitrailers. Liquid helium was shipped in dewars and semitrailers from the Exell helium plant. Private industrial gas distributors shipped helium as gas or liquid. Much of the private helium was transported in liquid form by semitrailers to distribution centers, where a portion was gasified and compressed into trailers and small cylinders for delivery to the end user.

Table 4.—Total sales of Grade-A helium in the United States

(Million cubic feet)

Year	Volume
1978	811
1979	817
1980	863
1981	866
1982	867

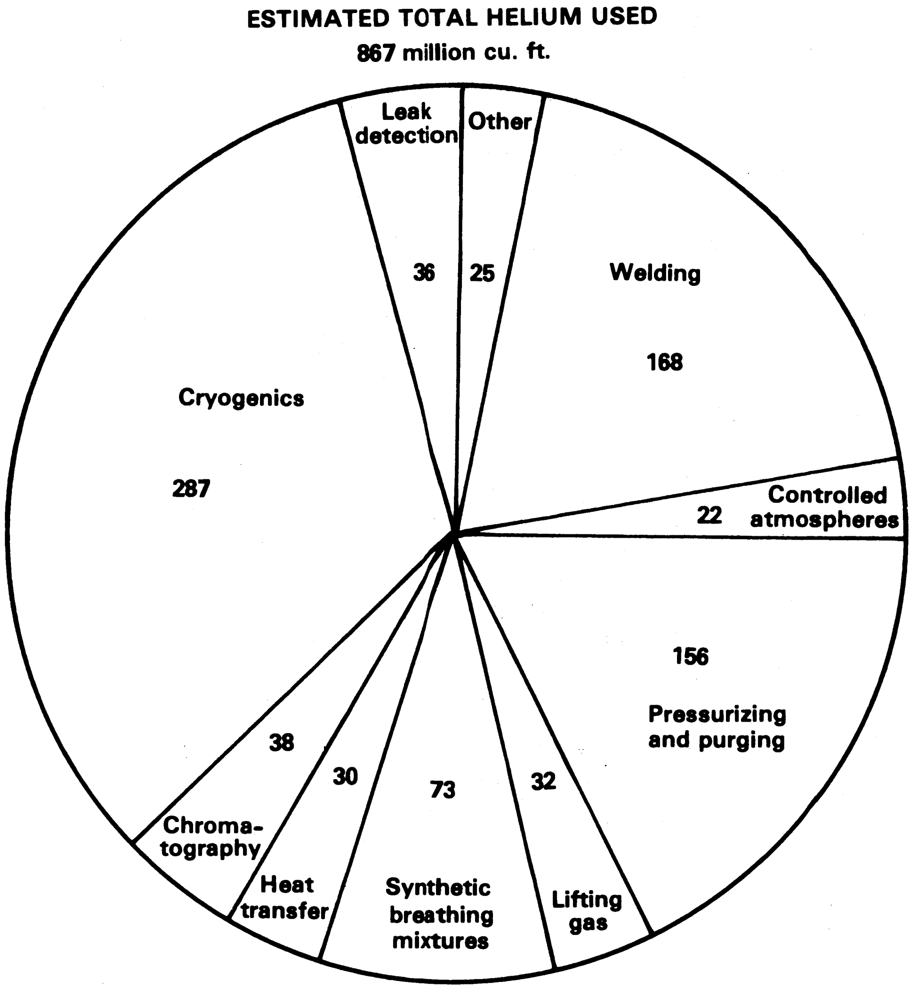

Figure 3.—Helium consumption by end use in the United States in 1982 (million cubic feet).

Table 5.—Bureau of Mines sales of Grade-A helium, by purchaser[1]

(Thousand cubic feet)

Purchaser	1980	1981	1982
Federal agencies:			
Department of Energy	24,894	29,441	29,939
Department of Defense	103,267	92,405	93,535
National Aeronautics and Space Administration	24,059	44,221	37,447
National Weather Service	1,301	1,002	1,077
Other	2,464	2,661	2,812
Total	155,985	169,730	164,810
Federal agency sales supplied by private-contract helium distributors[2]	29,478	68,551	136,359
Commercial sales	2,272	2,599	3,902
Grand total	187,735	240,880	305,071

[1]Table identifies purchaser, which is not necessarily a Federal helium user.

[2]Purchased from the Bureau of Mines by commercial firms and redistributed to Federal installations under contract authority of 30 CFR 602.

CONSERVATION

The volume of helium stored for future use in the Bureau of Mines helium conservation storage system, which includes the conservation pipeline network and the Cliffside Field near Amarillo, Tex., totaled more than 39 billion cubic feet (Bcf) at the end of 1982 (table 6). The conservation storage system contains crude helium purchased by the Bureau of Mines under contract, Bureau helium extracted in excess of sales, and privately owned helium stored under contract. During 1982, 113 MMcf of private helium was delivered to the Bureau's helium conservation storage system and 775 MMcf was withdrawn, for a net decrease of 662 MMcf of private helium in storage.

Table 6.—Summary of Bureau of Mines helium conservation storage system[1] operations

(Thousand cubic feet)

	1980	1981	1982
Helium in conservation storage system at beginning of period:			
Stored under Bureau of Mines conservation program	37,860,427	37,883,314	36,137,610
Stored for private producers under contract	2,415,532	2,582,426	4,137,724
Total	40,275,959	40,465,740	40,275,334
Input to system:			
Net deliveries from Bureau of Mines plants[2]	22,887	[3]-1,745,704	-350,235
Stored for private producers under contract	634,309	[3]1,940,492	113,261
Total[2]	657,196	194,788	-236,974
Redelivery of helium stored for private producers under contract[2]	-467,415	-385,194	-775,347
Net addition to system[2]	189,781	-190,406	-1,012,321
Helium in conservation storage system at end of period:			
Stored under Bureau of Mines conservation program	37,883,314	36,137,610	35,787,375
Stored for private producers under contract	2,582,426	4,137,724	3,475,638
Total	40,465,740	40,275,334	39,263,013

[1]Crude helium is injected into or withdrawn from the Government's underground helium storage facility, a partially depleted natural gas reservoir at Cliffside Field near Amarillo, Tex.
[2]Negative numbers denote net withdrawal from storage.
[3]Includes 1,518,008 Mcf of helium (minus 2%) originally accepted under court order but returned to private producers under terms of court settlements.

RESOURCES

Domestic measured and indicated identified helium resources as of January 1, 1982 (the latest figures available), are estimated to be 434 Bcf. The resources included measured reserves and indicated resources estimated to be 171 and 27 Bcf, respectively, in natural gas with a minimum helium content of 0.3%. The measured reserves included 40 Bcf stored in the Bureau's helium conservation storage system. Measured helium resources in natural gas with a helium content of less than 0.3% are estimated to be 50 Bcf. Indicated helium resources in natural gas with a helium content of less than 0.3% are estimated to be 186 Bcf. Approximately 93% of the domestic helium resources under Federal ownership are in the Tip Top and Church Buttes Fields in Wyoming, and the Cliffside Field in Texas.

Most of the domestic helium resources are located in the midcontinent and Rocky Mountain regions of the United States. The measured helium reserves are located in approximately 76 gasfields in 10 States. About 94% of these reserves are contained in the Hugoton Field in Kansas, Oklahoma, and Texas, the Keyes Field in Oklahoma, the Panhandle and Cliffside Fields in Texas, and the Tip Top Field in Wyoming. The Bureau analyzed a total of 313 natural gas samples from 23 States during 1982 in conjunction with a program to survey and identify possible new sources of helium.

FOREIGN TRADE

Exports of Grade-A helium, all by private industry, decreased by 3% in 1982 to 378 MMcf (table 7). Nearly 56% of the exported helium was shipped to Europe. The United Kingdom, Belgium-Luxembourg, and France, collectively, received more than

93% of the European helium imports. Eighteen percent of the U.S. helium exports went to Asia, 4% to North America, 13% to Central and South America, 5% to Australia and New Zealand, 3% to the Middle East, and less than 1% each to Africa and the Caribbean. The shipments of large volumes of helium to Western Europe in 1982 were attributed to helium's use in breathing mixtures for diving and for welding in the exploration for oil and gas, especially in the North Sea.

Table 7.—Exports of Grade-A helium from the United States

(Million cubic feet)

Year	Volume
1978	190
1979	245
1980	298
1981	389
1982	378

Source: U.S. Bureau of the Census.

WORLD REVIEW

World production of helium, excluding the United States, was estimated to be 150 MMcf. This production was attributed to the central economy countries, most of which was extracted in Poland.

TECHNOLOGY

Three more successful launches of the Columbia Space Shuttle of the National Aeronautics and Space Administration's Space Transportation System were made using Bureau helium.

The 4,000-liter-per-hour helium liquefier, the world's largest, at Fermi National Accelerator Laboratory near Batavia, Ill., continued successful operation. Liquid helium was circulated to 12 satellite liquefiers. All of the magnets have been shop tested with liquid helium and final installation in the ring is almost complete.

Superconducting magnet development for fusion and magnetohydrodynamic systems is proceeding at several other Department of Energy national laboratories. The Los Alamos National Laboratory installed and has cooled a large superconducting magnet for energy storage for the Bonneville Power Administration in Washington State. The electrical tests were successful; additional tests are in progress.

The Electric Power Research Institute has entered into a $19 million, cost-sharing contract with Westinghouse Electric Corp. for the design and construction of a 270-megawatt superconducting electric generator. The intermediate design has been completed, and detail drawings are being made. Manufacture of parts of the rotor has begun, and materials are being received for the stator. This generator will be the largest of its kind and will be cooled by liquid helium to maintain the near-absolute-zero temperature (-452° F) necessary to acheive the superconducting state. Superconducting generators are smaller, lighter, and more efficient than conventional generators of the same capacity.

[1]Program analysis officer, Helium Field Operations, Amarillo, Tex.

[2]All helium volumes herein reported at 14.7 pounds per square inch absolute at 70° F.

Iron Ore

By F. L. Klinger[1]

U.S. production, imports, and consumption of iron ore in 1982 fell to the lowest levels in many years, as a severe recession affected the iron and steel industry.

Production, trade, and consumption of iron ore in the rest of the world also declined, although recession of steel demand in most countries was not as severe as that in the United States. With depressed conditions in the iron ore market, ocean freight rates continued to fall, and with further cutbacks in steel production expected in Western Europe and Japan, iron ore prices were expected to decline in 1983. Except for a major iron ore project in Brazil and construction of direct-reduction plants in several countries, investments affecting the iron ore market were few.

Domestic Data Coverage.—Domestic production data for iron ore are developed by the Bureau of Mines from three separate voluntary surveys of U.S. operations. The annual Iron Ore survey (1066-A) provides the basic data used in this report. Of approximately 65 operations to which a survey was sent, 58 responded, representing 99.9% of the total production shown in tables 1 through 6. Production for nonrespondents was estimated using data from railroad reports and reported prior year production levels adjusted by trends in employment and other guidelines.

Table 1.—Salient iron ore statistics

(Thousand long tons and thousand dollars unless otherwise specified)

	1978	1979	1980	1981	1982
United States:					
Iron ore (usable,[1] less than 5% manganese):					
Production	81,583	85,716	69,613	73,174	35,433
Shipments[2]	83,207	86,218	69,594	72,181	35,756
Value[2]	$2,401,387	$2,814,440	$2,544,121	$2,915,239	$1,491,809
Average value at mines dollars per ton	$28.86	$32.64	$36.56	$40.39	$41.72
Exports	4,213	5,148	5,689	5,546	3,178
Value	$136,721	$178,749	$230,568	$244,685	$150,522
Imports for consumption	33,616	33,776	25,058	28,328	14,501
Value	$845,039	$923,426	$772,844	$947,977	$470,847
Consumption (iron ore and agglomerates)	124,797	125,431	98,879	104,385	63,916
Stocks, Dec. 31:					
At mines[3]	12,359	11,266	11,725	12,734	12,129
At consuming plants	39,301	38,969	35,706	36,203	29,923
At U.S. docks	3,569	5,416	6,095	6,571	5,750
Manganiferous iron ore (5% to 35% manganese): Shipments	279	215	155	[r]156	28
World: Production	[r]833,274	[r]897,650	883,671	[p]843,204	[e]783,302

[e]Estimated. [p]Preliminary. [r]Revised.

[1]Direct-shipping ore, concentrates, agglomerates, and byproduct ore.

[2]Includes byproduct ore.

[3]Excludes byproduct ore.

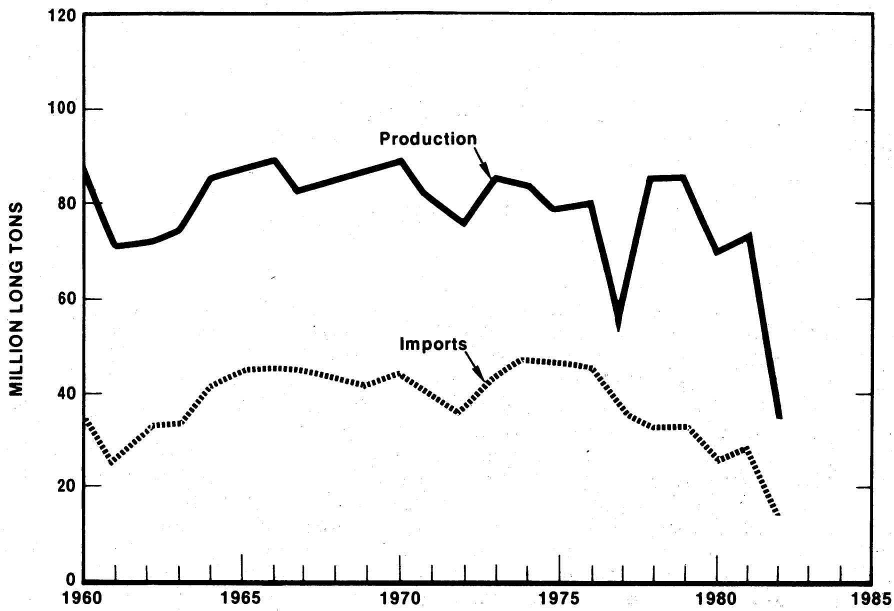

Figure 1.—United States iron ore production and imports for consumption.

Legislation and Government Programs.—Under the Tax Equity and Fiscal Responsibility Act of 1982, the depletion allowance for the iron ore mining industry will be reduced to 12.75%, effective January 1, 1984. The current depletion allowance for iron ore is 15%. This will increase the taxable income of iron ore producers.

EMPLOYMENT

Statistics on employment and productivity in the U.S. iron ore industry in 1982 are shown in table 2. Quarterly employment data were supplied by the Mine Safety and Health Administration of the U.S. Department of Labor, from reports received from producers. The statistics include production workers employed at mines, concentrating, and pelletizing plants but do not include 1,456 engaged in management, research, and office work.

The average number of employees and total hours worked in 1982 were about 50% of those reported in 1981. This resulted from numerous closures of mines and plants, and temporary layoffs ranging up to 80% of the industry's work force during the year. Productivity declined in the Lake Superior district and for the Nation as a whole, owing to frequent interruptions of production schedules and lower utilization of production capacity at most mines and plants. An increase in productivity in the Western States appeared to be because of reductions in the number of employees without corresponding declines in production, particularly in California and Utah. Nationwide, however, the decline in output of crude and usable ore was steeper than declines in average employment and the number of hours worked.

DOMESTIC PRODUCTION

U.S. production of iron ore declined in 1982 to the lowest level in 44 years. With relatively large stocks of ore at mines and consuming plants in the spring, and demand continuing to fall, mine production was drastically reduced in the second quarter and had fallen to less than 10% of capacity by early July. Production remained at this level through September but gradually increased to about 25% of capacity by yearend. Total output of usable ore products during the year was about one-third of the industry's annual capacity, which was estimated at 105 million long tons[2] on January 1.

Iron ore was produced by 26 open pit mines and 1 underground mine in 1982. Of the 19 largest mines, all except 1 were closed during the year for periods ranging from 2 to 12 months. In the Lake Superior district, which accounted for 88% of U.S. production, 2 of the 13 taconite operations were idle in 1982, and most of the others were closed for 6 months or more.

Output of crude ore and usable ore in 1982 was slightly less than one-half of the quantities produced in 1981. An average of 3.01 tons of crude ore was mined for each ton of usable ore produced, compared with 3.10 tons in 1981 and 3.05 tons in 1980. The decline of this ratio in 1982 was due to a small increase in the proportion of direct-shipping ore and concentrates in total output of usable ore. Pellets and sinter made up 93% of all usable ore produced in 1982, compared with about 96% in 1981. Output of pellets was slightly less than 33 million tons and was equivalent to about 35% of total rated capacity of the Nation's 16 operational pelletizing plants at the beginning of the year. Average iron content of usable ore produced was 63.9% in 1982, compared with 63.6% in 1981 and 63.0% in 1980.

In Minnesota, production of pellets from magnetite taconite was less than one-half of the quantity produced in 1981 and was equivalent to about 36% of the rated capacity of the State's eight taconite operations. Eveleth Mines, operated by Oglebay Norton Co., was the only producer to operate throughout 1982. Reserve Mining Co. suspended operations from March 7 to May 16, and from June 19 through the rest of 1982. Hanna Mining Co. closed the National Steel Pellet Project and Butler Taconite facilities on April 25 and May 30, respectively, and both operations remained closed through December 31. Inland Steel Mining Co. closed the Minorca Mine and plant at Virginia, Minn., from May 30 to September 26. United States Steel Corp. closed the Minntac facility, which is the country's largest taconite operation, from June 6 through December 31. Pickands Mather & Co. shut down Hibbing Taconite and Erie Mining Co. on July 4; production was resumed at Hibbing on September 12, but operations at Erie remained idle for the rest of 1982. Almost all of these shutdowns lasted longer than originally planned, as demand for ore remained unusually low, and about 11,000 employees were laid off between March and September.

Minnesota's production of so-called natural ores, which consist of hematite and goethite concentrates produced from oxidized ore, was less than one-third of the quantity produced in 1981. Virtually all of the output in 1982 was produced by J&L Steel Corp. from the McKinley Mine near Biwabik, Minn. This mine was closed permanently by J&L in late August, owing to exhaustion of ore reserves, and the company began moving its plant and equipment to the Stephens-Donora properties where production was expected to start in 1983. J&L leased the Stephens-Donora properties from United States Steel in 1982 and renamed them the McKinley Extension. United States Steel also leased the Arcturus and Plummer Mine properties on the western Mesabi Range to Rhude & Fryberger Inc. United States Steel's large processing plants for natural ores at Coleraine, Chisholm, and Virginia were dismantled in 1982.

In other Minnesota developments, Hanna sold its 15% interest in National Steel Pellet to National Steel Corp. National Steel now owns 100% of the taconite facility, which has a production capacity of 5.8 million tons of pellets per year. Hanna will continue to manage the operation. In legal developments, Minnesota mining companies were challenging the constitutionality of State methods of taxing natural ores and taconite. United States Steel alleged that unmined natural ores were being valued by the State at several times their actual market value. In another case, Erie Mining asserted that the State's use of alternative methods to calculate production taxes on taconite resulted in excessive payments by the company for several years since 1977.

Because both cases involve possible overpayments of several million dollars, the potential loss of revenue to State and local governments was substantial. Neither case was resolved by yearend. Electric power costs also became an important issue in 1982, because under existing contracts between several taconite producers and Minnesota Power Co., the mining companies are required to pay a minimum charge of up to 90% of contractual power demand even if the power is not used. Because most of the taconite facilities were closed for long periods in 1982, the resulting power costs per ton of product became particularly high. United States Steel, which stated that the power bill for its Minntac facility was $50 million per year, unsuccessfully petitioned the Minnesota Public Utility Commission to reduce the minimum charge and was considering legal action. Butler Taconite, which was closed for 7 months in 1982, reportedly filed suit in a Federal court to contest the power rates. The position of Minnesota Power was that a $400 million generating facility had been built in 1980, principally to supply power to the taconite companies, and that the power company was entitled to recover its cost.

Production of iron ore in Michigan in 1982 was about one-third of total capacity at the beginning of the year, and the number of employees laid off rose to about 4,000 during the summer. Owing to low demand for ore, the Empire Mine was closed from January 1 to January 11, and from May 1 until late in November. The Tilden Mine was closed from May 15 until September 19. Both mines are operated by The Cleveland-Cliffs Iron Co. (CCI) and have production capacities of 8 million tons of pellets per year. CCI did not operate the Republic Mine in 1982. In December, Hanna permanently closed the Groveland Mine, citing depressed conditions in the iron ore industry and the imbalance between domestic production capacity for pellets and projected demand. The Groveland facility had a production capacity of about 2 million tons of pellets per year but had not been operated since January 1981. During 1982, CCI acquired an additional 40% interest in the Empire Mine by assuming the shares of a long-term debt owed by McLouth Steel Corp. and International Harvester Co. The latter two companies disposed of their interests for financial reasons. CCI thereby increased its ownership of the Empire facility to 60%; the remaining 40% interest is owned by Inland Steel. International Harvester also disposed of its 10% interest in the Marquette Iron Mining Partnership, which includes the Republic Mine. International Harvester's share was taken over by J&L, which now owns about 56.5% of the venture. Production capacity of the Republic facility is about 2.7 million tons of pellets per year.

Elsewhere in the Lake Superior district, the taconite mine and pelletizing plant at Black River Falls, Wis., were closed on April 9 and remained idle for the rest of 1982. The facility is operated by Jackson County Iron Co., a subsidiary of Inland Steel.

In Missouri, the Pea Ridge underground mine was operated during most of the year but was closed from September 25 to November 1 because of poor market conditions. In Texas, Lone Star Steel Co. closed its blast furnace and iron ore mines from August 24 through yearend. In Colorado, CF&I Steel Corp. shut down its blast furnaces at Pueblo in August and did not resume production of iron for the remainder of 1982. The company's underground mine at Guernsey, Wyo., and open pit mine near Cedar City, Utah, remained closed all year. Utah International Inc. produced no ore in the Cedar City area in 1982, and its concentrating plants were put up for sale by the fall. The company formerly operated the Comstock Mine for CF&I, a mobile concentrating plant in the Pinto district, and another concentrator at Iron Springs, Utah. United States Steel produced direct-shipping ore from the Mountain Lion Mine, but production was suspended for the latter half of the year while the company's operating blast furnaces at Provo, Utah, were adequately supplied with pellets from the Atlantic City Mine in Wyoming.

In California, Kaiser Steel Corp. permanently closed the Eagle Mountain Mine in 1982. The pelletizing plant was closed June 4, the mine was closed early in October, and the concentrating plant was closed on November 30. Production capacity of the facility was about 4 million tons per year, including about 2.4 million tons of pellets and 1.6 million tons of hematite concentrates. The company was expected to permanently close its blast furnaces at Fontana, Calif., in 1983.

Armco Inc., ended production of direct-reduced iron (DRI) at Houston, Tex., early in May 1982, owing to the high cost of natural gas. The company's contract for low-cost gas had been negotiated many years before, and if the contract had been renewed the price of gas would have been about 10 times higher. The plant had a production capacity of about 360,000 short tons of DRI per year and was built in 1972. Direct-reduction plants owned by other companies at Georgetown, S.C., and Rockwood, Tenn., were idle in 1982.

CONSUMPTION

Consumption of iron ore in 1982 was about 40% less than that of 1981, as demand from the iron and steel industry continued to fall. With production of iron and steel declining almost every month, and 31 blast furnaces shut down during the year, monthly consumption of ore dropped from 5.5 million tons in January to 3.6 million tons in December. Total consumption of iron ore in 1982 was the lowest since 1939.

Consumption of primary ore totaled about 56.8 million tons, including 42.5 million tons of pellets and 4.3 million tons of natural ore charged directly to ironmaking and steelmaking furnaces, 8.9 million tons of fines and concentrates consumed in production of sinter, and 1.1 million tons used in the manufacture of cement, heavy media materials, and other miscellaneous products. In addition, about 0.2 million tons of manganiferous iron ore was consumed in blast furnaces. Of the primary ore consumed by the iron and steel industry, approximately 72% came from domestic mines, 19% came from Canadian mines, and 9% came from other countries.

Consumption data do not include iron ore fines or concentrate used to produce pellets at or near minesites. In table 11, the difference in weight between iron ore consumed and sinter produced is because of the elimination of moisture and the addition of other materials to the sinter mix. Consumption of other materials reported in sintering plants in 1982, in million tons, was as follows: limestone, dolomite, and other fluxes, 3.6; mill scale, 2.2; slag, 1.5; coke breeze, 1.0; and flue dust, 0.8. Consumption of sinter totaled 15.9 million tons, virtually all of which was consumed in blast furnaces.

STOCKS

Stocks of iron ore and agglomerates reported at U.S. mines, receiving docks, and consuming plants on December 31, 1982, totaled 47.8 million tons, 7.7 million tons less than the total 1 year earlier. Most of the reduction in stocks occurred at consuming plants, as steel companies opted to reduce inventories by cutting back on domestic shipments and imports. Of the total stocks reported at yearend, about 72% consisted of domestic ores, 16% consisted of Canadian ores, and 12% consisted of other foreign ores.

PRICES

Prices for Lake Superior iron ore pellets were increased by four producers in 1982, but one producer maintained its price at the 1981 level. Consequently, published prices ranged from 80.5 cents to 86.9 cents per long ton unit (ltu) of iron, natural, delivered rail-of-vessel at lower lake ports. The spread of 6.4 cents per ltu was unusual and reflected increased competition for sales in a period of low demand for iron ore.

On February 15, 1982, Hanna raised its pellet price to 88 cents per ltu, but after February 26, when CCI raised its price to 86.9 cents, Hanna lowered its original quote to the CCI level for competitive reasons. Both the Hanna and CCI prices were made effective February 26. Subsequently, United States Steel and Oglebay Norton raised their pellet prices to 86.9 cents, effective March 15 and March 25, respectively. Pickands Mather did not raise its price from the 80.5 cents per ltu quoted in 1981. The new price of 86.9 cents quoted by CCI, Hanna, United States Steel, and Oglebay Norton was approximately 8% higher than that quoted in 1981, but CCI and Oglebay Norton indicated that the net increase was less than 6% because the new price included increased tranportation charges that were previously for the account of the buyer. Hanna and CCI stated that the price increase only partially offset increased costs of production.

Published prices for other Lake Superior iron ores were unchanged from the levels of 1981. Prices per long ton, basis 51.5% iron, natural, delivered rail-of-vessel at lower lake ports, were as follows: Mesabi nonbessemer ore, $32.25 to $32.58; Old Range nonbessemer ore, $32.78; and manganiferous ore, $32.78. These prices were equivalent to 62.63 cents to 63.65 cents per ltu.

The average f.o.b. mine value of usable ore shipped from domestic mines in 1982 was estimated at $41.72 per long ton, equivalent to about 65.3 cents per ltu of contained iron. This represented an increase of about 3% compared with the average value in 1981. Average values are principally based on producers' statements and are thought to approximate the average commercial selling price less the cost of mine-to-market transportation. Because pellets usually comprise 90% or more of usable ore shipments, and the price of pellets is relatively high compared with prices for other iron ores, the average value is weighted toward pellets and tends to mask the fact that the average value of other ore products such as direct-shipping ore and concentrates is about 50% less.

Prices for most Canadian and other foreign ores marketed in the United States in 1982 were not available. The price of Canadian (Wabush) pellets, f.o.b. Pointe Noire, Quebec, was unchanged at 63.5 cents per ltu. The estimated average f.o.b. value of all Canadian ores imported by the United States in 1982, as determined from data compiled by the U.S. Bureau of the Census, was $38.75 per long ton, equivalent to about 61.5 cents per ltu. Prices for Canadian and other foreign iron ores are usually lower than prices for U.S. Lake Superior ores, partly because foreign ore prices are quoted on an f.o.b. basis, whereas U.S. prices include transportation charges to lower lake ports.

The published price of DRI, f.o.b. Georgetown, S.C., during 1982 was $125 to $135 per metric ton, unchanged from that of 1981. Published f.o.b. prices for DRI at Contrecoeur, Quebec, and at Point Lisas, Trinidad, were also unchanged at $115 and $120 per metric ton, respectively.

TRANSPORTATION

Vessel shipments of iron ore from U.S. ports on the upper Great Lakes in 1982 totaled 31.4 million tons, 49% less than shipments in 1981. An estimated 90% of the total quantity was destined for domestic ironmaking and steelmaking plants, and the rest was exported to Canada. Shipments of iron ore from Canadian ports to destinations on the Great Lakes totaled 7 million tons, of which approximately 4.9 million tons was destined for U.S. plants.

Ore shipments from all seven U.S. ports on the upper lakes declined sharply from 1981 levels. The declines ranged from 2.7 million tons at Superior, Wis., to 7.1 million tons at Duluth, Minn. Tonnage shipped from each port during 1982 is shown in the accompanying tabulation:

Port	Date of first shipment	Date of last shipment	Total tonnage (thousand long tons)
Duluth, Minn	Apr. 20	Dec. 4	5,982
Two Harbors, Minn	Apr. 20	Dec. 24	4,478
Silver Bay, Minn	Apr. 30	Oct. 22	2,124
Taconite Harbor, Minn	Apr. 22	Nov. 28	3,624
Superior, Wis	Apr. 13	Dec. 13	7,958
Marquette, Mich	Apr. 22	Dec. 13	1,934
Escanaba, Mich	Apr. 22	Dec. 21	5,319
Total[1]			31,420

[1]Data do not add to total shown because of independent rounding.

Source: American Iron Ore Association, and various issues of Skillings' Mining Review.

U.S. lake freight rates for iron ore in 1982 were unchanged from those in effect during the 1981 shipping season. Rates to Lake Erie ports therefore ranged from $7.13 per ton at Duluth, Minn., to $5.42 at Escanaba, Mich., and the rate from Escanaba to lower Lake Michigan ports remained at $4.28. The basic freight rate from the Gulf of St. Lawrence to Lake Erie ports also remained at $3.01 per ton, but toll charges on the St. Lawrence Seaway between Montreal and Lake Erie increased by $0.16 per ton in 1982 to a total of $1.15. Seaway tolls were scheduled to increase in 1983 by about $0.09 per ton.

Rail freight rates increased for iron ore and pellets shipped from Minnesota and Michigan mines to upper lake ports, but rates for all-rail shipments from mines to consuming plants and from receiving ports to consuming plants appeared unchanged from those in effect in late 1981. For example, the volume rate for pellets from the Marquette Range to Escanaba, Mich., delivered direct into vessel, was $2.34 per ton in late 1982, an increase of about 22% from the rate quoted about 1 year earlier. In Minnesota, the volume rate for pellets from the western Mesabi Range to the Allouez docks to Superior, Wis., delivered direct into vessel, was $4.57 per ton, about 32% higher than that of 1981. All-rail rates from the Mesabi to Minnequa, Colo., and from Black River Falls, Wis., to Chicago were unchanged at $21.83 per ton and $6.23 per ton, respectively. Most dock, handling, and storage charges at Great Lakes ports also increased substantially in 1982, but some declined from 1981 levels.

Ocean freight rates to U.S. east coast ports from Canada and Liberia appeared to decline further in 1982. Several cargoes of 70,000 tons were reportedly shipped from Sept-Iles, Quebec, for about $2.05 per ton, compared with about $3.50 per ton in 1981. A cargo of about 70,000 tons was reportedly shipped from Liberia for $4.00 per ton, compared with shipments contracted in mid-1981 at rates of about $6.50 per ton.

FOREIGN TRADE

U.S. exports and imports of iron ore in 1982 were drastically reduced from 1981 levels, owing to low demand in both the United States and Canada. U.S. exports, which consisted almost entirely of pellets shipped to Canadian steel companies that own shares of taconite operations in Minnesota and Michigan, declined by more than 40%. U.S. imports from Canada, which consisted mainly of pellets, concentrates, and direct-shipping ore produced in the Quebec-Labrador region, dropped by more than 50%. Imports from Venezuela, which provide much of the ore used at integrated steel plants near the east and gulf coasts, fell to almost one-third of the quantity imported in 1981. No imports of Venezuelan ore were received during the last 4 months of 1982. Owing to the decline in shipments from Venezuela, Liberia became the second largest supplier of imports for the first time in many years. Imports from Liberia, which are an important source of ore for the east coast plants of Bethlehem Steel Corp., increased in 1982. The total tonnage of imports from all sources, however, was the lowest in 28 years.

The customs districts of Philadelphia, Baltimore, Cleveland, Chicago, and Mobile continued to receive the largest tonnages of imports in 1982, but imports into the Chicago district declined by about 1 million tons and declines ranging from 1.9 million tons to 3.7 million tons were evident in the other four districts.

WORLD REVIEW

World iron ore production and trade continued to decline in 1982, mainly because of lower demand in the United States and Western Europe. World production was the lowest in 10 years. World trade was estimated at 315 million tons, about 11% less than that of 1981.

Lower demand for iron ore led to cutbacks in production and exports by Canada, France, Liberia, the Republic of South Africa, Sweden, Venezuela, and several other countries, including the United States. On the other hand, demand for ore increased in Taiwan and the Republic of Korea, and imports of ore by Japan remained relatively high.

World production of iron ore pellets continued to decline, owing to lower demand and the relatively high cost of pellets compared with the cost of sinter feed and lump ore. World production was estimated at 153 million tons, less than 60% of the installed capacity of existing plants. Most of the reduction in world output was due to temporary closures of pelletizing plants in the United States and Canada during 1982. One new plant was completed in the U.S.S.R., and others were under construction or planned in five countries.

Production of DRI totaled about 7.4 million tons, about 40% of installed capacity. About 70% of the output was produced in Latin America, mostly in Mexico and Venezuela. Reduction plants fueled by natural gas were completed in 1982 in Indonesia, Nigeria, Saudi Arabia, Trinidad and Tobago, and Mexico. Others were under construction in several countries. Coal-based plants were under construction in India, New Zealand, and the Republic of South Africa. Because of high prices for natural gas and competition from low-priced ferrous scrap, reduction plants were closed in the United States and the Federal Republic of Germany, and others were idle in several countries including Canada and the United Kingdom.

Most prices for iron ore increased in 1982. Compared with prices in 1981, the increases ranged from 10% to 20% for ores marketed in Japan, and from 5% to 22% for ores marketed in Western Europe. The 1982 prices (f.o.b., per ltu of contained iron) ranged from about 29 to 40 cents for lump ore, 26 to 37 cents for sinter fines, 25 to 28 cents for pellet feed, and 46 to 57 cents for pellets. The price of titaniferous magnetite concentrates from New Zealand for Japan was 21.7 cents per ltu.

Ocean freight rates continued to decline in 1982. Spot rates published by various sources indicated reductions of $1 to $2 per ton for shipments to Western Europe, Japan, and the United States. Rates for cargoes of 100,000 to 150,000 tons destined for Western Europe were about $5 to $6 per ton from Brazil, $3 to $4 from Canada, $5 to $7 from Australia, and $1.80 from Norway. Rates for cargoes of 130,000 to 150,000 tons destined for Japan were about $7 to $9 per ton from Brazil, $6.50 to $10 from Canada, $4 to $8 from Australia, and $8 from the west coast of the Republic of South Africa.

Angola.—Production of hematite concentrates was scheduled to begin in 1983 by Austromineral GmbH, under contract to an Angolan state company. Recoverable reserves of about 21.5 million tons of ore were stated by Austromineral to have been proved in the area formerly mined by Companhia Mineira do Lobito S.A.R.L.. The run-of-mine ore, which contains about 44% iron, is to be transported by conveyor to a concentrating plant at Jamba. Jigs will be used to concentrate the ore. The plant can process about 2 million tons of ore per year, to produce about 1 million tons of coarse and fine concentrate containing at least 62% iron.

Australia.—Exports of iron ore in 1982 totaled about 71.3 million tons, slightly more than in 1981 as shipments were increased to Western Europe and Taiwan. Domestic consumption was estimated at 9 million tons, about 12% less than in 1981. Total shipments of iron ore products by Australian producers were as follows, in million tons: Hamersley Iron Pty. Ltd., 27.8; Mount Newman Iron Ore Pty. Ltd., 27.1; Cliffs Robe River Iron Associates, 14.1; The Broken Hill Pty. Co., 4.3; and Savage River Mines, 2.1. Ore reserves at the original Mount Goldsworthy Mine were exhausted in December 1982, but the company will continue to produce ore from the Sunrise Hill Mine for shipment to Japan. Mount Newman completed a $29 million project to improve ore crushing facilities at Nelson Point.

Brazil.—Exports of iron ore totaled 71.3 million tons, about 10% less than exports in 1981. Ore shipped for domestic consumption was estimated at about 24 million tons, including fines destined for pelletizing plants at Tubarão. Consumption of ore for ironmaking was estimated at 13 million tons.

Cia. Vale do Rio Doce (CVRD) shipped 15.5 million tons of ore for domestic consumption and exported 56.3 million tons from Tubarão. Exports included 37.5 million tons produced by CVRD, 9.8 million tons produced by Ferteco Mineração S.A. and S.A. Mineração da Trindade (SAMITRI), and 8.9 million tons of pellets produced by the Nibrasco, Itabrasco, and Hispanobras joint ventures.

Minerações Brasileiras Reunidas S.A. (MBR) exported 10.6 million tons of ore from Sepetiba Bay and shipped 0.9 million tons to domestic consumers. Total shipments included 10.3 million tons from the Aguas Claras Mine and 0.7 million tons from the Mutuca Mine. MBR's plan to increase production capacity to about 30 million tons per year by 1986 was deferred for an indefinite period.

Ferteco Mineração produced 9.2 million tons of ore products, including 2.3 million tons of pellets at the Fabrica Mine. Production by SAMITRI totaled 7 million tons, of which 4.6 million tons was produced at the Alegria Mine. Samarco Mineração S.A. produced 4.1 million tons of concentrates at the Germano Mine and transported the product 240 miles by pipeline to the company's pelletizing plant and shipping facility at Ponta Ubu. Shipments of pellets and concentrates from Ponta Ubu totaled 3.7 million tons, of which most were exported. Cia. Siderúrgica Nacional (CSN) produced 3.3 million tons of concentrates from the Casa de Pedra Mine, for consumption at Volta Redonda.

In Minas Gerais, Minas da Serra Geral S.A. began production of ore at the Capanema Mine in 1982. The company was owned 51% by CVRD and 49% by Japanese companies including Kawasaki Steel Corp. The mine is to supply ore to a steelworks being built at Tubarão. At Itabira, CVRD was completing construction of a plant for production of direct-reduction-grade hematite concentrates. Using pellet feed produced by CVRD at Caué, the plant is to have an annual production capacity of 1 million tons of concentrate containing 0.5% silica and 69% iron. Two large iron ore sintering plants were completed in 1982, including a 5,900-ton-per-day plant for CSN and a 7,900-ton-per-day plant for Cia. Siderúrgica Paulista.

Construction of the Carajás iron ore project was continued by CVRD. At yearend, project completion was reported to be 44% for the mine and railroad and 29% for the port. In August, the International Bank for Reconstruction and Development (World Bank) approved a loan of $304 million for the project, and by early September, agreements were reportedly signed for other loans including $600 million from the European Coal and Steel Community, $500 million from Japanese sources, $200 million from U.S. commercial banks, and $130 million from Kreditanstalt fur Wiederaufbau of the Federal Republic of Germany. Total financing for the project was estimated at $4.9 billion, of which 62% was to be provided by Brazilian sources. The mine was expected to have a production capacity of 35 million tons of ore per year by 1988. Purchase agreements for about 24 million tons per year were reportedly signed by foreign consumers in 1982.

Canada.—Production of iron ore was less than one-half of Canadian capacity as domestic and export demand declined sharply. Exports fell to about 25 million tons, mainly because shipments to the United States were about 50% less than those of 1981. Domestic consumption declined to about 12 million tons.

Shipments of iron ore products, by producers, were as follows, in million tons: Iron Ore Co. of Canada (IOC), 13.0 including 5.9 of pellets and 5.4 of concentrates; Quebec Cartier Mining Co., 9.1; Pickands Mather, 3.0 from Wabush Mines and 0.9 from the Griffith Mine; Sidbec-Normines Inc., 3.8 of pellets including 0.6 of low-silica pellets; CCI, 1.9 of pellets including 1.0 from the Adams Mine; The Algoma Steel Corp. Ltd., 0.9 of sinter from Wawa, Ontario; and Falconbridge Ltd., 0.6 from the Wesfrob Mine in British Columbia. Inco Ltd. shipped 57,000 tons of pellets from its stockpile at Sudbury, Ontario.

IOC announced that its Schefferville mines will be closed permanently in 1983, owing to declining markets for the direct-shipping ore. Most ore produced at Schefferville was shipped to the United States in recent years. IOC's pelletizing plant at Sept-Iles, Quebec, which processed concentrates produced from Schefferville ores, remained closed in 1982. Sidbec's two direct-reduction plants at Contrecoeur, Quebec, were operated in 1982, but total output of DRI was only about one-half of that produced in 1981. The direct-reduction plant at Bruce Lake, Ontario, was idle. In British Columbia, Craigmont Mines Ltd. closed its copper mine near Merritt and ended production of byproduct magnetite concentrates in December. Ore reserves at the Wesfrob Mine were expected to be exhausted by the fall of 1983.

Chile.—Production, exports, and domestic consumption of iron ore declined in 1982 compared with those of 1981. Shipments by Compañía Minera del Pacífico S.A. totaled 6.1 million tons, including 5.4 million tons for export and 0.7 million tons for domestic consumption at Huachipato. Iron ore shipped included 3.3 million tons of Algorrobo pellets, 1.7 million tons of lump ore and fines from El Romeral, and 0.7 million tons from Santa Fe. Improvements in port facilities at Guayacan, completed in 1982, allowed loading of iron ore carriers of up to 190,000 deadweight tons.

European Communities (EC).—Iron ore production, trade, and consumption continued to decline in 1982. Exports of iron ore from the Lorraine district of France to Belgium, Luxembourg, and the Federal Republic of Germany declined to about 5 million tons. Imports of ore by the EC from other countries were estimated at 97 million tons, about 11% less than imports in 1981. Consumption in 1982 declined about 13% from that of 1981.

In the Federal Republic of Germany, Stahlwerke Peine-Salzgitter closed the Haverlahwiese Mine on June 30 after producing 192,000 tons of ore in 1982. The direct-reduction plant at Emden produced 180,000 tons of DRI in 1982 but was closed by Norddeutsche Ferrowerke AG owing to the high price of natural gas and the low price of ferrous scrap. In Luxembourg, there was no production of iron ore in 1982 because the Differdange Mine was closed. In the United Kingdom, British Steel Corp. ceased iron ore mining operations near Scunthorpe and closed the Redcar pelletizing plant for an indefinite period.

India.—Exports of iron ore were estimated at 21.5 million tons, including 12.9 million tons shipped by producers in Goa and 6.6 million tons shipped by the National Mineral Development Corp. Ltd. from the Bailadila and Donimalai Mines. Kudremukh Iron Ore Co. Ltd. (KIOCL) shipped about 1 million tons of pellet feed from Mangalore.

The 3-million-ton-per-year pelletizing plant being built at Mangalore for KIOCL was scheduled for completion in 1984. In Goa the pelletizing plant of Mandovi Pellets Ltd. was expected to be idle for 3 years under an agreement between the producer and Japanese buyers. Instead of pellets, the Japanese agreed to take 1.8 million tons per year of iron ore fines. The Mandovi plant, which has a production capacity of 1.8 million tons of pellets per year, was closed in April 1981 because of the high price of fuel oil. The entire output of the plant was to have been shipped to Japan for 10 years. In Orissa, construction of a coal-based direct-reduction plant was expected to be completed by early 1983. The plant will use a reduction process developed by Allis Chalmers Corp. and was designed to produce 150,000 tons of DRI per year.

Indonesia.—A large direct-reduction plant utilizing the Mexican-developed HyL process was completed at Cilegon for P.T. Krakatau Steel. The plant has a production capacity of about 2.15 million tons of DRI per year and is fueled by natural gas. Production of DRI in 1982 was about 433,000 tons.

Japan.—Imports of iron ore totaled about 120 million tons, including 53 million tons from Australia, 26 million tons from Brazil, and 13 million tons from India. Imports included about 12 million tons of pellets and 4 million tons of sinter. Production of agglomerates in Japan included 92 million tons of sinter and 3 million tons of pellets. Consumption of iron ore totaled 111 million dry tons.

Korea, Republic of.—Imports of iron ore were estimated at 11 million tons in 1982, as production of iron and steel continued to rise. Consumption of iron ore was estimated at more than 12 million tons.

Liberia.—Exports of iron ore totaled 16.1 million tons, about 20% less than exports in 1981. Production and shipments by Lamco Joint Venture declined to 9.3 million tons and 7.7 million tons, respectively. Bong Mining Co. shipped 5 million tons of concentrates and 2.6 million tons of pellets. Shipments by the National Iron Ore Co. (NIOC) declined to 0.8 million tons. In early 1982, the World Bank loaned $20 million to NIOC for improvement of the concentration plant and transportation facilities.

Mauritania.—Exports of iron ore by Société Nationale Industrielle et Minière (SNIM) declined to 7.5 million tons, of which 83% was shipped to the EC and 9% was shipped to Japan. SNIM's contract with the Japanese expired in August 1982 but was not renewed. The company continued its project to develop the Guelbs magnetite deposits. Two concentrating plants, each with a processing capacity of 3 million tons of ore per year, were scheduled to begin production in 1984. A second stage of development was planned to increase output of concentrate to 9 million tons per year by 1990, when ore reserves at Zoverate are expected to be mined out.

Mexico.—Construction of iron ore concentrating plants, pelletizing plants, and slurry pipelines was continued in 1982 in northern Mexico and in Michoacán. By 1985, these projects were expected to increase Mexico's production capacity to about 17 million tons of concentrates per year. Pelletizing will also increase to 14 million tons per year, and the principal concentrating and pelletizing plants will be connected by slurry pipelines.

In northern Mexico, concentrators were being built at the La Perla and Hercules Mines, and 390 miles of pipeline were being laid to connect the concentrators with a pelletizing plant being built at Monclova. The system was designed to deliver up to 4.5

million tons of concentrates per year to Monclova, where up to two-thirds will be pelletized and the remainder will be sent by rail to an existing pelletizing plant at Monterrey.

In Michoacán, production capacity of concentration facilities at the Ferrotepec Mines is being tripled, to 4.5 million tons per year. Magnetite and hematite will be concentrated by magnetic separation followed by flotation, with high-intensity separators used in the hematite circuits. Two grades of concentrate will be produced: blast furnace grade (1.5 million tons per year) and direct-reduction grade (3 million tons per year). Concentrates will be pumped through a 16-mile pipeline to a pelletizing plant at the Lázaro Cardenas steelworks. A direct-reduction plant with production capacity of 2 million tons per year was expected to be completed at the steelworks by 1984. Increased ore requirements at Ferrotepec will be met by open pit mines being developed at the El Mango and El Volcán deposits.

New Zealand.—Exports of titaniferous magnetite concentrates declined to an estimated 2.6 million tons in 1982. The concentrates were produced from beach sands on North Island by New Zealand Steel Ltd. (NZS) and Waipipi Ironsands Ltd.

Four new direct-reduction kilns for processing magnetite concentrates were under construction at Glenbrook, where NZS was increasing its steelmaking capacity to 775,000 tons per year.

Nigeria.—Guarantee tests were successfully completed in November 1982 on the first module of a two-module Midrex direct-reduction plant at Warri. Final testing of the second unit was expected in 1983. The plant was built for Delta Steel Co. and will have a production capacity of about 1 million tons of DRI per year. Production of DRI in 1982 was about 82,000 tons.

At Ajaokuta, construction of a blast furnace and integrated steelworks was continued, with Soviet assistance. Iron ore concentrates for use in the blast furnace may be produced at Itakpe, about 50 miles from Ajaokuta, by 1984.

Norway.—Production and exports of iron ore declined in 1982. Exports were estimated at 2.4 million tons. Production of pellets by AS Sydvaranger was estimated at 1.7 million tons. Production of concentrates by AS Norsk Jernverk was 1.2 million tons. Fosdalens Bergverks AS produced about 393,000 tons of magnetite concentrates at Malm, and AS Titania recovered 28,000 tons of byproduct magnetite from ilmenite ore mined at Tellnes. At Rana Mines, Norsk Jernverk expected to begin operating a new crushing plant at the Ortfjell Mine in 1983, and at Storforshei, the company has built a high-intensity magnetic separation plant to increase the recovery of hematite concentrate.

Peru.—Exports of iron ore by Minpeco S.A. increased to 5.5 million tons, including 3.2 million tons of sinter fines, 1.3 millions tons of pellets, and 1 million tons of pellet feed. Shipments for domestic consumption at Chimbote totaled 339,000 tons and consisted mostly of pellets.

Saudi Arabia.—A Midrex direct-reduction plant built at Jubail for Saudi Iron & Steel Co. produced its first iron in December 1982. The plant has a production capacity of 400,000 tons per year and is one of two plants being built at the site. Completion of the second plant was expected in 1983.

Sierra Leone.—Production of iron ore was resumed at Marampa in November 1982 for the first time since 1975. The operating company, Marampa Iron Ore Mining Co. Ltd., is owned 100% by the Sierra Leone Government. The mining and concentrating operations were designed and built by Austromineral, under contract to the Government. Ore reserves include about 40 million tons of tailings from former plant operations, and an unspecified tonnage of hard itabirite. Iron content averages about 28% in the tailings and 38% in the itabirite. About 2.2 million tons of these materials will be concentrated by Reichert cones, followed by high-intensity magnetic separation, to produce about 1 million tons per year of concentrate containing 64% iron. The product will be transported 50 miles by rail to a shiploading facility at Pepel.

Spain.—Exports of iron ore were estimated at 1.8 million tons, including 1.1 million tons by Cía. Andaluza de Minas S.A. (CAM) from the Marquesado Mine and 0.7 million tons by Cía. Minera de Sierra Menera S.A. (CSM) from Ojos Negros. Shipments for domestic consumption included 2.2 million tons by CAM and 1.1 million tons by CSM. Imports by Spain in 1982 were estimated at 4.4 million tons.

Construction of a pelletizing plant by Prereducidos Suroeste de España S.A. was apparently authorized by the Government in 1982. The plant is to have a production capacity of 1.1 million tons per year and is to be built at Fregenal de la Sierra in Badajoz. Construction will be aided by the Government with a $32 million subsidy and a $30 million loan. Feed for the plant is to be magnetite concentrate, produced from crude ore averaging 34% iron and up to 0.5% copper. Most of the pellets are to be shipped to Government-owned steelworks.

South Africa, Republic of.—Exports and domestic consumption of iron ore declined in 1982 to an estimated 11.3 million tons and 10 million tons, respectively. Exports by Iscor from the Sishen Mine totaled 10.3 million tons, while shipments for the company's own consumption included 6.1 million tons from Sishen and 2.1 million tons from the Thabazimbi Mine. Production of titaniferous magnetite at the Mapouchs Mine by Highveld Steel and Vanadium Corp. Ltd. was 1.64 million tons.

Union Steel Corp. of South Africa Ltd. awarded a contract to a subsidiary of Fluor Corp. for construction of a coal-based direct-reduction plant at Vereeniging. The plant is to utilize plasma-arc technology for production of 250,000 tons of iron per year and was scheduled for completion in 1984. The company also planned to build a coal-fired pelletizing plant at the site, for processing magnetite concentrates from the Palabora Mine. Two other coal-based reduction plants were under construction, one at Germiston for Scaw Metals Ltd. and one at Vanderbijl Park for Iscor. The plant at Germiston, which will utilize a reduction process developed by DRC Corp., was expected to be completed in 1983.

Sweden.—Production and exports of iron ore again declined sharply in 1982. Exports totaled 12.7 million tons, 27% less than exports in 1981. Shipments for domestic consumption totaled 2.4 million tons, and stocks of iron ore at yearend totaled about 11 million tons.

In northern Sweden, Luossavaara-Kiirunavaara AB (LKAB) produced 13.6 million tons of iron ore products including 3.8 million tons of pellets. The company's output was nearly 7 million tons less than that of 1981, owing to declining export demand. In central Sweden, Svenskst Stal AB (SSAB) produced about 1.5 million tons of ore products at Grängesberg and about 354,000 tons of concentrate at the Dannemora Mine.

LKAB was substituting olivine for silica in the manufacture of iron ore pellets in 1982. Research by LKAB and SSAB indicated that the strength and reducibility of pellets could be improved by the addition of magnesia, and that improved blast furnace productivity could result. LKAB's olivine pellets reportedly made up 100% of the iron ore charged to SSAB's blast furnace at Lulea in 1982, and the pellets were tested in blast furnaces at several locations in Europe. Results of the tests reportedly led LKAB to produce the new type of pellet exclusively.

U.S.S.R.—The first stage of the Kostamus iron ore project in Soviet Karelia was completed. This added about 3 million tons to Soviet production capacity for pellets, which was previously estimated at about 55 million tons per year. Another 3 million tons of pelletizing capacity was expected to be added by 1985 when the Kostamus second stage was scheduled for completion. Production of pellets in the U.S.S.R. in 1981 was 53 million tons.

Venezuela.—Shipments of iron ore by C.V.G. Ferrominera Orinoco C.A. totaled 10.4 million tons, 30% less than shipments in 1981. The decline was due to sharply reduced sales to consumers in the United States and Europe. Exports to the United States fell to about 1.6 million tons, the lowest in 30 years. Total exports were estimated at less than 7 million tons. Domestic consumption rose to about 3.7 million tons as production of DRI increased.

Ore shipments by Ferrominera included about 8.6 million tons from mines at Cerro Bolivar and 1.8 million tons from the El Pao Mine. The company planned to shift part of its production from Cerro Bolivar to the San Isidro Mine, to reduce the average phosphorus content of its products. The San Isidro Mine was formerly operated by Siderúrgica del Orinoco (SIDOR).

SIDOR's pelletizing plant at Matanzas produced 3.6 million tons of pellets in 1982 and 2.4 million tons in 1981. The direct-reduction plant operated by Minerales Ordaz C.A. was closed early in 1982 and was not expected to reopen.

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[1]Physical scientist, Division of Ferrous Metals.
[2]Unless otherwise specified, the unit of weight used in this chapter is the long ton of 2,240 pounds.

Table 2.—Employment at iron ore mines and beneficiating plants, quantity and tenor of ore produced, and average output per worker in the United States in 1982, by district and State

District and State	Average number of employees	Worker hours (thousands)	Production (thousand long tons) Crude ore	Production Usable ore	Production Iron contained (in usable ore)	Iron content (natural, percent)	Average per worker-hour (long tons) Crude ore	Average per worker-hour Usable ore	Average per worker-hour Iron contained
Lake Superior:									
Minnesota	6,049	11,548	74,227	23,898	15,462	64.7	6.43	2.07	1.34
Michigan and Wisconsin	1,752	3,116	22,352	7,115	4,585	64.4	7.17	2.28	1.47
Total or average	7,801	14,664	[1]96,578	31,013	20,047	64.6	6.59	2.11	1.37
Missouri	282	524	1,241	807	535	66.3	2.37	1.54	1.02
Other States[2]	1,147	2,058	8,744	3,613	2,059	57.0	4.25	1.76	1.00
Total or average	1,429	2,582	9,985	4,420	2,594	58.7	3.87	1.71	1.00
Grand total or average	9,230	17,246	106,563	35,433	22,641	63.9	6.18	2.05	1.31

[1]Data do not add to total shown because of independent rounding.
[2]Includes California, Colorado, Montana, Nevada, Texas, Utah, and Wyoming.

Table 3.—Crude iron ore mined in the United States in 1982, by district, State, and mining method[1]

(Thousand long tons and exclusive of ore containing 5% or more manganese)

District and State	Open pit	Under-ground	Total quantity
Lake Superior:			
Michigan	W	--	W
Minnesota	74,227	--	74,227
Wisconsin	W	--	W
Total reportable	74,227	--	96,578
Other States:			
Missouri	--	1,241	1,241
Other[2]	8,744	--	8,744
Total	8,744	1,241	9,985
Total withheld	22,351	--	22,351
Grand total	105,322	1,241	106,563

W Withheld to avoid disclosing company proprietary data; included in "Total withheld" and "Total quantity."
[1]Excludes byproduct ore.
[2]Includes California, Colorado, Montana, Nevada, New York, Texas, Utah, and Wyoming.

Table 4.—Crude iron ore mined in the United States in 1982, by district, State, and variety

(Thousand long tons and exclusive of ore containing 5% or more manganese)

District and State	Number of mines	Hematite	Limonite[1]	Magnetite	Total quantity
Lake Superior:					
Michigan	2	W	--	W	21,631
Minnesota	10	910	--	73,316	[2]74,227
Wisconsin	1	--	--	721	721
Total reportable	13	910	--	74,037	[2]96,578
Other States:					
Missouri	1	--	--	1,241	1,241
Other[3]	13	W	W	W	8,744
Total reportable	14	--	--	1,241	9,985
Total withheld	--	16,885	[4]W	13,490	--
Grand total	27	17,795	[4]W	88,768	106,563

W Withheld to avoid disclosing company proprietary data; included in "Total withheld" and "Total quantity."
[1]Includes siderite ore.
[2]Data do not add to total shown because of independent rounding.
[3]Includes California, Colorado, Montana, Nevada, New York, Texas, Utah, and Wyoming.
[4]Included with hematite ore.

Table 5.—Usable iron ore produced in the United States in 1982, by district, State, and variety

(Thousand long tons and exclusive of ore containing 5% or more manganese)

District and State	Hematite	Limonite[1]	Magnetite	Total quantity[2]
Lake Superior:				
Michigan	W	--	W	6,874
Minnesota	525	--	23,373	23,898
Wisconsin	--	--	241	241
Total reportable	525	--	23,614	31,013
Other States:				
Missouri	--	--	807	807
Other[3]	W	W	W	3,613
Total reportable	--	--	807	4,420
Total withheld	6,194	[4]W	4,292	--
Grand total[2]	6,720	[4]W	28,714	35,433

W Withheld to avoid disclosing company proprietary data; included in "Total withheld" and "Total quantity."
[1]Includes siderite ore.
[2]Data may not add to totals shown because of independent rounding.
[3]Includes California, Colorado, Montana, Nevada, New York, Texas, Utah, and Wyoming.
[4]Included with hematite ore.

Table 6.—Usable iron ore produced in the United States in 1982, by district, State, and type of product

(Thousand long tons and exclusive of ore containing 5% or more manganese)

District and State	Direct-shipping ore	Concentrates	Agglomerates	Average iron content (natural), percent
Lake Superior:				
Michigan	--	--	W	64.4
Minnesota	--	527	23,372	64.7
Wisconsin	--	--	241	65.5
Total reportable or average	--	527	23,613	64.6
Other States:				
Missouri	--	W	742	66.3
Other[1]	270	W	W	57.0
Total reportable or average	270	--	742	58.7
Total withheld	--	1,603	8,678	--
Grand total or average	270	2,130	33,033	63.9

W Withheld to avoid disclosing company proprietary data; included in "Total withheld."
[1]Includes California, Colorado, Montana, Nevada, New York, Texas, Utah, and Wyoming.

Table 7.—Shipments of usable iron ore from mines in the United States in 1982

(Thousand long tons and thousand dollars exclusive of ore containing 5% or more manganese)

District and State	Gross weight of ore shipped				Iron content of ore shipped				Total value
	Direct-shipping ore	Concentrates	Agglomerates	Total quantity[1]	Direct-shipping ore	Concentrates	Agglomerates	Total quantity[1]	
Lake Superior:									
Michigan	W	--	W	7,776	W	--	W	4,956	W
Minnesota	--	752	22,963	23,715	--	398	14,810	15,208	1,021,056
Wisconsin	--	--	263	263	--	--	172	172	W
Total reportable	--	752	23,226	31,754	--	398	14,982	20,336	1,021,056
Other States:									
Missouri	--	65	652	717	--	43	431	474	27,820
Other[2]	W	1,375	W	3,284	W	777	W	1,903	73,022
Total reportable	--	1,440	652	4,001	--	820	431	2,377	100,842
Total withheld	374	--	9,311	--	203	--	5,879	--	369,911
Grand total	374	2,192	33,189	[3]35,756	203	1,218	21,292	22,713	1,491,809

W Withheld to avoid disclosing company proprietary data; included in "Total withheld."
[1]Data may not add to totals shown because of independent rounding.
[2]Includes California, Colorado, Montana, Nevada, New Mexico, New York, Texas, Utah, and Wyoming.
[3]Includes byproduct ore.

Table 8.—Usable iron ore produced in the U.S. Lake Superior district, by range

(Thousand long tons and exclusive after 1905 of ore containing 5% or more manganese)

Year	Marquette	Menominee	Gogebic	Vermilion	Mesabi	Cuyuna	Spring Valley	Black River Falls	Total[1]
1854-1976	453,786	320,467	320,334	103,528	3,096,253	70,336	8,149	5,871	4,378,722
1977	W	W	--	--	30,943	--	--	690	43,952
1978	W	W	--	--	55,316	--	--	660	72,727
1979	W	W	--	--	59,320	--	--	698	77,151
1980	W	W	--	--	45,162	--	--	699	62,282
1981	W	W	--	--	51,025	--	--	854	67,462
1982	W	W	--	--	23,898	--	--	241	31,013
Total	529,990	329,344	320,334	103,528	3,361,917	70,336	8,149	9,713	4,733,309

W Withheld to avoid disclosing company proprietary data; included in "Total."
[1]Data may not add to totals shown because of independent rounding.

Table 9.—Average analyses of total tonnage[1] of all grades of iron ore shipped from the U.S. Lake Superior district

Year	Quantity (thousand long tons)	Content (percent)[2] Iron	Phosphorus	Silica	Manganese	Alumina	Moisture
1976	64,928	61.38	0.029	6.72	0.26	0.43	3.20
1977	43,239	61.66	.028	6.60	.28	.44	2.99
1978	74,307	62.26	.025	6.44	.27	.40	2.61
1979	77,837	62.55	.031	6.24	.22	.35	2.61
1980	61,536	62.98	.023	5.88	.18	.32	2.57
1981	64,925	63.13	.020	5.70	.17	.30	2.59
1982	32,173	63.50	.018	5.40	.13	.31	2.60

[1]Railroad weight—gross tons.
[2]Iron and moisture on natural basis; phosphorus, silica, manganese, and alumina on dried basis.

Source: American Iron Ore Association.

Table 10.—Consumption of iron ore and agglomerates in the United States in 1982

(Thousand long tons and exclusive of ore containing 5% or more manganese)

State	Iron ore and concentrates[1]		Agglomerates[2]		Miscellaneous[3]	Total reportable
	Blast furnaces	Steel furnaces	Blast furnaces	Steel furnaces		
Alabama, Kentucky, Texas	433	W	W	W	W	433
California, Colorado, Utah	892	W	W	--	W	892
Ohio and West Virginia	1,474	W	12,683	W	W	14,157
Illinois, Indiana, Michigan	179	W	28,258	W	W	28,437
Maryland, New York, Pennsylvania	1,209	31	11,991	45	W	13,276
Undistributed	--	190	5,427	34	1,067	6,718
Total[4]	4,189	222	58,359	79	1,067	63,916

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Not including pellets or other agglomerated products.
[2]Includes 37,095,163 tons of pellets produced at U.S. mines and 5,416,641 tons of foreign pellets and other agglomerates.
[3]Includes iron ore consumed in production of cement and direct-reduced iron, and iron ore shipped for use in manufacturing of paint, ferrites, heavy media, cattle feed, refractory and weighting materials, and lead blast furnaces.
[4]Data may not add to totals shown because of independent rounding.

Table 11.—Iron ore consumed in production of sinter at iron and steel plants in the United States in 1982

(Thousand long tons)

State	Iron ore consumed[1]	Sinter produced
Alabama, Kentucky, Texas	586	1,
California, Colorado, Utah	W	
Ohio and West Virginia	W	
Illinois, Indiana, Michigan	2,839	6,5
Maryland, New York, Pennsylvania	4,062	5,6
Undistributed	1,449	2,7
Total	8,936	[2]16,2

W Withheld to avoid disclosing company proprietary data.
[1]Includes domestic and foreign ores.
[2]Data do not add to total shown because of independent rounding.

Table 12.—Beneficiated iron ore shipped from mines in the United States[1]

(Thousand long tons and exclusive of ore containing 5% or more manganese)

Year	Beneficiated ore	Total iron ore	Proportion of beneficiated ore to total (percent)
1977	52,061	53,880	96.6
1978	80,875	82,826	97.6
1979	84,489	86,130	98.1
1980	68,272	69,562	98.1
1981	71,169	72,181	98.6
1982	35,381	35,756	99.0

[1]Beneficiated by further treatment than ordinary crushing and screening. Excludes byproduct ore.

Table 13.—Stocks of usable iron ore at mines,[1] December 31, by district

(Thousand long tons)

District	1981	1982
Lake Superior	8,670	7,8
Other States	4,064	4,3
Total	12,734	12,1

[1]Excluding byproduct ore.

Table 14.—Production of iron ore agglomerates[1] in the United States, by type

(Thousand long tons)

Type	Agglomerates produced	
	1981	1982
Sinter	[2]24,327	[3]16,200
Pellets	69,538	32,775
Total	93,865	48,975

[1]Production at mines and consuming plants.
[2]Includes 10,683,505 tons of self-fluxing sinter.
[3]Includes 7,536,459 tons of self-fluxing sinter.

Table 15.—Average value of usable iron ore[1] shipped from mines or beneficiating plants in the United States in 1982

(Dollars per long ton)

Type of ore	Lake Superior district	Other States[2]
Direct-shipping	W	15.9
Concentrates	W	24.1
Pellets	44.19	27.8

W Withheld to avoid disclosing company proprietary data.
[1]F.o.b. mine or plant. Excludes byproduct ore.
[2]Includes California, Colorado, Missouri, Montana, Nevada, Texas, Utah, Wisconsin, and Wyoming.

Table 16.—U.S. exports of iron ore, by country

(Thousand long tons and thousand dollars)

Country	1980 Quantity	1980 Value	1981 Quantity	1981 Value	1982 Quantity	1982 Value
Canada	5,652	228,868	5,529	243,527	3,173	150,200
France	(1)	48	(1)	2	(1)	6
Germany, Federal Republic of	1	42	(1)	3	--	--
Japan	(1)	6	(1)	2	--	--
Mexico	25	1,212	11	720	1	67
Norway	--	--	(1)	59	--	--
Taiwan	(1)	3	--	--	(1)	1
United Kingdom	(1)	10	(1)	21	(1)	21
Other	11	379	5	351	3	227
Total[2]	5,689	230,568	5,546	244,685	3,178	150,522

[1]Less than 1/2 unit.
[2]Data may not add to totals shown because of independent rounding.

Table 17.—U.S. imports for consumption of iron ore, by country

(Thousand long tons and thousand dollars)

Country	1980 Quantity	1980 Value	1981 Quantity	1981 Value	1982 Quantity	1982 Value
Australia	(1)	1	--	--	(1)	4
Brazil	1,995	62,889	1,738	52,267	972	26,339
Canada	17,311	581,759	18,845	707,974	9,281	359,708
Chile	322	10,293	342	6,329	47	673
India	--	--	--	--	--	--
Liberia	1,590	27,612	2,160	35,505	2,399	43,036
Norway	--	--	--	--	--	--
Peru	193	6,678	77	2,402	35	1,057
South Africa, Republic of	6	82	--	--	52	1,083
Sweden	33	917	87	2,318	71	2,171
Venezuela	3,602	80,981	5,071	140,931	[2]1,643	[2]36,768
Other	6	1,632	8	251	(1)	7
Total[3]	25,058	772,844	28,328	947,977	14,501	470,847

[1]Less than 1/2 unit.
[2]Excludes approximately 175,000 long tons of direct-reduced iron valued at $24,000,000, originally reported as iron ore.
[3]Data may not add to totals shown because of independent rounding.

Table 18.—U.S. imports for consumption of iron ore in the United States, by customs district

(Thousand long tons and thousand dollars)

Customs district	1980 Quantity	1980 Value	1981 Quantity	1981 Value	1982 Quantity	1982 Value
Baltimore	5,230	185,445	5,421	212,960	3,451	118,425
Buffalo	592	10,756	629	13,096	299	5,791
Charleston	--	--	--	--	--	--
Chicago	2,811	102,566	3,854	128,320	2,667	91,454
Cleveland	4,333	124,893	4,995	179,616	2,087	77,001
Detroit	547	8,751	765	25,303	228	4,873
Galveston	212	5,979	123	2,579	--	--
Houston	944	34,633	775	30,809	376	14,654
Los Angeles	107	2,745	--	--	--	--
Mobile	3,675	113,050	3,847	131,445	1,278	49,584
New Orleans	180	3,465	237	5,177	423	9,915
Philadelphia	6,005	166,943	7,218	203,969	3,497	92,002
Portland, Oreg	--	--	--	--	--	--
Wilmington, N.C	406	13,140	425	13,428	76	2,949
Other	16	478	38	1,275	118	4,198
Total[1]	25,058	772,844	28,328	947,977	14,501	470,847

[1]Data may not add to totals shown because of independent rounding.

Table 19.—Iron ore, iron ore concentrates, and iron ore agglomerates: World production, by country[1]

(Thousand long tons)

Country[2]	Gross weight[3]					Metal content[4]				
	1978	1979	1980	1981[p]	1982[e]	1978	1979	1980	1981[p]	1982[e]
Albania[5]	502	521	541	590	590	176	84	189	197	197
Algeria	3,003	[r]2,819	3,399	3,352	3,400	1,622	[r]1,523	1,836	1,810	1,860
Argentina	895	601	430	392	615	[r]480	[r]390	271	247	387
Australia	81,821	90,268	94,025	83,324	[6]86,402	51,990	[r]56,932	59,482	52,692	[6]54,692
Austria	2,744	3,149	3,149	3,002	2,950	853	983	970	933	930
Belgium	42	--	--	--	--	13	--	--	--	--
Bolivia	[r]54	25	6	6	9	35	16	4	4	[6]5
Brazil	83,643	[r]102,439	112,920	96,314	108,300	54,368	[r]66,585	73,398	62,604	70,370
Bulgaria	2,413	2,070	1,856	1,726	1,530	750	641	581	529	470
Canada[7]	41,091	58,942	47,984	48,768	33,951	25,814	37,086	30,316	30,900	21,390
Chile	[r]6,694	7,006	8,139	7,621	5,714	[r]4,123	[r]4,316	5,014	4,695	3,520
China	68,900	73,800	73,800	69,000	68,900	34,400	36,900	36,900	34,500	34,500
Colombia	489	391	498	412	400	224	180	229	190	184
Czechoslovakia	1,991	1,980	1,938	1,904	1,870	597	[r]524	504	494	490
Denmark	5	[r]7	8	8	8	2	[r]3	3	3	2
Egypt	1,433	1,412	1,748	[e]1,771	2,100	717	706	874	[e]885	1,080
Finland[8]	1,071	1,126	1,153	1,211	[6]1,065	700	726	743	780	690
France	32,925	31,127	28,522	21,257	19,090	10,147	9,645	8,956	6,693	[6]6,088
German Democratic Republic[e 9]	79	69	69	69	69	33	29	29	29	29
Germany, Federal Republic of (salable)	1,572	1,622	1,917	1,547	1,380	[r]502	[r]518	588	469	440
Greece[5]	1,658	1,803	1,428	[e]1,378	1,380	725	788	624	[e]600	600
Hungary	526	524	419	415	460	120	[r]119	89	87	95
India	38,224	[r]39,229	41,274	40,700	[6]40,256	23,929	[r]24,558	24,853	25,479	25,200
Indonesia	230	79	62	85	145	133	46	36	49	84
Iran[10]	1,535	[e]600	[e]590	[e]590	700	937	[e]365	360	[e]360	400
Italy[11]	347	215	182	[e]121	118	139	88	73	[e]48	49
Japan[12]	586	453	470	[e]435	[6]355	361	284	294	270	[6]221
Kenya[13]	20	20	14	[e]14	14	[e]12	[e]12	9	[e]9	9
Korea, North[e]	7,000	7,300	7,900	[e]7,900	7,900	2,900	3,000	3,200	[e]3,200	3,200
Korea, Republic of	682	629	609	585	[6]544	382	352	342	327	305
Liberia	17,705	18,055	17,900	19,393	[6]17,878	[e]10,978	[e]11,194	11,000	12,000	11,100
Luxembourg	822	620	551	[e]492	--	246	186	165	[e]148	--
Malaysia	315	345	365	524	370	192	210	223	320	230
Mauritania	6,824	9,225	8,795	8,567	6,890	4,231	5,720	5,248	5,160	4,480
Mexico[14]	5,249	5,965	7,510	7,893	8,030	3,500	3,977	5,007	5,209	[6]5,297
Morocco	58	61	77	72	195	37	39	49	46	125
New Zealand[15]	3,884	3,472	3,580	3,202	3,000	2,214	1,979	2,041	1,824	1,700
Norway	3,713	[r]4,002	3,823	4,000	[6]3,214	2,413	[r]2,601	2,434	2,642	2,090
Peru	4,844	5,358	5,614	5,973	[6]5,683	3,148	3,565	3,735	3,944	3,750

Philippines	2	3	--	[e]7	10	1	[r]2	--	[e]4	6
Poland	521	[r]245	102	103	98	156	71	30	29	29
Portugal[16]	54	59	56	[e]56	54	26	28	25	[e]26	24
Romania	2,471	2,483	2,296	[e]2,362	2,360	642	646	597	[e]614	610
Sierra Leone	--	--	--	--	65	--	--	--	--	41
South Africa, Republic of[17]	[r]23,062	31,066	25,896	27,871	[6]24,166	15,247	19,883	16,574	17,837	[6]15,467
Spain[18]	8,444	8,687	9,081	[e]8,430	8,370	3,845	3,931	4,303	[e]4,151	4,130
Swaziland	1,246	--	--	--	--	748	--	--	--	--
Sweden	21,147	25,755	26,755	[e]22,858	[6]15,883	13,724	16,714	17,364	[e]14,835	10,320
Thailand	87	101	84	61	[6]27	48	56	46	33	15
Tunisia	334	387	383	390	[6]270	173	197	211	202	140
Turkey	3,157	[e]2,952	2,489	2,889	2,900	1,641	1,532	[e]1,292	1,560	1,570
U.S.S.R	[r]242,506	237,920	240,848	238,588	240,100	[r]132,247	[r]129,377	130,786	129,000	129,900
United Kingdom	4,172	4,202	901	719	460	1,102	[r]1,092	234	158	100
United States[18]	81,583	85,716	69,613	73,174	35,433	50,764	53,639	43,888	46,539	22,642
Venezuela	13,302	15,019	15,848	15,286	11,516	8,247	9,312	9,826	9,477	7,140
Yugoslavia	4,492	4,544	4,458	4,718	5,025	1,621	1,619	[e]1,600	1,680	1,560
Zimbabwe	1,105	1,182	1,596	1,079	820	674	721	973	658	500
Total	[r]833,274	[r]897,650	883,671	843,204	783,302	[r]475,049	[r]515,690	508,418	487,179	450,453

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through June 29, 1983.
[2]In addition to the countries listed, Cuba and Vietnam may produce iron ore, but definitive information on output levels, if any, is not available.
[3]Insofar as availability of sources permits, gross weight data in this table represent the nonduplicative sum of marketable direct-shipping iron ores, iron ore concentrates, and iron ore agglomerates produced by each of the listed countries. Concentrates and agglomerates produced from imported iron ores have been excluded, under the assumption that the ore from which such materials are produced has been credited as marketable ore in the country where it was mined.
[4]Data represent actual reported weight of contained metal or are calculated from reported metal content. Estimated figures are based on latest available iron ore content reported, except for the following countries for which grades are U.S. Bureau of Mines estimates: Albania, China, Denmark, Hungary, North Korea, and Zimbabwe.
[5]Nickeliferous iron ore.
[6]Reported figure.
[7]Series revised to represent gross weight and metal content of usable iron ore (including byproduct ore) actually produced, natural weight, except for 1982.
[8]Includes magnetite concentrate, pelletized iron oxide (from pyrite sinter), and roasted pyrite (purple ore).
[9]Includes "roasted ore," presumably pyrite sinter, not separable from available sources.
[10]Year beginning Mar. 21 of that stated.
[11]Excludes iron oxide pellets produced from pyrite sinter.
[12]Concentrate including concentrate derived from iron sand as follows in thousand long tons: 1978—66; 1979—2; 1980, 1981, and 1982—no production reported.
[13]For cement manufacture.
[14]Gross weight calculated from reported iron content based on grade of 66% Fe.
[15]Concentrates from titaniferous magnetite beach sands.
[16]Includes manganiferous iron ore.
[17]Includes magnetite ore as follows in thousand long tons: 1978—3,821; 1979—4,004; 1980—4,221; 1981—4,175; and 1982—4,253.
[18]Includes byproduct ore.

Iron Oxide Pigments

By William I. Spinrad, Jr.[1]

U.S. mine production, shipments, and value of crude iron oxide pigments increased in 1982, but shipments and value of domestic finished iron oxides and iron oxides from steel plant wastes declined. Synthetic iron oxide comprised 61% of total finished iron oxide shipments. Most producers of finished iron oxides reported declines in shipments in 1982, with one showing no production. Columbian Chemicals Co. permanently closed its synthetic iron oxide plant in Trenton, N.J.

Consumption of iron oxide pigments was greatest in the paint and coatings industry, with consumption in construction materials; colorants for plastics, rubber, paper, textiles, glass, and ceramics; and ferrites and other magnetic, and electronic applications ranking next in percentage of total consumption.

Price increases were reportedly announced for selected grades of synthetic iron oxides, but never materialized because of competitively priced imports, advanced buying, and discounting among some domestic producers.

A net trade deficit for iron oxide pigments was experienced by the United States in 1982, with U.S. imports of iron oxide pigments greatly surpassing U.S. exports. World mine production of natural iron oxide pigments for reporting countries declined in 1982 compared with that of 1981.

Domestic Data Coverage.—Mine production and sales data for crude iron oxide pigments and sales data for finished iron oxide pigments and iron oxides from steel plant wastes were compiled from voluntary responses received from an annual survey of U.S. producers conducted by the Bureau of Mines. Responses for crude iron oxide mine production and sales data were received from five companies representing 100% of all producers that mine and/or ship crude iron oxide pigments in the United States, as shown in table 1. Of the 19 companies canvassed for finished iron oxide pigments sales data in 1982, 100% responded representing 100% of the total production shown in table 2. Of the six companies canvassed for sales data for iron oxides recovered from steel plant wastes, 100% responded representing 100% of the total production shown in the text discussion under Domestic Production.

Table 1.—Salient iron oxide pigments statistics in the United States

	1978	1979	1980	1981	1982
Mine production short tons	84,796	87,869	49,078	46,213	48,828
Crude pigments sold or used do	75,967	74,548	62,642	67,214	67,294
Value thousands	$2,799	$2,578	r$3,272	r$2,285	$2,702
Iron oxides from steel plant wastes short tons	20,924	25,186	20,717	20,879	12,974
Value thousands	$1,396	$1,703	$1,394	$1,637	$972
Finished pigments sold short tons	152,510	156,036	136,336	141,252	121,679
Value thousands	$81,830	$94,175	$97,270	$110,859	$112,242
Exports short tons	7,064	4,852	5,046	4,967	9,065
Value thousands	$6,649	$7,359	$9,132	$11,704	$17,795
Imports for consumption short tons	70,549	55,377	39,446	39,661	25,855
Value thousands	$24,706	$24,341	$20,035	$18,915	$13,330

rRevised.

DOMESTIC PRODUCTION

Mine production of crude iron oxide pigments increased 6% in 1982, compared with that of the previous year. Shipments and value of these crude pigments increased less than 1% and 18%, respectively. Declines were experienced by most domestic producers, with one showing no mine production. In 1982, crude iron oxide pigments were mined and shipped by three producers with operations located in three States. Another producer reported no production or sales in 1982. Cleveland-Cliffs Iron Co. continued to ship hematite from a stockpile at its permanently closed Mather Mine in northern Michigan.

Total shipments of domestic finished iron oxides in 1982 decreased 14%, but total value increased 1% from that of 1981. Shipments of finished natural iron oxides decreased 17% and shipments of synthetic oxides including specialty oxides decreased 12% from those of 1981. Synthetic iron oxides comprised 61% of the total finished iron oxide shipments. Declines occurred in all categories of finished iron oxides except for burnt siennas and magnetite which increased 44% and 11%, respectively, during the year. Most domestic producers canvassed showed decreases in shipments with one showing no production and one plant closure in 1982.

Iron oxides recovered from steel plant wastes, namely steel plant dust and regenerator oxides, totaled 12,974 short tons in 1982, down 38% from that of 1981. Two of the six producers surveyed reported no production in 1982.

Table 2.—Finished iron oxide pigments sold by processors in the United States, by kind

Kind	1981		1982	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Natural:				
Black: Magnetite	6,068	$851	6,717	$1,023
Brown:				
Iron oxide[1]	13,111	3,720	10,739	3,615
Umbers:				
Burnt	3,723	2,572	2,983	2,139
Raw	1,344	885	949	652
Red:				
Iron oxide[2]	27,203	3,186	20,162	2,403
Sienna, burnt	567	504	815	687
Yellow:				
Ocher[3]	4,970	809	4,774	857
Sienna, raw	358	297	285	241
Total	57,344	12,824	47,424	11,617
Synthetic:				
Brown: Iron oxide[4]	11,158	12,595	10,974	13,943
Red: Iron oxide	32,423	40,014	28,887	34,298
Yellow: Iron oxide	23,925	25,982	21,107	25,183
Other: Specialty oxides	13,469	17,501	[5]13,287	[5]27,200
Total[6]	80,975	96,093	74,255	100,625
Mixtures of natural and synthetic iron oxides	2,933	1,942	W	W
Grand total	141,252	110,859	121,679	112,242

W Withheld to avoid disclosing company proprietary data.
[1]Includes Vandyke brown.
[2]Includes pyrite cinder.
[3]Includes yellow iron oxide.
[4]Includes synthetic black iron oxide.
[5]Includes mixtures of natural and synthetic iron oxides.
[6]Data may not add to totals shown because of independent rounding.

In 1982, a Federal Trade Commission (FTC) administrative law judge gave final approval to BASF Wyandotte Corp.'s 1979 purchase of Chemetron Corp. The purchase, which gave BASF a large boost in its overall share of the U.S. pigment market, had triggered an antitrust suit by the FTC. There was no appeal to the judge's ruling, making it final. Columbian Chemicals permanently closed its synthetic iron oxide plant in Trenton, N.J., in July 1982 to consolidate operations. Pfizer, Inc., announced plans to expand its magnetic materials research center located in Easton, Pa. The reported expansion was scheduled to be completed in December 1982 at a cost of $4 million. In December 1982, a major producer completed construction of a hydrogen chloride regenerator oxide facility for Republic Steel Corp. located in Warren, Ohio. Other regenerator oxide facilities recently completed by this producer include a plant in Fairfield, Ala., for United States Steel Corp. and a plant in Sharon, Pa., for Sharon Steel Corp.

Table 3.—Producers of iron oxide pigments in the United States in 1982

Producer	Mailing address	Plant location
Finished pigments:		
BASF Wyandotte Corp., Pigments Div	100 Cherry Hill Rd. Parsippany, NJ 07054	Wyandotte, Mich.
Blue Ridge Talc Co., Inc	Box 39 Henry, VA 24102	Henry, Va.
Chemalloy Co., Inc	Box 350 Bryn Mawr, PA 19010	Bryn Mawr, Pa.
Columbian Chemicals Co	Box 37 Tulsa, OK 74102	St. Louis, Mo. and Monmouth Junction, N.J.
Combustion Engineering, Inc., CE Minerals Div.	901 East 8th Ave. King of Prussia, PA 19406	Camden, N.J.
DCS Color & Supply Co., Inc	1050 East Bay St. Milwaukee, WI 53207	Milwaukee, Wis.
E. I. du Pont de Nemours & Co	Pigments Dept. Wilmington, DE 19898	Newark, N.J.
Ferro Corp., Ottawa Chemical Div	700 North Wheeling St. Toledo, OH 43605	Toledo, Ohio.
Foote Mineral Co	Route 100 Exton, PA 19341	Exton, Pa.
Hoover Color Corp	Box 218 Hiwassee, VA 24347	Hiwassee, Va.
Mobay Chemical Corp	Penn Lincoln Parkway West Pittsburgh, PA 15205	New Martinsville, W. Va.
New Riverside Ochre Co	Box 387 Cartersville, GA 30120	Cartersville, Ga.
Pfizer Inc., Minerals, Pigments & Metals Div.	235 East 42d St. New York, NY 10017	Emeryville, Calif.; East St. Louis, Ill.; Easton, Pa.; Valparaiso, Ind.
Prince Manufacturing Co	700 Lehigh St. Bowmanstown, PA 18030	Quincy, Ill. and Bowmanstown, Pa.
Reichard-Coulston, Inc	1421 Mauch Chunk Rd. Bethlehem, PA 18018	Bethlehem, Pa.
St. Joe Lead Co., Pea Ridge Iron Ore Co	7733 Forsyth Blvd. Clayton, MO 63105	Sullivan, Mo.
George B. Smith Chemical Works, Inc	1 Center St. Maple Park, IL 60151	Maple Park, Ill.
Solomon Grind-Chem Service, Inc	Box 1766 Springfield, IL 62705	Springfield, Ill.
Sterling Drug, Inc., Hilton-Davis Chemicals Div.	2235 Langdon Farm Rd. Cincinnati, OH 45237	Cincinnati, Ohio.
Crude pigments:		
Cleveland-Cliffs Iron Co., Mather Mine & Pioneer Plant (closed July 31, 1979; shipping from stockpile).	1460 Union Commerce Bldg. Cleveland, OH 44115	Negaunee, Mich.
Hoover Color Corp	Box 218 Hiwassee, VA 24347	Hiwassee, Va.
New Riverside Ochre Co	Box 387 Cartersville, GA 30120	Cartersville, Ga.
St. Joe Lead Co., Pea Ridge Iron Ore Co	7733 Forsyth Blvd. Clayton, MO 63105	Sullivan, Mo.
Virginia Earth Pigments Co	Box 1403 Pulaski, VA 24301	Patterson, Va.

CONSUMPTION AND USES

Iron oxide pigment data on consumption, reported in table 4, have been compiled from information received from the Bureau of Mines annual canvass of iron oxide pigment producers. These data, shown as percentages by end use of reported shipments, are estimates since some producers keep less detailed data concerning end-use breakdowns than others.

Iron oxide pigment consumption in paint and coatings, as a percentage of reported shipments, declined 14% in 1982 compared with that of 1981 to 40,150 short tons or 33% of total consumption. Paint consuming industries, such as the automotive, residential housing, and do-it-yourself home improvement markets all showed declines compared with that of 1981. Shipments of paint, varnish, and lacquer, reported by the U.S. Department of Commerce,[2] totaled 903 million gallons valued at $8.3 billion, down 9% in quantity and 1% in value from that of 1981. Of this total, architectural coatings comprised 454 million gallons; 269 million gallons were product coatings and original equipment manufacture, and 180 million gallons were special-purpose coatings. A forecast published by C. H. Kline & Co. calls for little or no growth in the paint industry through 1986, with unit sales estimated to grow at 0.1% per year through this period.[3]

Iron oxide pigment consumption in construction materials accounted for 21% of iron oxide pigment consumption and totaled 25,550 tons in 1982, down 5% from that of 1981. Declines in residential and nonresidential building construction hindered expected long-term growth in some construction materials, such as roofing and siding materials and colored preformed concrete; all are users of iron oxide pigments. A published forecast calls for a 1.6% and 1.9% annual growth rate in roofing and siding requirements for residential construction through 1995[4] and even larger growth rates are expected in colored preformed concrete markets over the next 4 years.

Colorants for plastics, rubber, paper, textiles, glass, and ceramics accounted for 14% of reported iron oxide consumption in 1982 and totaled 17,050 tons, a decrease of 20% from 1981 quantities consumed.

Ferrites and other magnetic and electronic applications of iron oxides declined 7% from 1981 levels to 15,800 tons, but gained a larger share of reported iron oxide pigment consumption, increasing to 13%. Increases in magnetic tape applications were offset by a sizable decrease in the ferrite sector, which includes hard and soft ferrite applications. Slumps in the automotive and consumer electronics industries influenced this decline.

The remaining 19% of reported iron oxide pigment consumption was used in the manufacture of industrial chemicals, animal feed and fertilizers, foundry sands, cosmetics, and jeweler's rouge.

The Roof Coatings Manufacturers Association, formed in 1982, plans to develop market research on the size, volume, and number of companies in the roof coatings industry and also plans to conduct financial management surveys and business studies. An adhesives and coatings research center is to open January 1, 1983, at Case Western Reserve University, Cleveland, Ohio. Research on adhesives, coatings, and sealants will be conducted by graduate students in fields of chemistry, civil engineering, macromolecular science, metallurgy, and materials science, these projects being supported by industrial sponsors. A magnetic recording research center will be located at the University of California at San Diego. It will be the first such site outside of Japan and will be a combined effort between the university and corporate sponsors. Carnegie-Mellon University in Pittsburgh, Pa., is also planning to start a center for magnetics research and is presently waiting for sufficient corporate backing to initiate the center. The center will have a staff of faculty members, researchers, and graduate students and will concentrate on magnetic materials design and fabrication and on the development of new storage systems. Sponsors will be able to send their own researchers for 1-year assignments to do cooperative research, in addition to receiving annual reviews and reprints of papers written for publication or presentation by members at the center.

Table 4.—Estimated iron oxide pigment consumption, by end use, as a percentage of reported shipments

End use	All iron oxides		Natural iron oxides		Synthetic iron oxides	
	1981	1982	1981	1982	1981	1982
Coatings (industrial finishes, trade sales paints, varnishes, lacquers)	[r]33	33	[r]24	23	40	39
Construction materials (cement, mortar, preformed concrete, roofing granules)	[r]19	21	[r]21	20	[r]18	21
Ferrites and other magnetic and electronic applications	[r]12	13	6	6	[r]17	17
Colorants for plastics, rubber, paper, textiles, glass, ceramics	[r]15	14	[r]14	14	[r]15	14
Industrial chemicals (such as catalysts)	6	4	5	3	[r]6	5
Animal feed and fertilizers	7	8	[r]15	18	[r]1	1
Foundry sands	6	6	[r]14	15	--	--
Other (including cosmetics and jeweler's rouge)	2	1	[r]1	1	[r]3	3
Total	100	100	100	100	100	100

[r]Revised.

PRICES

Price increases for selected grades of synthetic iron oxide pigments were announced by Pfizer and Mobay Chemical Corp. to become effective on August 15 and September 15, 1982, respectively. The increases, which were to average 9%, reportedly never materialized, however, because of competitively priced imports, advanced buying, and discounting among some domestic producers. Price reductions were also announced by Pfizer to become effective September 15, 1982. These reductions, ranging from 0.25 cent to 2.25 cents per pound on selected grades of red synthetic iron oxide, were to readjust certain grades to protect market positions from discounted imported materials. "Kroma" reds were reported to decrease from 66.25 cents to 66 cents per pound and copperas reds reduced from 70 cents to 68 cents per pound.

Table 5.—Prices quoted on finished iron oxide pigments, per pound, bulk shipments, December 31, 1982

Pigment	Low	High
Black:		
Synthetic	$0.5575	$0.6875
Micaceous	.6875	--
Brown:		
Ground iron ore	.1300	.1450
Metallic	.1950	.2325
Pure, synthetic	.5750	.6000
Sienna, Italian, burnt	--	.7000
Umber, Turkish, burnt	.3400	.4250
Red:		
Domestic primers	.3100	.6300
Indian	.4550	.4850
Pure, synthetic	.5950	.6300
Spanish	.3200	.3600
Yellow:		
Synthetic	--	.5875
Ocher, domestic	.1000	.2200

Source: American Paint and Coatings Journal.

FOREIGN TRADE

A net trade deficit for iron oxide pigments was experienced by the United States in 1982, although imports declined and exports increased relative to that of 1981.

U.S. exports of pigment-grade iron oxides and hydroxides received by 49 countries in 1982 increased 83% in quantity and 52% in value from 1981 levels, their highest level in 8 years. Most of this increase was effected by a nearly twentyfold increase in exports to the Federal Republic of Germany with an average value of 28 cents per pound. Chief destinations were the Federal Republic of Germany, Canada, and the United Kingdom, with these countries receiving 71% of all such exports. Exports of other grade iron oxides and hydroxides increased 2% in quantity and 13% in value with main destinations of Japan, the Netherlands, and Canada.

U.S. imports for consumption of selected iron oxide pigments, which were received from 22 countries in 1982, decreased 35% in quantity and 30% in value compared with that of 1981. Monthly import levels were below 1981 levels in all but the last 2 months of 1982. These yearend increases were mainly in synthetic iron oxides, which comprised 80% of all U.S. imports in 1982. Synthetic iron oxides decreased 34% in quantity and 28% in value from 1981 levels and were received chiefly from the Federal Republic of Germany, Canada, and Japan. Natural iron oxide pigments decreased 36% in quantity and 39% in value and were received mainly from Cyprus, Spain, and the Federal Republic of Germany. Italy has again become a major supplier of finished sienna to the United States because of resumption of production at mines in Italy.

Table 6.—U.S. exports of iron oxides and hydroxides, by country

Country	1981				1982			
	Pigment grade		Other grade		Pigment grade		Other grade	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Algeria	--	--	--	--	154	$103	43	$41
Argentina	10	$24	15	$15	13	21	2	5
Australia	88	231	146	443	131	209	163	682
Belgium-Luxembourg	33	89	176	249	12	65	237	435
Brazil	174	412	53	176	387	666	10	37
Canada	2,178	2,386	684	973	1,963	2,266	547	644
Colombia	45	41	9	21	104	159	8	12
Denmark	1	6	6	5	16	49	4	3
Ecuador	12	27	([1])	1	10	28	--	--
Egypt	--	--	--	--	28	20	--	--
El Salvador	r8	r11	--	--	17	37	--	--
Finland	4	5	30	33	17	22	16	18
France	213	293	115	149	344	449	150	272
Germany, Federal Republic of	196	325	177	601	3,849	2,132	138	466
Guatemala	6	17	([1])	1	7	39	--	--
Hong Kong	76	198	--	--	174	567	15	7
India	6	16	42	81	2	12	--	--
Indonesia	25	182	1	4	([1])	1	81	27
Iraq	--	--	--	--	--	--	57	100
Israel	--	--	56	253	4	6	123	359
Italy	388	1,164	55	190	279	1,938	20	30
Jamaica	1	2	--	--	11	23	--	--
Japan	200	1,653	1,651	5,085	309	2,784	2,241	7,372
Korea, Republic of	21	38	41	204	69	122	101	457
Liberia	12	18	10	10	4	5	--	--
Mexico	379	661	356	873	90	291	156	598
Netherlands	77	272	2,308	5,298	70	298	1,515	4,523
New Zealand	11	20	11	10	8	20	2	7
Oman	--	--	--	--	--	--	125	24
Philippines	8	20	2	4	10	13	3	6
Portugal	--	--	33	89	([1])	1	2	19
Saudi Arabia	5	21	--	--	1	4	39	73
Singapore	10	35	104	241	46	333	15	25
South Africa, Republic of	8	22	5	6	16	109	1	1
Spain	8	10	--	--	15	47	--	--
Sweden	14	68	25	148	7	24	110	225
Taiwan	5	69	6	24	23	32	8	28

See footnotes at end of table.

Table 6.—U.S. exports of iron oxides and hydroxides, by country —Continued

Country	1981				1982			
	Pigment grade		Other grade		Pigment grade		Other grade	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Thailand	7	$32	16	$13	23	$23	--	--
Trinidad	--	--	64	194	--	--	105	$361
Turkey	--	--	1	4	--	--	67	152
United Arab Emirates	--	--	--	--	--	--	119	266
United Kingdom	515	2,947	162	494	643	4,574	274	637
Venezuela	169	271	141	248	168	231	108	174
Other	r56	r120	r27	r53	39	69	77	151
Total[2]	4,967	11,704	6,527	16,193	9,065	17,795	6,679	18,237

rRevised.
[1]Less than 1/2 unit.
[2]Data may not add to totals shown because of independent rounding.

Source: U.S. Bureau of the Census.

Table 7.—U.S. imports for consumption of selected iron oxide pigments

Pigment	1981		1982	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Natural:				
Crude:				
Ochers	2	$3	9	$9
Siennas	--	--	21	6
Umbers	5,404	763	3,410	508
Other	r36	r244	84	112
Total	5,442	1,010	3,524	635
Finished:				
Ochers	150	80	22	11
Siennas	98	42	91	40
Umbers	515	181	358	141
Vandyke brown	1,070	340	423	153
Other	933	723	796	464
Total	2,766	1,366	1,690	809
Synthetic:				
Black	2,854	1,576	1,050	682
Red	5,241	3,740	4,763	3,136
Yellow	10,768	5,909	5,988	3,873
Other[1]	12,590	5,314	8,840	4,195
Total	31,453	16,539	20,641	11,886
Grand total	39,661	18,915	25,855	13,330

rRevised.
[1]Includes synthetic brown oxides, transparent oxides, and magnetic and precursor oxides.

Source: U.S. Bureau of the Census.

Table 8.—U.S. imports for consumption of iron oxide and iron hydroxide pigments, by country

Country	Natural				Synthetic			
	1981		1982		1981		1982	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Australia	7	$3	--	--	--	--	98	$44
Austria	103	57	98	$63	--	--	9	5
Belgium-Luxembourg	(1)	(1)	22	6	36	$20	--	--
Brazil	128	66	--	--	--	--	19	13
Canada	69	41	91	32	11,190	3,258	8,770	2,564
Cyprus	5,804	894	3,662	587	--	--	--	--
France	11	172	50	230	1	2	38	15
Germany, Federal Republic of	1,077	412	437	187	16,912	8,944	9,296	6,021
Italy	--	--	45	22	11	13	3	7
Japan	64	499	11	60	1,846	3,387	1,441	2,748
Mexico	--	--	--	--	1,111	672	647	290
Netherlands	--	--	1	25	--	--	--	--
South Africa, Republic of	--	--	20	7	--	--	--	--
Spain	757	144	597	120	68	23	98	32
United Kingdom	189	87	157	75	179	158	220	138
Other	r(1)	r(1)	21	29	99	64	2	7
Total[2]	8,208	2,376	5,214	1,444	31,453	16,539	20,641	11,886

rRevised.
[1]Less than 1/2 unit.
[2]Data may not add to totals shown because of independent rounding.

Source: U.S. Bureau of the Census.

WORLD REVIEW

World mine production of natural iron oxide pigments for reporting countries declined in 1982 compared with that of 1981. In addition to these countries, which are identified in table 9, other countries undoubtedly produce natural iron oxide pigments, including but not limited to the centrally planned economy countries. Principal producers of natural red iron oxide included India and Spain; yellow ocher was produced mainly by the Republic of South Africa, France, Cyprus, Spain, and the United States; sienna was produced primarily by Cyprus and Italy; Cyprus was the major umber producer; and micaceous iron oxide was produced chiefly by Austria.

Estimated worldwide production capacity of synthetic iron oxides was reported to be 584,000 short tons in 1982. Synthetic iron oxides comprised 14.6% of total synthetic inorganic pigment production capacity, ranking second to titanium dioxide.[5] Principal world producers of synthetic iron oxide included the Federal Republic of Germany, Japan, the United States, and Canada.

Australia.—Tubemakers of Australia Ltd., Newcastle, New South Wales, Australia, has developed plans to build a $4 million facility to produce synthetic iron oxide from spent pickle liquor. This facility will be capable of producing 1,900 tons of synthetic yellow iron oxide from ferrous sulfate through a new proprietary process. Other synthetic oxide colors will be produced at a later date. The synthetic iron oxides produced at this facility will replace some of Australia's imports, which now total approximately 11,000 tons per year.

Japan.—Domestic production and sales of synthetic iron oxides in 1982 are expected to remain near the 1981 levels of 146,700 and 128,300 tons, respectively. Magnetic materials, consisting mainly of magnetic tape and ferrite end uses, accounted for 79% of all synthetic iron oxide sales. Based on reported forecasts, consumption by the magnetic tape industry is expected to increase 43% to 4,300 tons in 1982 compared with that of 1981. Major Japanese producers of iron oxide magnetic tapes and their estimated production capacities included Toda Industrial Co. Ltd., 11,000 tons; Ishihara Co. Ltd., 7,700 tons; and Titan Industrial Co. Ltd., 6,100 tons. Total estimated production capacity of synthetic iron oxide is 29,700 tons, with an additional 16,500 to 17,600 tons becoming available as other facilities, which are presently under construction, are completed. Consumption by the ferrite industry is expected to decline in 1982 with forecasts for a slump in demand for hard and soft ferrites. Major producers of iron oxides addressing these end uses and estimated production capacities include The Dowa Mining Co., Ltd., 45,200 tons, and Tetsuhara Co., Ltd., 26,500 tons. Total estimated production capacity of synthetic iron oxides for 1982 for ferrites is 138,900 tons. In addition to magnetic material end uses, other major areas of iron oxide consumption include usage in building and road construction materials.[6]

Because of rapid developments within the magnetic recording industry, joint research projects have emerged to keep abreast of its evolving technological base and to ensure market positions of the participants into the future. Large corporations such as Hitachi Ltd., Fujitsu Ltd., Nippon Electric Co., Ltd., and Nippon Telephone and Telegraph Co., Ltd., along with up to a dozen universities, are sharing information on magnetic recording technology and coordinating individual projects under the direction of Shunichi Iwasaki, professor of electrical engineering, Tohoku University in Sendai. These corporations are also sending employees there to be trained and updated on developments in the technology.[7]

Table 9.—Natural iron oxide pigments: World mine production, by country[1]

(Short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Argentina	534	963	1,053	815	770
Australia	310	245	58	138	140
Austria	11,640	13,556	12,080	12,478	12,000
Brazil	6,833	8,303	7,126	[e]8,380	7,700
Burma	508	([3])	([3])	([3])	--
Canada[e]	--	3,000	3,100	3,100	3,100
Chile	5,801	2,855	4,906	5,390	5,300
Cyprus	33,069	[r]28,660	22,046	22,046	[4]22,046
Egypt	270	154	139	[e]140	160
France[e]	17,600	18,200	17,600	16,530	15,400
Germany, Federal Republic of[5]	23,672	31,483	27,193	24,828	25,000
India	85,374	109,168	95,017	87,778	77,200
Iran[e 6]	2,200	1,100	550	550	550
Italy[e]	1,500	1,100	1,100	1,100	900
Morocco	22	28	133	([3])	--
Pakistan	5,150	1,133	359	483	500
Paraguay[e]	165	220	220	220	220
Portugal	90	[e]65	72	[r e]65	55
South Africa, Republic of	2,411	2,492	1,510	1,130	[4]2,355
Spain:					
Ocher	13,478	16,621	15,097	[e]15,400	14,300
Red iron oxide[e]	26,500	27,600	27,600	27,600	25,000
United States	84,796	87,869	49,078	46,213	[4]48,828
Zimbabwe[e]	100	500	1,000	1,200	1,100

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through Apr. 27, 1983.
[2]In addition to the countries listed, a considerable number of others undoubtedly produce iron oxide pigments, but output is not reported, and no basis is available for formulating estimates of output levels. Such countries include (but are not limited to) China and the U.S.S.R. Because unreported output is probably substantial, this table is not added to provide a world total.
[3]Revised to zero.
[4]Reported figure.
[5]Includes Vandyke brown.
[6]Iranian calendar year (Mar. 21 to Mar. 20), beginning in the year stated.

TECHNOLOGY

Research and developments in magnetic fluid technology over the last 15 years have brought about useful industrial applications such as airtight seals for machinery and material separation according to density differences. Magnetic fluids consist of colloidal ferromagnetic particles such as iron, cobalt, nickel, and compounds or alloys of these elements suspended in a liquid carrier. Magnetic fields applied to these fluids generate magnetic body forces within the colloids which, in turn, have been manipulated to accomplish various commercial end uses. Magnetite, one such ferromagnetic material, has been used successfully in magnetic fluid applications. Using this technology, the Bureau of Mines Twin Cities (Minn.) Research Center has been conducting research on magnetogravimetric separation of nonferrous automobile scrap and upgrading of diamondiferous concentrates.[8] Other research in the United States is being conducted by Ferrofluidics Corp. of Nashua, N.H. Research there includes magnetic fluid seals for machinery, gas laser motors, blowers and computers, and ferrofluid voice coils for loudspeakers. In Japan, Hitachi has sorted components of household electrical appliances by type of metal, and in the U.S.S.R. magnetic fluid technology is being used in mineralogical analysis, ink-jet printing, in control of alphanumeric displays, and in the detection of magnetic domains and other metallurgical structures. Technologies to be explored in the future include magnetocaloric engines for cooling and heating devices and pumps.[9]

A study concerning anticorrosive pigments for primer systems has found that iron oxides modified with barium, calcium, and lead exhibit superior anticorrosive properties compared with those of unmodified iron oxides. Better barrier protection was achieved because of the high electrical resistivity, lower water solubility, and slight alkalinity exhibited by these modified pigments.[10]

A study of chemical and pigment markets in the North American pulp and paper industry to 1990 has been completed by Gorham International Inc., Gorham, Maine. Projections of chemical and pigment consumption in 1985 and 1990 were made separately for the pulp and paper industries in the United States and Canada.[11]

Part 27, Paint-Pigments, Resins and Polymers, of the Annual Book of ASTM Standards for 1982 is available from the American Society for Testing and Materials. This part covers 27 new and revised standards and 37 standards adopted by the U.S. Department of Defense. Included are pigment test methods, pigment specifications, and general methods of testing.[12]

A method of fine grinding iron oxide particles below 15 micrometers in narrow size distributions is being utilized by Reichard-Coulston, Inc., thus gaining greater color intensity per pound of pigment. Reichard-Coulston uses a two-bag stainless steel system capable of producing 2,000 pounds of iron oxide pigment per hour with up to 99% of this ground material collected in the bags. Currently this is the only operation of this type in the United States. Pigment, 40 micrometers in size, and steam are injected into a jet mill where autogenous grinding at high velocity accomplishes this reduction. Particles under 15 micrometers are fed to the first baghouse for packaging in 50-pound bags. The second baghouse is used for further collection of iron oxide fines before exhaust air is vented to the atmosphere and also serves as a backup in case of a rupture in the primary bag. Heaters are incorporated in these bags to prevent dew point corrosion and to prevent condensation of steam, which can cause particle agglomeration.[13]

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[1]Physical scientist, Division of Ferrous Metals.

[2]Bureau of the Census, U.S. Department of Commerce. Paint, Varnish, and Lacquer. Report M28F, 1982 (monthly).

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[5]Schmidt, L. K. Synthetic Inorganic Pigments and Their Markets. Chem. Ind. 1982, v. 20, No. 8. pp. 452-456.

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[10]Shirsalkar, M. M., V. N. Muley, and M. A. Sivasamban. New Anticorrosive Pigments From Iron Oxide. Met. Finishing, v. 79, No. 7, July 1981, pp. 57-60.

[11]Industrial Minerals Publications. No. 174, March 1982, p. 80.

[12]American Paint and Coatings Journal. ASTM Coatings Standards Available. V. 67, No. 9, Sept. 13, 1982, p. 36.

[13]Modern Paint and Coatings. Baghouse-Based Grinding Process. V. 72, No. 4, April 1982, p. 47.

Iron and Steel

By Frederick J. Schottman[1]

Steel production continued to decline in 1982 and dropped to the lowest production level since 1946 because of the recession. In December, the steel industry operated at about one-third of capacity. Shipments to all major markets were down sharply, but those to capital goods markets were particularly depressed. Because of financial losses caused by weak demand and weak prices, the domestic steel industry reduced investment plans and closed capacity.

Imports dropped less sharply than domestic shipments and gained a larger share of the U.S. market. Actions were taken under trade laws to restrict imports of dumped or subsidized steel. The steel industries in many older industrialized countries were contracting while some new capacity was being added in developing countries.

Domestic Data Coverage.—Domestic data for the iron and steel industry are developed by the Bureau of Mines from the annual Blast Furnace and Steel Furnace Report. Of the 52 steel operations to which a survey request was sent, 100% responded.

Table 1.—Salient iron and steel statistics

(Thousand short tons unless otherwise specified)

	1978	1979	1980	1981	1982
United States:					
Pig iron:					
Production	87,690	86,975	68,699	73,755	43,342
Shipments	88,543	87,781	69,445	74,218	43,449
Annual average composite price, per ton	$198.31	$203.00	$203.00	$204.66	$213.00
Exports	51	105	73	16	54
Imports for consumption	655	476	400	468	322
Steel:[1]					
Production of raw steel:					
Carbon	116,916	116,226	94,689	r101,462	64,143
Stainless	1,954	2,107	1,701	r1,743	1,235
All other alloy	18,161	18,008	15,445	r17,623	9,198
Total	137,031	136,341	111,835	r120,828	[2]74,577
Capability utilization[3] percent	86.8	87.2	72.8	r78.3	48.4
Net shipments of steel mill products	97,935	100,262	83,853	r88,450	61,567
Finished steel annual average composite price cents per pound[4]	17.957	20.006	21.655	24.224	25.271
Exports of major iron and steel products[5]	3,271	3,400	4,729	3,557	2,367
Imports of major iron and steel products[5]	22,027	18,428	16,355	20,818	17,385
World production:					
Pig iron	r557,438	r585,629	568,400	p557,333	e500,026
Raw steel (ingots and castings)	r787,944	r821,083	787,058	p777,359	e708,269

eEstimated. pPreliminary. rRevised.
[1]American Iron and Steel Institute (AISI).
[2]Data do not add to total shown because of independent rounding.
[3]Raw steel production capability is defined by AISI as the tonnage capability to produce raw steel for a sustained full order book.
[4]Iron Age.
[5]U.S. Bureau of the Census.

Legislation and Government Programs.—The Environmental Protection Agency (EPA) expanded the use of "bubble" plans for air pollution control. Under a bubble plan, total emissions of a pollutant from an entire plant are regulated rather than from each source in the plant. The company is allowed to choose the most economical means to meet the overall standard, even though emissions from some of the individual sources may exceed source standards. Under the new EPA policy, the use of bubble plans, which had been allowed only in regions already meeting air quality standards, was expanded to regions that do not yet meet the standards. However, a Federal court ruled that such a policy was not permitted under the Clean Air Act. At the end of the year, the issue was being appealed. EPA also issued rules allowing companies to bank credits for pollution control better than required by law. The credits could be used in the future for plant expansion.

EPA issued rules for water pollution by the iron and steel industry. EPA estimated that the rules would require the iron and steel industry to spend $310 million by 1984 for equipment for existing plants and $420 million for new plants by 1990. However, these costs were significantly lower than the $1 billion expected to be needed for existing plants alone under regulations proposed earlier. In addition to easing some of the requirements of the earlier regulations, EPA proposed to allow bubble plans for water pollution.

The Tax Equity and Fiscal Responsibility Act (Public Law 97-248) reversed some of the tax relief that had been provided to industry in 1981. Particularly important to capital-intensive, cyclical industries such as iron and steel, were changes that slowed down cost recovery and restricted leasing arrangements used to make use of investment tax credits.

DOMESTIC PRODUCTION

Production and shipments of steel in 1982 dropped to the lowest levels since 1946. The decline of the rate of capability utilization, as reported by the American Iron and Steel Institute (AISI), that began in the first half of 1981, continued through 1982. The rate of capability utilization, which was 88.6% in March 1981, was 59.3% in January 1982, rose slightly above 60% in February and March, and then fell to 34.0% in December. The average rate in 1982 was 48.4% compared with 78.3% in 1981. The drop in the rate of production was made more severe by a reduction of inventories by steel producers, steel service centers, and steel consumers. According to the U.S. Department of Commerce, total end-of-year steel inventories decreased 26% from 30.0 million to 22.2 million short tons.

Domestic shipments of steel mill products in 1982, as reported by AISI, were 30% lower than in 1981 and 39% lower than in 1979. Shipments to many major markets including the automotive industry, construction, and appliances in 1982 were down 25% to 30% compared with those of 1981. However, shipments to the oil and gas, the railroad, and the nonelectrical machinery industries were down 56%, 53%, and 44%, respectively.

Total domestic shipments of iron and steel castings were down by about one-third in 1982, according to Commerce data. Shipments included 6.39 million tons of gray iron, 1.80 million tons of ductile iron, 0.28 million tons of malleable iron, and 1.03 million tons of steel castings. The comparable figures for 1981 were 9.73 million, 2.20 million, 0.42 million, and 1.75 million tons, respectively.

The structure of the steel industry was changing rapidly during 1982. Major steel companies reported net losses of over $3 billion in 1982, and several companies were forced into bankruptcy. Plans were announced to close several major steel mills, others were shut down indefinitely, and others were changing ownership. At the same time, capital investment was being reduced because of financial restraints and uncertain future demand.

Bethlehem Steel Corp. announced plans to eliminate about 20% of its capacity by 1984. Iron and steelmaking and most rolling operations at its Lackawanna, N.Y., plant were to be ended, and operations at other plants were to be realigned. About 7,300 jobs were to be eliminated at Lackawanna and another 2,300 at Johnstown, Pa. Bethlehem closed its electric furnace steel mill in Los Angeles, Calif., and announced its intention to close or sell a similar plant in Seattle, Wash. Including costs for closing plants, Bethlehem reported a net loss of $1.5

billion for the year.

Kaiser Steel Corp. announced that it would discontinue iron and steelmaking at its Fontana, Calif., plant but planned to continue rolling operations using imported slabs. The company was negotiating with several groups, including its union employees, for the possible sale of the plant.

McLouth Steel Corp., the 11th largest domestic steelmaker, filed for bankruptcy in late 1981 and was threatened with foreclosure and possible liquidation during much of 1982. Late in the year, the company was bought by Tang Industries, Inc.

Early in 1982, Colt Industries, Inc., announced that it wished to sell its Crucible Steel Division specialty steel plant at Midland, Pa. After unsuccessful talks with potential buyers, the plant was closed. However, late in the year, Jones & Laughlin Steel Corp. agreed to buy the plant and reopen at least part of it in 1983.

National Steel Corp. announced that it would not continue investing in its Weirton, W. Va., plant. The employees at the plant organized a new company and at yearend were negotiating with National to buy the plant. A consultant's report advised that for the new Employee Stock Ownership Plan company to succeed, workers would have to give up about 32% of current wages and benefits.

The United States Steel Corp. (U.S.S.) shut down its Fairfield, Ala., plant indefinitely. At the time of the shutdown, the plant had 3,300 active employees and another 6,000 on layoff. Steel production was not expected to start again before 1984 when a new seamless pipe mill is to be completed. Despite the slump in demand for oil-country tubular products, construction of the new pipe mill was proceeding. This was at least in part because major customers for the pipe were involved in financing its construction. These customers provide a relatively firm market for the new mill's production. U.S.S. reorganized some of its other steel operations in order to make the most efficient use of its facilities. Four plants in the Pittsburgh, Pa., area were combined into a new Mon Valley Works. Two continuous caster projects were delayed, one at the Edgar Thomson plant in the Mon Valley Works and one at the Lorain-Cuyahoga Works in Ohio. Construction continued on a new $250 million rail mill at the South Works in Chicago.

Armco Inc. postponed a $671 million project to increase its pipe capacity because of the poorer outlook for pipe. However, work continued on a $95 million continuous caster at Ashland, Ky., that will eventually produce billets for the pipe mill. In Armco's specialty steel operations, a second slab caster began operating at Butler, Pa., and a new horizontal bloom caster was planned for the Baltimore, Md., stainless steel plant.

Wheeling-Pittsburgh Steel Corp. discussed a joint venture with Kobe Steel Ltd. of Japan to build a $140 million pipe mill at Allenport, Pa. However, talks were ended when the market weakened. The Buffalo, N.Y., integrated steel plant of Republic Steel Corp. was closed indefinitely. Timken Co. continued construction of its new $500 million electric furnace steel plant near Canton, Ohio, but delayed its completion for 6 months until the autumn of 1985.

Hanna Furnace Corp. permanently closed the two merchant pig iron blast furnaces at Buffalo, N.Y. Armco shut down its Houston, Tex., direct-reduction plant because of a sharp increase in natural gas prices.

H. K. Porter Co. closed the Huntington, W. Va., plant of its Connors Steel Co. subsidiary, but the plant was reopened as Steel of West Virginia, Inc. After the bankruptcy of Penn-Dixie Industries, the Penn-Dixie Steel Corp., of Kokomo, Ind., was reorganized as Continental Steel Corp. Guterl Special Steel Corp., Lockport, N.Y., filed for bankruptcy but continued operations under Chapter 11 of the Bankruptcy Act.

Because of the weak financial condition of many domestic steel producers and because of the threat to jobs from lower-priced imported steel, many steel companies received concessions from labor unions. However, the coordinated bargaining group of eight of the largest steel companies twice negotiated tentative agreements with the United Steelworkers of America to replace the contract due to expire in 1983, but both agreements were rejected by votes within the union. Most major steel companies reduced salaries and benefits for salaried workers and eliminated many salaried jobs.

Materials Used in Ironmaking.—Materials needed in ironmaking are shown in tables 3 and 5. Domestic pellets charged to blast furnaces in 1982 totaled 41.5 million tons, and sinter charged amounted to 17.8 million tons. Pellets and other agglomerates from foreign sources amounted to 6.0 million tons. A total of 10.2 million tons of iron ore was consumed by agglomerating plants at or near blast furnaces in producing 17.8 million tons of agglomerates. Other materials consumed by agglomerating plants were 2.4 million tons of mill scale, 0.9 million tons of flue dust, 1.0 million tons of coke breeze, 83,000 tons of anthracite, and 3.9 million tons of fluxes.

Blast-furnace oxygen consumption totaled 16.1 billion cubic feet according to AISI. Blast furnaces, through tuyere injection, consumed 16.1 billion cubic feet of natural gas; 3.2 billion cubic feet of coke oven gas; 105 million gallons of oil; 56.2 million gallons of tar, pitch, and miscellaneous fuels; and 90,000 tons of bituminous coal.

Materials Used in Steelmaking.—In addition to the materials shown in tables 8 and 9, steelmaking furnaces, according to AISI, consumed 0.27 million tons of fluorspar, 0.58 million tons of limestone, 4.19 million tons of lime, 0.52 million tons of other fluxes, and 108 billion cubic feet of oxygen. Metalliferous materials consumed in domestic steel furnaces, per ton of raw steel produced, averaged 1,152 pounds of pig iron, 1,083 pounds of scrap, 25 pounds of ferroalloys, and 5 pounds of ore and agglomerates. The revised figures for 1981 were 1,180 pounds of pig iron, 1,046 pounds of scrap, 28 pounds of ferroalloys, and 5 pounds of ore and agglomerates.

PRICES

The annual average composite price for finished steel in 1982, as reported by Iron Age, was 25.271 cents per pound, an increase of 4.3% over the price in 1981. This percentage increase was the smallest since 1973. The composite price increased only slightly from 25.195 cents per pound in December 1981 to 25.297 cents per pound in December 1982. The composite price for pig iron, according to Iron Age, was unchanged during the year at $213 per ton.

Because of the extremely weak market, discounts of 10% to 20% from list prices for domestic products were common in the second half of the year for products such as structural shapes, plates, and sheet. In coastal areas, imported steel in such forms was sometimes available at 30% to 40% below list.

Minimills tried to raise prices on products as demand for bars and light structurals strengthened early in 1982 but the prices fell as the market deteriorated. Typical prices for merchant-grade products of about 16 cents per pound early in the year fell to below 14 cents per pound in some areas in the second half of the year. In response to competition for minimills, some integrated mills changed their pricing policy for competitive products. One integrated producer established a separate price for steels produced by electric furnaces and continuous casting and for those produced in oxygen or open-hearth furnaces or by ingot casting.

Prices for oil country tubular goods and line pipe dropped sharply in 1982. Prices were discounted as much as 50% and near the end of the year, U.S.S. cut its list prices by 20%. Dealers and consumers had built up stocks during 1981 when they had expected continued strong demand and tight supplies. When drilling activity declined, demand for pipe and tube from steel producers fell sharply and some dealers were forced to sell their stocks at distress sale prices.

FOREIGN TRADE

Exports of major iron and steel products from the United States decreased by over 33% in 1982 compared with those of 1981 because of generally weak foreign markets, strong competition from foreign producers, and a strong U.S. dollar. As in previous years, Canada and Mexico were the most important buyers of U.S. steel, taking 21% and 16% of total exports, respectively. However, exports to Mexico were down 62% because of economic problems in Mexico. Saudi Arabia, Egypt, Italy, and Venezuela were other important markets for exports.

Imports of major iron and steel products decreased in 1982 compared with those of 1981, but they gained a larger share of the U.S. market. The high value of the U.S. dollar for foreign exchange and generally weak prices in world steel markets made foreign steel strongly competitive in the United States.

The European Economic Community (EEC) and Japan supplied 5.6 million and 5.2 million tons, respectively, of steel mill products. Among the EEC countries, the Federal Republic of Germany, France, and

Belgium-Luxembourg supplied 2.1 million, 1.0 million, and 0.9 million tons, respectively. Other leading suppliers were Canada, 1.8 million tons and the Republic of Korea, 1.1 million tons.

Over 100 trade complaints were filed by U.S. steel producers in 1982 against allegedly subsidized or dumped steel imports. Many of these complaints led to extra tariffs or negotiated restrictions on imports.

In January, 7 major U.S. steel producers filed 132 complaints against imports of various carbon and alloy steel products from 11 countries. The complaints included both dumping and subsidization cases. Immediately after the complaints were filed, the U.S. Department of Commerce suspended the trigger-price mechanism that had been in effect to discourage and detect unfairly priced imports. After investigating the complaints, Commerce and the International Trade Commission (ITC) made positive findings in many cases that could have resulted in extra import duties. In some cases the extra duties were applied, but in others, the countries involved agreed to eliminate subsidies or dumping. A major agreement was negotiated with the EEC to limit exports to a maximum share of the U.S. market for each of 10 product categories. The market shares, which were based on recent import levels, ranged from 2.2% for tin plate to 21.85% for sheet piling, with a weighted average for all covered products of 5.5%. In addition, the EEC agreed to cooperate to control exports of pipe and tube if they exceeded 5.9% of the U.S. market. The agreements were to be in effect from November 1, 1982, until the end of 1985. Together, the agreements covered almost all steel imports from the EEC except specialty steel.

The U.S. specialty steel industry also filed dumping and subsidy complaints against imported steel from specific countries. Some of these cases resulted in penalty import duties or negotiated settlements. As the result of an unfair trade practices complaint brought in late 1981, the President of the United States determined in November 1982 that the domestic specialty steel industry was being injured by subsidized imports. The President directed the U.S. Trade Representative to begin negotiations with the countries named in the complaint, but he also requested that the ITC investigate whether the industry should have broader, temporary relief against imports from all countries.

WORLD REVIEW

For the third year, world production of pig iron and steel decreased. Production of steel in 1982 was 14% below that of 1979, leaving a large excess in production capacity. Because of low operating rates and low free-market prices, many steel companies operated at a loss. In many countries, steel industries requested Government help in the form of financial aid, market restraints to maintain domestic prices, or trade protection.

Belgium.—A consultant's report recommended that the steelmaking capacity of Cockerill Sambre S.A. be reduced from 9.4 to 6.3 million tons per year and that 3,500 jobs be eliminated. Several other plans called for similar cuts. The company was forced toward such cuts by the refusal of the EEC to approve any restructuring plan that did not include major capacity reductions and by the threat of the national Government to withhold any further subsidies. However, the plans resulted in strikes and civil unrest in Wallonia where Cockerill plants are located.

Canada.—Because of reduced demand for steel, Canadian steel producers cut back production, laid off workers, reduced pay, and deferred capital investment. Stelco Inc. delayed the completion of a new 145,000-ton-per-year bar mill for 12 months. Dofasco Inc. reduced planned capital spending by 40%. However, a new $360 million, 1.2-million-ton-per-year hot-strip mill was still expected to be finished in 1983. The Algoma Steel Corp. Ltd. slowed work on a 300,000-ton-per-year seamless pipe mill, delaying the expected completion date from early 1984 to late 1984. Algoma also postponed the construction of a 500,000-ton-per-year coke oven battery.

European Economic Community.—The EEC continued to try to control the European steel market through a system of voluntary and mandatory production quotas, pricing regulations, and controls on the quantity and price of imports. Within the EEC countries, independent steel companies, usually small electric furnace plants, complained that the system of market controls worked to the benefit of larger, state-subsidized companies.

Under an agreement made in 1981, state subsidies to the steel industry were to be used only for restructuring the steel industry within plans approved by the EEC. The EEC desired to reduce capacity by about 35 million tons per year by 1985 and rejected several national plans that did not include significant reductions in capacity.

France.—The publication of a plan to restructure the state-owned part of the steel industry that would result in a loss of up to 12,000 jobs resulted in widespread demonstrations by steelworkers. The restructuring is needed under an EEC requirement that subsidies to the steel industry be eliminated by the end of 1985. The restructuring plan included $4.3 billion of state aid through 1985.

State-owned Aciéries et Laminoirs de Lorraine (Sacilor) took over Ugine Aciers, the specialty steel subsidiary of Péchiney Ugine Kuhlmann. The action brought all of the French specialty steel industry under the control of the two major nationalized steel companies.

Germany, Federal Republic of.—German steel companies were attempting to restructure the industry, and Government aid was requested because of losses suffered by the industry. Estel NV, the company formed in 1972 by the merger of Hoesch Werke AG of the Federal Republic of Germany and Hoogovens IJmuiden BV of the Netherlands, was redivided. Various possible mergers were discussed, especially a merger of Hoesch Werke AG with Friedrich Krupp Huttenwerke AG. Arbed Saarstahl was formed by the merger of the German subsidiaries of Arbed S.A. The new company ended iron and steelmaking at Neunkirchen when a new oxygen-furnace shop started up at Völklingen.

The direct-reduction plant at Emden owned by Nordferro, a joint venture of Sydvaranger AS of Norway and Korf Stahl AG, was closed. Higher than expected natural gas prices and low scrap prices made the plant uneconomical.

India.—A new integrated steel mill was under construction at Visakhapatnam for Rashtriya Ispat Nigam Ltd., a new company set up by the Indian Government. The plant has a planned capacity of 1.3 million tons per year by 1986 and 3.7 million tons per year by the end of 1987. Negotiations were underway for equipment and construction of new integrated steel mills at Vijayanagar and Daitari. The Daitari plant had originally been intended for Paradip but it was moved to an inland site reportedly because of high winds along the coast.

Expansion projects were planned for the state-owned steel mills at Bhilai and Bokaro and at the privately owned The Tata Iron & Steel Co. Ltd.

Japan.—Japanese steel production declined again in 1982, and by late in the year investment plans were being modified to reflect the weakness expected in steel markets in the near future. Most investments were to replace older equipment or for equipment such as continuous casting machines to reduce costs.

Although demand for seamless pipe and tube fell in 1982, Nippon Steel Corp., Nippon Kokan K.K., and Kawasaki Steel Corp. continued expansion projects. Sumitomo Metal Industries Ltd. completed a new 660,000-ton-per-year seamless tube mill at its Kainan works.

Mexico.—The startup of the new 2-million-ton-per-year direct-reduction plant at the steel mill of Siderúrgica Lázaro Cárdenas Las Truchas S.A. (Sicartsa) was delayed past 1982. The first two of four reactors were expected to begin production in late 1983 while startup of the other two may be delayed till 1984. Contracts were signed for other equipment for the Sicartsa expansion including four 220-ton electric furnaces and three 2-strand continuous casters. When the new facilities are in operation in the mid-1980's, the raw steel capacity of the plant will be increased from 1.3 million to 3.3 million tons per year, with the additional production going to a new plate mill.

Productos de Acero S.A., a rod and wire producer, ordered electric furnace and continous casting equipment to supply 200,000 tons per year of billets to its rod mill.

Nigeria.—Production of direct reduced iron and steel began at the new Delta Steel Co. Ltd. steelworks near Warri. The plant has two Midrex direct-reduction units, four 130-ton electric furnaces, and direct casting machines. Designed capacity is about 1.1 million tons per year. About one-third of the semifinished billets will be rolled at Warri while the other two-thirds will be sent to three other Nigerian rolling mills.

Philippines.—The National Steel Corp. of the Philippines was negotiating with possible suppliers of equipment for its Iligan City steelworks. Plans included a 1.5-million-ton-per-year direct-reduction plant using domestic coal, three 200-ton electric furnaces, and two slab casting machines.

Saudi Arabia.—Saudi Iron & Steel Co. began production at its reinforcing bar plant in Al-Jubail Province. The plant has two Midrex direct-reduction units and a raw steel capacity of 900,000 tons per year.

South Africa, Republic of.—The Union Steel Corp. Ltd. signed a contract with Fluor Engineers S.A. (Pty.) Ltd. for the construction of a 250,000-ton-per-year sponge iron plant for its steelwork in Vereeniging. The plant will use a plasma process developed by Chemische Werke Huels AG.

Taiwan.—China Steel Corp. began operation of a second blast furnace, a third basic oxygen furnace, and hot-strip and cold-rolled-strip mills. The new facilities raised the company's raw steel capacity to 3.2 million tons per year. However, because of worldwide overcapacity for steel production, plans for further expansion were delayed indefinitely.

U.S.S.R.—The large Magnitogorsk and Kuznetsk integrated steel plants will be modernized by 1990. The open-hearth furnaces at Magnitogorsk, one of the largest steel plants in the world, will be replaced by oxygen furnaces and capacity will be increased. At Kuznetsk, the open hearths will be replaced by electric furnaces.

United Kingdom.—The British Steel Corp. (BSC) continued to shrink as it closed several small operations. The company announced plans to maintain raw steel capacity at 15.8 million tons per year while reducing employment from 92,000 to 75,000 workers over several years. However, under the pressure of continuing losses caused by the recession, company officials suggested that the relatively modern Ravenscraig plant in Scotland might be closed. The Government extended by 2 years, until March 1985, the deadline for BSC to become profitable and independent of subsidies.

Venezuela.—Corporación Venezolana del Guayana, also known as CVG, and U.S.S. permanently closed their jointly owned 1-million-ton-per-year Minorca iron briquette plant. The 8-year-old plant had operated at a loss because of technical problems and weak markets for its products.

The Government of Venezuela enacted a law permitting it to borrow $2.2 billion to finance the initial stage of the Empresa Siderurgia de Zulia C.A., also known as Siderzulia, coal and steel project, which includes a 390,000-ton-per-year coke plant and a 530,000-ton-per-year steel rolling mill. Eventually, the $7 billion project is intended to produce 5.5 million tons per year of steel products. However, it has been delayed from original plans because of worldwide overcapacity for steel. Initial plans for the steel mill included iron smelting and steelmaking, but under the new first-stage plan the mill will roll semifinished steel from other Venezuelan plants.

TECHNOLOGY

Various combinations of top and bottom injection in the oxygen steel furnace continued to be developed. The new processes result in higher yields, better removal of some impurities, and better recovery of alloying elements.[2] The argon-oxygen process was used for the production of high-quality carbon and low-alloy steel.[3]

A practice to produce stainless steels from ores combining the use of electric furnaces (EF), basic oxygen furnaces, and argon-oxygen decarburization (AOD) was reported. The practice was claimed to result in better recovery of alloying elements, higher productivity, and lower energy consumption compared with conventional EF-AOD practice.[4]

Continuous annealing processes have been developed that result in steel with the high formability and aging resistance needed by important sheet consumers such as the automotive industry. The processes also offer advantages over batch annealing in the production of certain high-strength steels.[5]

Two approaches to reduce electrode consumption in electric furnaces were reported. A commercial-size, direct-current furnace was in use and reported significantly lower electrode and refractory wear than in a conventional furnace.[6] Systems for water-cooling electrodes have been developed. Savings of about 20% on electrode consumption were achieved by reducing oxidation of the exposed portion of the electrodes.[7]

Pilot plant development continued on several coal-fueled processes for smelting iron.[8] These processes may be the successors to the blast furnace in regions that have coal but lack inexpensive natural gas used in the most successful direct-reduction processes. Commerical plants using two of the new processes are planned.[9]

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Table 2.—Pig iron produced and shipped in the United States in 1982, by State

State	Production (thousand short tons)	Shipped from furnaces: Quantity (thousand short tons)	Shipped from furnaces: Value (thousands)	Average value per ton at furnace
Alabama	940	856	$193,884	$226.50
Illinois	2,264	2,261	449,475	198.79
Indiana	13,525	13,527	2,717,899	200.92
Michigan	4,144	4,149	766,492	184.74
New York	1,005	1,079	229,854	213.03
Ohio	7,870	7,876	1,780,503	226.07
Pennsylvania	5,448	5,491	1,187,516	216.27
California, Colorado, Utah	1,962	1,961	412,109	210.15
Kentucky, Maryland, Texas, West Virginia	6,184	6,249	1,313,105	210.13
Total or average	43,342	43,449	9,050,837	208.31

Table 3.—Foreign iron ore and manganiferous iron ore (excluding agglomerates) consumed in manufacturing pig iron in the United States, by source

(Thousand short tons)

Source	1981[1]	1982[2]
Australia	250	--
Brazil	37	197
Canada	492	1,876
Venezuela	1,968	1,171
Other countries	130	59
Total[3]	2,878	3,302

[1]Excludes 11,404,938 tons used in making agglomerates.
[2]Excludes 7,931,305 tons used in making agglomerates.
[3]Data may not add to totals shown because of independent rounding.

Table 4.—Pig iron shipped from blast furnaces in the United States, by grade[1]

Grade	1981			1982		
	Quantity (thousand short tons)	Value		Quantity (thousand short tons)	Value	
		Total (thousands)	Average per ton		Total (thousands)	Average per ton
Foundry	429	$87,711	$204.46	195	$39,839	$204.30
Basic	71,922	14,810,426	205.92	42,184	8,799,327	208.59
Bessemer	411	88,491	215.31	572	105,288	184.07
Low phosphorus	W	W	W	W	W	W
Malleable	931	215,637	231.62	368	80,700	219.29
All other (not ferroalloys)	524	106,454	203.16	130	25,683	197.56
Total or average	[2]74,218	15,308,719	206.27	43,449	9,050,837	208.31

W Withheld to avoid disclosing company proprietary data; included with "All other."
[1]Includes molten iron transferred directly to steel furnaces.
[2]Data do not add to total shown because of independent rounding.

Table 5.—Iron ore and other metalliferous materials, coke, and fluxes consumed in blast furnaces, and pig iron produced in the United States, by State

(Thousand short tons unless otherwise specified)

State	Metalliferous materials consumed in blast furnaces: Iron and manganiferous ores: Domestic	Metalliferous materials consumed in blast furnaces: Iron and manganiferous ores: Foreign	Metalliferous materials consumed in blast furnaces: Agglomerates	Metalliferous materials consumed in blast furnaces: Net ores and agglomerates[1]	Metalliferous materials consumed in blast furnaces: Net scrap[2]	Metalliferous materials consumed in blast furnaces: Miscellaneous[3]	Metalliferous materials consumed in blast furnaces: Net total[4]	Net coke	Fluxes	Pig iron produced	Metalliferous materials consumed per ton of pig iron made (short tons): Net ores and agglomerates[1]	Metalliferous materials consumed per ton of pig iron made (short tons): Net scrap[2]	Metalliferous materials consumed per ton of pig iron made (short tons): Miscellaneous[3]	Metalliferous materials consumed per ton of pig iron made (short tons): Net total[4]	Coke and fluxes consumed per ton of pig iron (short tons): Net coke	Coke and fluxes consumed per ton of pig iron (short tons): Fluxes
1981:																
Alabama	W	472	3,906	4,334	5	12	4,351	1,683	192	2,656	1.632	0.002	0.005	1.638	0.634	0.072
Illinois	W	--	6,815	7,000	516	79	7,594	2,495	449	4,504	1.554	.115	.018	1.686	.554	.100
Indiana and Michigan	295	204	36,665	36,708	1,552	928	39,190	12,570	1,043	24,021	1.528	.065	.039	1.631	.523	.043
New York	W	W	4,114	4,226	159	--	4,385	1,630	279	2,714	1.557	.059	--	1.616	.601	.103
Ohio	148	117	17,092	17,159	283	914	18,356	6,540	1,467	11,756	1.460	.024	.078	1.561	.556	.125
Pennsylvania	375	1,577	20,555	22,209	490	604	23,303	8,203	1,214	14,176	1.567	.035	.043	1.644	.579	.086
California, Colorado, Utah	316	W	5,869	6,376	215	9	6,600	2,349	580	4,263	1.496	.050	.002	1.548	.551	.136
Kentucky, Maryland, Texas, West Virginia	--	141	15,585	15,368	330	168	15,865	4,909	454	9,666	1.590	.034	.017	1.641	.508	.047
Total[4]	1,583	2,878	110,601	113,380	3,550	2,714	119,644	40,379	[5]5,678	73,755	1.537	.048	.037	1.622	.547	.077
1982:																
Alabama	--	W	W	1,516	1	30	1,545	624	122	940	1.613	.001	.032	1.644	.664	.130
Illinois	W	--	W	3,871	900	112	4,884	1,472	302	2,264	1.710	.398	.049	2.157	.650	.133
Indiana and Michigan	71	29	27,946	27,649	1,086	501	29,235	9,254	686	17,669	1.566	.061	.028	1.655	.524	.039
New York	W	W	W	1,600	45	1	1,646	577	25	1,005	1.592	.045	.001	1.638	.574	.025
Ohio	66	1,628	11,614	13,182	321	814	14,318	4,206	726	7,870	1.675	.041	.103	1.819	.534	.092
Pennsylvania	323	974	7,414	8,610	235	221	9,065	3,083	612	5,448	1.580	.043	.041	1.664	.566	.112
California, Colorado, Utah	1,000	8	2,298	3,269	150	56	3,475	960	297	1,962	1.666	.076	.029	1.771	.489	.151
Kentucky, Maryland, Texas, West Virginia	--	139	9,763	9,738	144	65	9,947	3,114	190	6,184	1.575	.023	.011	1.609	.504	.031
Total[4]	1,655	3,302	65,363	69,435	2,882	1,800	74,117	23,290	[6]2,960	43,342	1.602	.066	.042	1.710	.537	.068

W Withheld to avoid disclosing company proprietary data; included in "Total."
[1]Net ores and agglomerates equal ore plus agglomerates plus flue dust used minus flue dust recovered.
[2]Excludes home scrap produced at blast furnaces.
[3]Does not include recycled material.
[4]Data may not add to totals shown because of independent rounding.
[5]Fluxes consisted of the following: 2,701 limestone, 1 burnt lime, 2,827 dolomite, and 150 other fluxes, excluding 2,980 limestone, 26 burnt lime, 3,299 dolomite, and 67 other fluxes used in agglomerating production at or near steel plants and an unknown quantity used in making agglomerates at mines.
[6]Fluxes consisted of the following: 1,340 limestone, 46 burnt lime, 1,553 dolomite, and 122 other fluxes, excluding 1,908 limestone, 21 burnt lime, 1,979 dolomite, and 27 other fluxes used in agglomerating production at or near steel plants and an unknown quantity used in making agglomerates at mines.

Table 6.—Number of blast furnaces in the United States, by State

State	1981			1982		
	In blast[1]	Out of blast	Total	In blast[1]	Out of blast	Total
Alabama	3	3	6	1	5	6
California	3	1	4	1	3	4
Colorado	3	1	4	--	4	4
Illinois	6	2	8	2	6	8
Indiana	18	4	22	8	14	22
Kentucky	2	--	2	1	1	2
Maryland	2	2	4	1	3	4
Michigan	7	2	9	5	4	9
New York	4	5	9	1	8	9
Ohio	14	9	23	11	10	21
Pennsylvania	17	23	40	7	33	40
Texas	2	--	2	1	1	2
Utah	2	1	3	1	2	3
West Virginia	3	1	4	2	2	4
Total	86	54	140	42	96	138

[1]In blast for 180 days or more during the year.

Table 7.—Steel production in the United States, by type of furnace

(Thousand short tons)

Year	Open-hearth	Basic oxygen converter	Electric	Total
1978	21,310	83,484	32,237	137,031
1979	19,158	83,256	33,927	136,341
1980	13,054	67,615	31,166	111,835
1981	13,452	73,231	[r]34,145	[r]120,828
1982	6,110	45,309	23,158	74,577

[r]Revised.

Source: American Iron and Steel Institute.

Table 8.—Metalliferous materials consumed in steel furnaces[1] in the United States

(Thousand short tons)

Year	Iron ore[2]		Agglomerates[2]		Pig iron	Ferro-alloys[3]	Iron and steel scrap
	Domestic	Foreign	Domestic	Foreign			
1978	110	537	[r]365	79	83,577	1,917	70,375
1979	73	409	[r]146	74	81,948	1,978	71,715
1980	45	244	[r]111	50	65,543	1,603	61,930
1981	27	207	[r]43	34	71,284	1,663	63,195
1982	29	64	31	58	42,941	947	40,379

[r]Revised.
[1]Basic oxygen converter, open-hearth, and electric furnace.
[2]Consumed in integrated steel plants only.
[3]Includes ferromanganese, spiegeleisen, silicomanganese, manganese metal, ferrosilicon, ferrochromium, and ferromolybdenum. Includes ferroalloys added to steel outside the furnace.

Table 9.—Consumption of pig iron in the United States, by type of furnace or other use

Type of furnace or other use	1980		1981		1982	
	Thousand short tons	Percent of total	Thousand short tons	Percent of total	Thousand short tons	Percent of total
Basic oxygen converter	56,414	81.7	62,162	82.8	38,553	86.8
Open-hearth	8,606	12.5	8,867	11.8	3,635	8.2
Electric	855	1.2	583	.8	496	1.1
Cupola	698	1.0	685	.9	481	1.1
Air and other furnaces[1]	299	.4	254	.3	141	.3
Direct castings[2]	2,182	3.2	2,489	3.3	1,102	2.5
Total[3]	69,053	100.0	75,040	100.00	44,409	100.0

[1]Includes vacuum-melting furnaces and miscellaneous melting processes.
[2]Castings made directly from blast furnace hot metal. Includes ingot molds and stools.
[3]Data may not add to totals shown because of independent rounding.

Table 10.—Consumption of pig iron[1] in the United States, by State

(Thousand short tons)

State	1981	1982
Alabama	2,583	816
Arkansas	1	1
California	1,751	762
Connecticut	9	6
Georgia	3	2
Illinois	5,432	2,751
Indiana	18,287	13,600
Iowa	24	25
Kansas	7	5
Maine	(2)	(2)
Massachusetts	19	14
Michigan	5,869	4,212
Minnesota	30	18
Missouri	10	6
Nevada	(2)	(2)
New Jersey	4	3
New York	2,374	1,003
North Carolina	3	2
Ohio	11,880	8,142
Oklahoma	13	10
Pennsylvania	14,444	5,537
Texas	1,262	747
Virginia	23	13
West Virginia	2,565	1,628
Wisconsin	69	50
Undistributed[3]	[r]8,378	5,053
Total	75,040	[4]44,409

[r]Revised.
[1]Includes molten pig iron used for ingot molds and direct castings.
[2]Less than 1/2 unit.
[3]Includes Colorado, Florida, Kentucky, Maryland, New Hampshire, Oregon, Rhode Island, South Carolina, Tennessee, Utah, and Washington.
[4]Data do not add to total shown because of independent rounding.

Table 11.—U.S. exports of major iron and steel products

Product	1980 Quantity (short tons)	1980 Value (thousands)	1981 Quantity (short tons)	1981 Value (thousands)	1982 Quantity (short tons)	1982 Value (thousands)
Steel mill products:						
Ingots, blooms, billets, slabs, sheet bars	912,310	$249,092	540,600	$154,511	362,299	$82,066
Wire rods	212,823	70,291	102,688	44,878	25,150	13,374
Structural shapes, 3 inches and over	151,075	83,950	131,384	80,328	56,399	36,992
Structural shapes, under 3 inches	25,234	21,196	16,176	16,065	9,580	11,761
Sheet piling	2,677	1,664	7,607	9,654	5,623	3,406
Plates	207,840	119,042	199,536	126,794	121,930	89,111
Rails and track accessories	130,016	65,289	78,325	51,696	36,490	25,256
Wheels and axles	4,520	20,392	7,390	24,785	2,711	11,501
Concrete reinforcing bars	166,171	52,030	137,317	41,927	114,740	29,705
Bars, carbon, hot-rolled	80,913	34,386	91,041	48,587	31,014	18,083
Bars, alloy, hot-rolled	128,587	76,346	58,518	57,793	48,262	41,303
Bars, cold finished	28,442	34,261	28,724	36,498	17,400	25,471
Hollow drill steel	4,241	6,369	4,818	9,379	1,447	3,523
Pipe and tubing	470,168	718,647	472,447	841,474	430,630	791,252
Wire	42,648	55,054	37,360	62,470	26,269	49,539
Nails, brads, spikes, staples	11,600	31,681	11,949	34,152	7,089	24,232
Blackplate	179,459	52,046	89,717	25,711	71,888	17,897
Tinplate and terneplate	707,023	440,671	381,089	220,993	240,127	118,870
Sheets, hot-rolled	211,291	104,937	195,294	105,394	62,191	42,744
Sheets, cold-rolled	145,462	110,958	92,485	89,378	50,770	52,198
Strip, hot-rolled	40,764	27,568	36,598	24,258	27,488	18,709
Strip, cold-rolled	44,320	72,064	51,534	73,855	25,421	42,991
Plates, sheets, strip, galvanized, coated or clad	193,134	108,685	131,266	94,686	67,395	51,447
Total	4,100,718	2,556,619	2,903,863	[1]2,275,267	1,842,313	1,601,431
Other steel products:						
Plates and sheets, fabricated	28,763	52,913	40,244	66,404	23,216	52,335
Structural shapes, fabricated	175,035	313,644	172,388	390,526	119,303	268,678
Architectural and ornamental work	10,405	23,966	10,193	23,998	5,578	14,609
Sashes and frames	12,470	32,283	12,804	39,141	10,137	39,514
Pipe and tube fittings	50,104	259,805	50,716	300,810	41,578	293,573
Pipe and tubing, coated or lined	18,012	21,729	19,470	23,806	16,037	21,630
Bolts and nuts	56,131	123,230	70,254	133,442	70,601	114,964
Forgings	47,413	104,586	58,195	144,420	46,139	89,277
Cast-steel rolls	4,265	7,729	5,074	8,811	3,206	10,987
Railway track material	4,503	7,209	4,458	7,386	6,611	7,544
Total	407,101	947,094	443,796	[1]1,138,745	342,406	913,111
Iron products:						
Cast-iron pipes, tubes, fittings	86,245	140,661	95,386	145,519	113,185	160,091
Iron castings	134,714	83,755	113,521	88,998	69,548	59,522
Total	220,959	224,416	208,907	234,517	182,733	219,613
Grand total	4,728,778	3,728,129	3,556,566	[1]3,648,528	2,367,452	2,734,155

[1]Data do not add to total shown because of independent rounding.

Table 12.—U.S. imports for consumption of pig iron, by country

Country	1980 Quantity (short tons)	1980 Value (thousands)	1981 Quantity (short tons)	1981 Value (thousands)	1982 Quantity (short tons)	1982 Value (thousands)
Australia	46,482	$6,258	3,707	$470	8,506	$527
Belgium-Luxembourg	--	--	27	12	1,202	200
Brazil	84,862	10,123	138,951	15,443	146,413	16,313
Canada	222,365	39,837	267,877	46,658	127,337	26,995
China	--	--	--	--	17,116	1,560
France	8,746	1,303	4,833	771	1,624	329
South Africa, Republic of	18,885	2,608	45,988	6,972	19,445	2,966
Spain	--	--	--	--	--	--
Sweden	18,658	2,884	4,526	430	--	--
Venezuela	--	--	2,204	236	--	--
Other	33	24	12	21	57	49
Total[1]	400,031	63,036	468,125	71,013	321,702	48,940

[1]Data may not add to totals shown because of independent rounding.

Table 13.—U.S. imports for consumption of major iron and steel products

Product	1980		1981		1982	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Steel mill products:						
Ingots, blooms, billets, slabs, sheet bars	155,345	$51,802	790,062	$212,449	716,588	$180,612
Wire rods	829,272	347,210	888,456	388,315	961,768	366,267
Structural shapes, 3 inches and over	1,739,543	589,762	1,976,769	727,669	1,483,486	544,550
Structural shapes, under 3 inches	136,939	49,960	105,412	38,027	59,711	21,732
Sheet piling	89,423	33,750	98,718	40,512	114,864	50,810
Plates	2,059,710	670,729	2,447,687	900,595	1,619,538	565,989
Rails and track accessories	271,164	106,264	282,877	109,788	320,353	135,445
Wheels and axles	142,906	101,150	35,702	30,955	19,936	18,682
Concrete reinforcing bars	78,641	23,770	52,647	15,415	51,675	12,700
Bars, carbon, hot-rolled	366,659	129,253	418,006	163,516	297,493	118,733
Bars, alloy, hot-rolled	129,147	90,054	176,571	119,706	164,414	112,848
Bars, cold finished	146,786	145,251	231,278	219,096	218,317	211,012
Hollow drill steel	1,814	1,742	1,442	1,588	1,462	1,761
Welded pipe and tubing	1,862,058	824,876	2,740,842	1,414,377	2,124,745	1,124,642
Other pipe and tubing	1,914,540	1,262,704	3,827,736	3,157,481	2,984,566	3,021,885
Wire	414,429	339,254	412,802	332,389	346,520	271,039
Wire nails	292,169	152,841	303,471	160,045	264,388	140,491
Wire fencing, galvanized	8,318	6,430	8,446	6,419	8,457	5,825
Blackplate	68,250	27,365	97,836	41,353	119,395	50,482
Tinplate and terneplate	309,292	179,232	288,414	180,390	218,394	134,718
Sheets, hot-rolled	1,491,791	441,740	1,628,141	526,902	1,355,024	421,498
Sheets, cold-rolled	1,477,122	589,037	1,626,016	720,356	1,706,708	747,464
Sheets, coated (including galvanized)	1,349,790	597,424	1,303,588	604,046	1,227,867	553,108
Strip, carbon, hot-rolled	15,807	6,762	24,934	10,719	21,655	9,309
Strip, carbon, cold-rolled	46,965	43,023	50,866	50,218	49,209	45,368
Strip, alloy, hot- or cold-rolled (including stainless)	15,341	34,362	23,087	42,832	22,375	46,156
Plates, sheets, strip, electrolytically coated (other than with tin, lead, or zinc)	81,854	41,716	56,565	32,502	57,384	34,006
Total	15,495,075	[1]6,887,462	19,898,371	10,247,660	16,536,292	8,947,132
Other steel products:						
Plates, sheets, strip, fabricated	6,010	5,879	4,832	5,526	4,016	5,447
Structural shapes, fabricated	175,292	170,719	168,779	179,719	146,596	139,589
Pipe fittings	88,329	131,293	131,829	221,691	112,680	192,912
Rigid conduit	2,058	3,705	1,928	3,952	105	488,282
Bale ties made from strip	2,050	1,339	1,390	1,190	1,197	1,028
Nails, brads, spikes, staples, tacks, not of wire	14,464	12,174	16,123	12,709	12,135	10,013
Bolts, nuts, rivets, washers, etc	430,011	473,632	445,743	491,230	422,151	471,710
Forgings	34,967	26,962	51,772	38,601	45,910	33,897
Total	753,181	[1]825,702	822,396	954,618	744,790	1,342,878
Iron products:						
Cast-iron pipes, tubes, fittings	23,859	25,278	25,554	27,515	28,565	31,517
Iron castings	82,712	53,577	71,207	56,442	75,817	72,768
Total	106,571	78,855	96,761	83,957	104,382	104,285
Grand total	16,354,827	7,792,019	20,817,528	11,286,235	17,385,464	10,394,295

[1]Data do not add to total shown because of independent rounding.

Table 14.—Pig iron: World production, by country[1]

(Thousand short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Algeria	529	437	440	470	440
Argentina[3]	2,012	2,136	1,976	1,914	2,140
Australia	8,088	8,610	7,672	7,529	[4]6,565
Austria	3,392	4,081	3,842	3,832	3,400
Belgium	[r]11,330	11,878	11,614	10,820	8,600
Brazil[3]	11,388	[r]13,270	14,286	12,150	9,900
Bulgaria	1,645	1,598	1,683	1,667	[4]1,667
Canada	11,399	12,021	12,007	10,740	8,800
Chile	594	674	710	704	[4]500
China	38,349	40,488	41,910	37,666	39,100
Colombia	327	265	307	290	[4]271
Czechoslovakia	10,961	10,504	10,824	10,916	[4]10,504

See footnotes at end of table.

Table 14.—Pig iron: World production, by country[1] —Continued

(Thousand short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Egypt	661	661	717	715	[4]125
Finland	2,112	2,247	2,226	2,180	2,100
France	19,952	20,906	20,580	18,697	[4]16,569
Greece	660	362	[e]385	[e]385	385
German Democratic Republic[5]	2,822	2,630	2,709	2,691	[4]2,695
Germany, Federal Republic of	[r]27,350	[r]38,765	37,339	35,137	30,200
Hungary	2,568	2,611	2,441	2,417	[4]2,406
India	10,397	[r]9,643	9,362	10,443	10,600
Iran[e]	1,000	900	900	550	660
Italy	12,500	12,486	13,392	13,513	[4]12,717
Japan	86,629	92,402	95,946	88,239	[4]85,603
Korea, North[e]	3,100	3,200	3,300	3,300	3,300
Korea, Republic of	3,022	5,581	6,148	8,739	[4]9,309
Luxembourg[5]	4,102	4,190	3,934	3,185	2,900
Mexico[3]	5,662	5,541	5,815	6,011	5,670
Morocco[e]	13	13	13	13	13
Netherlands	[r]5,885	5,307	4,771	5,070	4,000
New Zealand[e 3]	31	30	149	148	165
Norway	611	717	681	626	620
Peru	[r]269	283	288	195	[3 4]226
Poland	12,246	12,087	12,787	10,307	[4]9,866
Portugal	389	403	385	452	230
Romania	8,989	9,787	9,934	10,400	10,100
South Africa, Republic of	6,515	7,750	8,284	8,119	[4]7,454
Spain	6,882	7,174	7,408	7,080	[4]6,604
Sweden[3]	2,735	3,343	2,685	1,896	1,870
Switzerland	38	33	32	33	40
Taiwan	1,962	1,940	1,857	1,775	3,000
Thailand	[r]19	33	20	11	13
Tunisia	148	165	166	175	170
Turkey	2,014	2,456	2,249	2,150	1,320
U.S.S.R	[r]122,021	[r]120,102	118,232	[e]116,600	118,800
United Kingdom	12,712	14,213	7,068	10,439	9,100
United States	87,690	86,975	68,699	73,755	[4]43,342
Venezuela[3]	764	1,468	2,609	2,458	[4]2,598
Yugoslavia	2,294	2,603	6,958	10,291	[4]2,969
Zimbabwe[e]	660	660	660	440	400
Total	[r]557,438	[r]585,629	568,400	557,333	500,026

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table excludes all ferroalloy production except where otherwise noted. Table includes data available through June 1, 1983.
[2]In addition to the countries listed, Vietnam and Zaire have facilities to produce pig iron and may have produced limited quantities during 1978-82, but output is not reported and available general information is inadequate to permit formulation of reliable estimates of output levels.
[3]Includes sponge iron output.
[4]Reported figure.
[5]Includes blast furnace ferroalloys.

Table 15.—Raw steel:[1] World production, by country[2]

(Thousand short tons)

Country	1978	1979	1980	1981[p]	1982[e]
Algeria	460	459	589	[e]600	630
Angola[e]	11	11	11	11	11
Argentina	3,071	[r]3,531	2,978	2,775	[3]3,193
Australia	8,365	8,956	8,370	8,416	[3]7,022
Austria	4,779	5,420	5,097	5,132	4,740
Bangladesh[4]	129	139	152	153	[3]120
Belgium	13,890	14,817	13,580	13,543	10,900
Brazil	13,346	15,314	16,908	14,584	[3]14,329
Bulgaria	2,723	2,736	2,830	2,738	2,730
Burma	44	([5])	([5])	([5])	([5])
Canada	16,423	17,723	17,512	16,326	13,900
Chile	[r]659	724	785	814	[3]525
China	35,031	37,953	40,918	39,242	40,960
Colombia	431	399	446	435	[3]430

See footnotes at end of table.

Table 15.—Raw steel:[1] World production, by country[2] —Continued

(Thousand short tons)

Country	1978	1979	1980	1981[p]	1982[e]
Cuba	357	361	335	364	[3]332
Czechoslovakia	16,859	16,333	16,783	16,832	[3]16,526
Denmark	952	886	809	675	[3]617
Ecuador	--	9	18	29	[3]31
Egypt	660	[r]882	882	992	660
El Salvador[e]	15	15	15	11	11
Finland	2,572	[r]2,755	2,766	2,676	2,685
France	25,178	25,750	25,547	23,433	[3]20,300
German Democratic Republic	7,690	7,742	8,056	8,231	7,830
Germany, Federal Republic of	45,474	50,750	48,323	45,867	39,580
Ghana[e]	11	6	6	6	6
Greece	1,032	1,102	1,031	1,002	[3]1,003
Hong Kong[e]	[r]130	[r]130	130	130	130
Hungary	4,274	4,308	4,149	4,018	[3]4,082
India	[e]11,009	11,019	[e]10,384	[e]11,883	11,810
Indonesia	[r]248	[r]336	397	551	660
Iran	[r]1,433	[r]1,576	[e]1,320	[e]1,320	1,320
Iraq[e]	55	388	287	50	50
Ireland	76	79	2	35	[3]61
Israel	[r]104	[r]118	127	126	100
Italy	26,767	26,731	29,212	27,312	[3]26,434
Japan	112,551	123,181	122,792	112,078	[3]109,733
Jordan[e]	66	100	100	100	100
Kenya[e]	11	11	11	11	11
Korea, North[e]	3,500	3,700	3,900	3,860	3,860
Korea, Republic of	5,477	8,389	9,434	11,854	[3]12,955
Lebanon[e]	7	--	--	--	--
Libya[e]	11	11	11	11	11
Luxembourg	5,280	5,456	5,092	4,178	3,900
Malaysia	224	[r]228	[e]230	[e]230	230
Mexico	7,469	7,845	7,888	8,383	[3]7,782
Morocco[e]	7	7	7	7	7
Mozambique[e]	19	22	22	[r]22	22
Netherlands	6,162	6,400	5,811	6,032	4,790
New Zealand	249	252	254	244	[3]254
Nigeria[e]	17	17	17	17	110
Norway	895	1,015	941	935	940
Peru	412	481	519	397	300
Philippines	304	438	364	386	390
Poland	21,221	21,184	21,478	17,327	[3]15,984
Portugal	636	715	720	607	590
Qatar	[r]126	[r]418	485	499	495
Romania	12,984	14,230	14,523	14,358	[3]14,330
Saudi Arabia[e]	6	50	55	80	110
Singapore	309	327	375	386	385
South Africa, Republic of	8,710	9,775	9,996	9,925	[3]9,117
Spain	12,422	13,563	13,874	14,233	14,500
Sweden	4,767	5,101	4,665	4,150	[3]4,299
Switzerland	864	977	1,024	1,065	[3]1,047
Syria[e]	132	100	110	110	110
Taiwan[6]	3,783	[r]3,512	3,767	3,465	[3]4,495
Thailand	[r]381	[r]485	496	331	330
Trinidad and Tobago	--	--	--	50	[3]220
Tunisia	175	194	196	198	190
Turkey	2,394	2,641	2,795	2,605	2,920
Uganda	17	--	--	--	--
U.S.S.R	[r]166,948	164,353	163,077	163,632	162,900
United Kingdom	22,389	23,631	12,432	17,170	15,100
United States	137,031	136,341	111,835	120,828	[3]74,577
Uruguay	10	[r]15	18	15	[3]22
Venezuela	948	[r]1,625	1,967	2,003	[3]2,531
Vietnam[e]	110	120	130	120	110
Yugoslavia	3,804	3,899	4,006	4,383	[3]4,244
Zimbabwe	858	[r]816	886	762	550
Total	[r]787,944	[r]821,083	787,058	777,359	708,269

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Steel formed in first solid state after melting, suitable for further processing or sale; for some countries, includes material reported as "liquid steel," presumably measured in the molten state prior to cooling in any specific form.
[2]Table includes data available through June 1, 1983.
[3]Reported figure.
[4]Data are for year ending June 30 of that stated.
[5]Remelt capacity is 40,000 tons; however, plant output, if any, is not known.
[6]As reported by International Iron and Steel Institute; differs from figures reported in Taiwanese sources.

Iron and Steel Scrap

By Franklin D. Cooper[1]

In 1982, brokers, dealers, and other outside sources supplied domestic consumers with 27.5 million tons[2] of all types of ferrous scrap at a delivered value of approximately $1.7 billion, while exporting 6.8 million tons valued at $610 million. In 1981, domestic consumers received 40 million tons at a delivered value approximating $3.6 billion, while exports of 6.4 million tons were valued at $639 million. Scrap industry profits in 1982 generally were unsatisfactory because of market conditions, the worst since 1932-33.

Domestic Data Coverage.—Domestic production data for ferrous scrap are developed by the Bureau of Mines from voluntary monthly surveys of U.S. operations. Of the 823 operations to which a survey request was sent, 67% responded, representing an estimated 83% of the total consumption shown in table 2 for three types of scrap consumers. Consumption for the remaining 270 nonrespondents was estimated using prior reports adjusted by industrial trends. An estimation error is also contained in the difference between the reported total consumption of purchased and home scrap and the sum of scrap receipts plus home scrap production, less scrap shipments, and adjustments for stock changes. For the 1982 scrap consumption data shown in table 2, this difference amounted to 1%, 4.5%, and 1.0% for the three user industries.

Table 1.—Salient iron and steel scrap and pig iron statistics in the United States

(Thousand short tons and thousand dollars)

	1978	1979	1980	1981	1982
Stocks, Dec. 31:					
Scrap at consumer plants	8,277	8,724	8,018	8,118	6,418
Pig iron at consumer and supplier plants	889	881	889	859	622
Total	9,166	9,605	8,907	8,977	7,040
Consumption:					
Scrap	99,223	98,901	83,710	85,097	56,386
Pig iron	88,420	87,458	69,053	75,040	44,409
Exports:					
Scrap (excludes rerolling material and ships, boats, other vessels for scrapping)	9,039	11,054	11,168	6,415	6,804
Value	$698,237	$1,142,406	$1,225,941	$638,644	$610,302
Imports for consumption:					
Scrap (includes tinplate and terneplate scrap)	794	760	582	556	468
Value	$50,220	$70,804	$61,192	$62,126	$37,572

Legislation and Government Programs.—A U.S. Court of Appeals denied a petition by the Nation's railroads to review an Interstate Commerce Commission (ICC) ruling that ordered railroads to make refunds to shippers who had been charged excessive rates on nonferrous recyclables. The Institute of Steel and Iron Scrap (ISIS) had previously requested that the provision dealing with rates on ferrous scrap be excluded because of the adverse effect on rail service available for ISIS members that would result from the decreasing number of gondola cars.

AVAILABLE SUPPLY, CONSUMPTION, AND STOCKS

The Bureau of Mines publishes ferrous scrap data for three categories of domestic consumers designated as Type 1, the manufacturers of pig iron, raw steel, and raw steel castings; Type 2, the manufacturers of refined steel castings; and Type 3, comprising iron foundries and miscellaneous users.

The 1982 delivered values of ferrous scrap supplied by brokers, dealers, and other outside sources to Type 1 consumers equaled $19 compared with $31 in 1981 per ton of finished steel shipments; to Type 2 consumers, $86 compared with $99 in 1981 per ton of steel castings shipped; and to Type 3 consumers, $52 compared with $60 in 1981 per ton of three grades of iron castings shipped.

All types of ferrous scrap available for domestic consumption in 1982, in million tons, totaled 57.2 comprising net receipts, 28.0; home scrap, 27.1; imports, 0.47; and withdrawals from stocks, 1.65. Domestic consumption ranged from 6.2 million tons in March to 3.6 million tons in December. Monthly maximum and minimum consumption, in thousand tons, by type of furnace were as follows: blast furnaces, 263 in May and 158 in September; basic oxygen furnaces (BOF), 1,609 in March and 905 in November; open-hearth furnaces, 473 in March and 129 in November; electric furnaces, 3,123 in January and 1,825 in December; cupola furnaces, 703 in March and 448 in December; and air and other furnaces, 107 in February and 55 in December. The consumption of stainless steel scrap, in thousand tons, totaled 782 ranging from 81 in March to 57 in October. Type 1 manufacturers in 1982 used 746; Type 2 manufacturers, 24; and Type 3 manufacturers, 12.

The maximum and minimum receipts of all types of ferrous scrap from brokers, dealers, and other outside sources, in thousand tons, were as follows: Type 1 consumers, 2,081 in March and 1,247 in November; Type 2 consumers, 152 in March and 85 in December; and Type 3 consumers, 763 in March and 504 in December. Maximum and minimum receipts of stainless steel scrap from the same sources, in tons, were as follows: Type 1 consumers, 33,366 in August and 26,972 in January; Type 2 consumers, 1,337 in November and 412 in July; and Type 3 consumers, 1,985 in June and 79 in August. Yearend stocks of stainless steel scrap for 1981 and 1982, in thousand tons, respectively, were as follows: Type 1 consumers, 102 and 92; Type 2 consumers, 5 and 6; and Type 3 consumers, 3 and 2.

In midyear, some U.S. steelmakers had enough scrap inventory to last through yearend at their midyear melting rates while other steelmakers, because of policy, held inventories as small as when production rates were high and interest rates were lower. The supply of prompt industrial scrap in some areas was below normal because of low operating rates of the metalworking industry.

According to a study prepared for the Metal Scrap Research and Education Foundation by Robert R. Nathan Associates, products containing 148 million tons of iron and steel were discarded in the United States during 1980-81, but only 67 million tons was recovered for recycling. The study showed the total backlog of ferrous discards in the United States was 682.9 million tons at yearend 1981. However, it has been suggested that an estimate of scrap backlog should be based only on recycled home scrap and industrial scrap because it is difficult to collect widely scattered automobile hulks or rebar imbedded in concrete.[3]

Domestic demand for ferrous scrap was at the lowest level since 1962 when 25.3 million tons was purchased domestically because raw steel production at 74.6 million tons was 38% less than the 119.9 million tons in 1981; steel-castings shipments were 41% less; and iron castings shipments were 33% less. As a result, scrap-processing-utilization capacity was variously reported as ranging from 30% to 45% for individual processors. According to a 1982 survey by the National Association of Recycling Industries, Inc. (NARI), ferrous scrap annual processing capacity was at least 85 million tons on a single-shift operating basis.

The low demand for ferrous scrap in 1982 resulted in some sporadic deviations from normal marketing practices including the termination of purchases of some machine shop turnings and other low-valued scrap requiring extensive processing before resale; consignment sales to customers with payments made after actual consumption; a weakening of the collection system supplying scrapyards; sales made on an appraisal basis in the absence of firm prices; sales by two large steelmakers in the Pittsburgh area of ingot croppings together with scrap from stockpiles; and the scarcity of prompt industrial scrap, bundles, and good busheling scrap particularly near the east coast necessitating movement of some such materials from the Midwest. Small scrapyard owners reduced their stocks because of cash-flow problems while strong merchants, holding ample stocks of top-quality grades awaiting sales at more favorable prices, reduced their overhead, operating costs, and administrative personnel.

Some ferrous scrap industry spokespersons questioned how smaller dealers could survive before terminating operations because of the poor economic performance of the industry in 1982. This situation prompted more than 300 small independent dealers in Southwestern and Southern States to consider forming associations to increase their operating capital and profit margins while remaining competitive with larger dealers.

Purchases or acquisitions announced in 1982 included Azcon Scrap Corp.'s purchase of the assets of O. S. Metals, Sharon, Pa.; the sale of several small scrapyards in northern California to unknown purchasers; Lone Star Steel Co.'s purchase of the Texas operation of Friedman Industries, Inc.; Luria Bros. & Co. Inc.'s acquisition of a small yard in Calera, Ala., and construction of a new yard in Youngstown, Ohio; the purchase by the Marc Rich Group, Zug, Switzerland, of Metals Processing Co.'s yards in Worcester, Mass., and Providence, R.I., from Steelmet, Inc.; and Proler International Corp.'s acquisition of the MRI Corp., after which Proler planned to build a detinning processing plant near Stockton, Calif., and close MRI facilities in Chandler, Ariz., and Deming, N. Mex.

Partnerships or mergers announced included the merger of Universal Waste, Inc., and Empire Recycling Corp., both in Utica, N.Y., and the partnership between Thyssen Carbonmetal Co., New York, N.Y., and Schiavone Corp., New Haven, Conn., for exporting ferrous and stainless steel scrap.

Diversifications included Schiavone-Chase Corp.'s purchase of Clean Venture Inc., an environmental and pollution control company, and the Birmingham, England-based Cronite Group setting up a new processing operation near Cleveland, Ohio, to specialize in high-temperature alloy scrap.

New ventures included David J. Joseph Co.'s entry into the mill service business, at the Florida Steel Corp.'s Jackson, Tenn., plant, to recover sized cleaned steel from slag and processed home scrap; the entry by Joseph Simon & Sons, Tacoma, Wash., into the export market with 80,000 tons annually following the purchase of a shredder; and Luria Bros.' preparation to supply a portion of the ferrous scrap exported by National Metal & Scrap Corp. from Terminal Island, Calif.

Several scrap processors petitioned for protection under Chapter 11, reorganization, sections of the Bankruptcy Act of 1978. Ten creditors of Stainless Processing Co., Chicago, Ill., requested the U.S. Bankruptcy Court in August to protect their unsecured claims. Following a suit favoring the creditors, liquidation of the company started December 20. Five creditors in mid-December filed petitions with the U.S. Bankruptcy Court in Charlotte, N.C., requesting Chapter 11 proceedings relating to the holding company International Metal Corp. and its subsidiary International Metals Trading Corp. New England Metal Co., Providence, R.I., and seven subsidiaries and affiliates requested protection from their creditors under Chapter 11. Part of the firm was sold to Vereinigte Deutsche Nickel-Werke AG of Schwerte, Federal Republic of Germany, to satisfy debt obligations.

Scrap processing equipment offered by U.S. manufacturers during 1982 included baling presses by Harris Div., American Hoist and Derrick Co., and International Baler Corp.; briquetters by Bepex Corp. and G-E Cast Equipment Div. of Combustion Engineering; choppers by P/A Industries, Inc.; conveyors by General Kinematics Corp.; cranes by GS Industries, Inc., and Railcrane Co.; crushers by AL Jon Inc.; feeders by Kingery Corp.; forklifts by Clark Equipment Co. and Waldon Inc.; grapples by Young Corp.; scrap sorting systems by EDAX International Inc. and Preb Conveyors Inc.; shears by Constellation Steel Equipment Corp., Econ Scrap Shear Co., Harris Press and Shear Inc., La Bounty Manufacturing Co., Lindeman of America, and Mosley Machinery Co.; knives by American Shear Knife Div. of Asko Inc.; turnings presses by Allan-Ross Machinery Corp.; and weigh systems by Streeter-Amet Measurement System Div. of Mangood Corp.

In 1982, U.S. ferrous scrap processors, with 180 dry and wet variety shredders, reportedly had an annual automobile-shredder capacity of 11 million tons, but only 6 million tons of product was sold.

In 1982, sales of all types of new scrap-processing equipment were down 75% and sales of replacement parts were one-third below normal. However, scrap processors maintained at a high level the capability of their $2.0 to $2.5 billion investment, some of which followed the scrapping of obsolete equipment in recent years.

According to a survey made by ISIS, electricity costing about $1.50 per ton of ferrous scrap sold represented 18% of the energy costs in scrap processing.

Magnetic separation used in 27 municipal refuse recycling plants produced 13,500 tons per day of ferrous scrap containing 80 weight percent cans. The American Iron and Steel Institute (AISI) in its new report on solid waste processing facilities stated that 13.5 million steel cans were recovered daily in 1982 by magnetic separation from refuse and that on an annual basis 3.5 billion steel cans were recovered in the United States and 700 million in Canada.

In 1982, an estimated 1,300 domestic iron foundries were in operation, reportedly at about 20% to 60% of capacity for individual foundries, or about the same level as that of 1981 when output per employee was 5.9% greater than that of 1980. The steel-castings industry, depressed by a lack of orders from industrial equipment manufacturers, reportedly lost 2.25 million tons of capacity annually since 1979. This decrease included only those steel foundries permanently closed and not those temporarily closed but which could be reopened if demand was warranted.

Some of the foundries that were permanently closed or had suspended operations in 1982 included Dayton Malleable Inc., Dayton, Ohio; Griffin Wheel Div., Amsted Industries, Inc., Chicago, Ill., and Colton, Calif.; New England Malleable Iron Co., Warwick, R.I.; General Motors Corp.'s two plants in the Detroit, Mich., area and one plant in Alabama; Rockwell International Corp., Chattanooga, Tenn.; and Midland-Ross Corp., Cleveland, Ohio.

Expansion or modernization programs were underway or announced by Grede Foundries, Reedsburg and Milwaukee, Wisc.; Lynchburg Foundry Co., Lynchburg, Va.; and Lufkin Industries, Lufkin, Tex.

Chromoalloy American Corp., St. Louis, Mo., sold its foundries at Elyria, Ohio, West Allis, Wisc., and Kendallville, Ind., to MTC Gear, Libertyville, Ill.

The U.S. Pipe and Foundry Co., a division of Jim Walters Resources, selected an automatic iron pouring system manufactured by the West German company, Otto Junken GmbH, for use in the firm's Soil Pipe Div., Chattanooga, Tenn.

The U.S. General Accounting Office, based on the study of the domestic foundry industry, issued two reports.[4]

TRANSPORTATION

General-purpose gondola cars in service on Class I railroads at yearend 1982 totaled 134,746 units, 7,554 less than at yearend 1981. In 1982, 8,400 units were retired and 846 were added. At yearend, no new gondola cars were on order. Class II railroads had 10,350 units at yearend, down 1,000 from December 31, 1981, and privately owned units totaled 27,800, up 1,800 from December 31, 1981.

The weight of ferrous scrap per carload continued to be an important factor when negotiating freight-rate reductions as permitted in the Staggers Rail Act of 1980. A railroad executive suggested that the average weight of 63 tons shipped in a 2,000-cubic-foot, 100-ton-capacity gondola could be increased by the orderly placement of bundles in the car. Further, the shipment of fragmented scrap could use hopper cars currently in oversupply.

The dismissal of a case on September 10, 1982, filed by Platnick Bros. Inc., Bluefield, Va., against the Norfolk and Western Railroad Co. claiming excessive rates for hauling ferrous scrap from Bluefield to Roanoke, Va., was based on lack of evidence showing market dominance. ISIS petitioned ICC to reopen the case because of its value as a legal precedent.

The CSX Corp. (Chessie System) established a per-car-rate equivalent to about $13 per gross ton on heavy scrap loaded to 75 gross tons per car moving 450 miles from Chicago to Pittsburgh. This particular rate, negotiated between a steel company and the Chessie System, was dependent on a shipping volume of between 450 and 2,000 cars per year.

Consolidated Rail Corp. (Conrail) introduced econo-rate reductions in June 1981 that applied to nearly 1,900 carload shipments of ferrous scrap through June 1982. For example, a 65-gross-ton shipment from Chicago, Ill., to Pittsburgh, Pa., or Indianapolis, Ind., to Johnstown, Pa., cost $18.34 per gross ton, about 22% to 28% less than former rates: Conrail also reduced rates in a 6% to 28% range, based on Conrail's interline reciprocal switching costs for Northeastern and Midwestern shippers not located on Conrail lines.

PRICES

The 11-month continuing decline in quoted prices for domestic sales through November 1982 reportedly left little profit margin after the purchased price from collectors and processing costs were considered. Domestic steelmakers bought better grades of scrap at about the same prices paid for lower grades in 1981, but most buyers remained cautious even after yearend 1982. Some steelmakers were not interested in shredded scrap, and considered it suitable only for the export trade. Price changes in No. 1 bundles and No. 1 busheling were closely tied to winning bids on industrial scrap auctioned by automobile makers.

By yearend 1982, small increases in the prices of scrap sold to domestic consumers were attributed to an increased demand and the small tonnage of available prompt-industrial scrap. According to some brokers, one Pittsburgh area steel producer was trading 3,000 to 4,000 tons of home scrap for more desirable grades. Nonintegrated U.S. steelmakers increased the use of recycled ferrous scrap formerly consumed only in steel foundries.

The steady decline in prices for stainless steel scrap throughout the year reportedly was closely related to prime nickel whose producers competed with stainless scrap at practically all price levels.

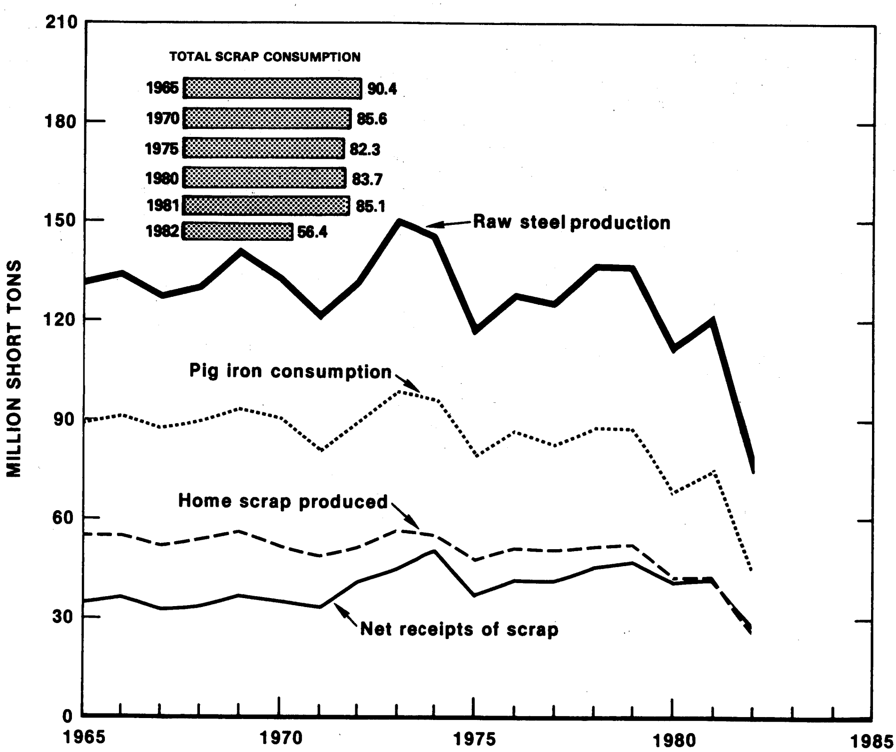

Figure 1.—Raw steel production (AISI), total iron and steel scrap consumption, pig iron consumption, home scrap production, and net scrap receipts.

The following approximate average prices in 1982 of various types of ferrous scrap per long ton delivered to domestic customers were based on all quotations appearing in Iron Age and some quotations in American Metal Market for prices not published by Iron Age: 1 foot and under (not bundles), \$86.65; No. 1 machinery and cupola cast iron, $81.35; cut structural and plate, $80.17; railroad specialties, $75.69; shredded, $74,000; low-phosphorus plate and punchings, $73.60; No. 1 bundles, $71,65; No. 1 busheling, $63.60; No. 1 heavy melting, $63.28 (composite for Pittsburgh, Chicago, and Philadelphia); random length railroad rails, $61.17; unstripped motor blocks, $58.52; No. 2 bundles, $45.05; No. 2 heavy melting, $44.73; ingot mold and stool scrap, $41.24; cast iron borings, $19.90; and mixed turnings and borings, $16.28. The composite price of No. 1 heavy melting ranged from $84.34 in January to $51.23 in November according to Iron Age.

Composite delivered prices of four major grades of stainless steel scrap as quoted by Iron Age in dollars per long ton delivered in 1982 were as follows: 18/8 bundles and solids, $480.87 average, $563.75 in May and $402.50 in December; 18/8 turnings, $394.20 average, $461.25 in May and $302.50 in December; Type 430 bundles and solids, $114.29 average, $125.00 in March and $92.50 in December; and Type 430 turnings, $73.23 average, $77.50 in March through September, and $67.50 in November and December.

FOREIGN TRADE

Ferrous scrap exports, in 1982 totaling 6.8 million tons, were up 6.1% over that of 1981. Exports, in thousand tons, ranged from 812 in May to 375 in December. Reduction of raw steel output in the United Kingdom and Northern Europe resulted in a scrap surplus closer to traditional U.S. markets in the Mediterranean area where centrally planned economies exported increased tonnages to former U.S. markets such as Italy, Spain, and Turkey. Sharp reductions in ocean freight rates and the low price of scrap were cited as the major reasons for exports in May and June 1982 being the largest since October 1980. Ocean freight rates to Japan on 15,000-ton cargoes from west coast ports in June were about $16 per ton and about $23 per ton from east coast ports for 20,000-ton cargoes.

Scrap trading was difficult because of the strength of the U.S. dollar and the practice used by most U.S. merchants requiring that cash payments be made immediately upon arrival.

East coast exporters reported aggressive competition, lower demand, and declining prices while west coast exporters were more comfortable because of the 3-million-ton demand in Asian areas. Increased exports during May-July 1982 largely depleted eastern seaboard stocks while west coast shippers sold almost all of their stocks in August to meet September shipments.

Total ferrous scrap exports from the United States averaged $89.70 per ton compared with $99.55 per ton in 1981. The tonnages and values of 1982 exports were as follows:

Type	Quantity	Total customs value	Average customs value per ton
Ferrous	6,562,635	$517,413,771	$78.84
Stainless steel	131,338	74,051,959	563.83
Alloy steel (excluding stainless)	109,794	18,836,671	171.56
Total	6,803,767	610,302,401	89.70

Japan, the Republic of Korea, and Spain collectively received 3,919,200 tons, valued at $322,213,548 of the total scrap exported, while six other countries, each importing more than 100,000 tons, received 2,344,801 tons valued at $216,106,643.

The tonnages and values of total scrap exported from 38 customs districts were as follows:

Area	No. of customs districts	Quantity	Total customs value	Average customs value per ton
East coast[1]	14	2,916,946	$259,290,962	$ 88.89
Great Lakes	6	775,225	49,368,769	63.68
Gulf coast	5	634,407	63,955,879	100.81
Inland	7	409,052	34,142,621	83.47
West coast[2]	6	2,068,137	203,544,170	98.42
Total	38	6,803,767	610,302,401	89.70

[1]Includes U.S. Virgin Islands and San Juan, P.R.
[2]Includes Honolulu, Hawaii.

For respective areas, the largest tonnages were handled by Laredo, Tex.; New Orleans, La.; New York, N.Y.; Detroit, Mich,; and Los Angeles, Calif. These five custom districts reported 2,950,455 tons valued at $271,391,487.

WORLD REVIEW

Processing equipment and shipbreaking activities played a significant role in worldwide scrap supply.

New scrap-processing equipment offered by foreign manufacturers included the AL-30 model horizontal-feed and discharge baler from the Officiana Carpenteria Metallica. This baler had a hydraulic feeding pusher and powered roller bed made by the Lindemann Group, Düsseldorf, Federal Republic of Germany. The Lindemann Group installed a 1,400-ton scrap shear for National Iron and Steel Mills, Singapore. Venti-Oelde GmbH, Oelde, Federal Republic of Germany, in the first 2 months of 1982, supplied four windsifters for separating shredder scrap containing both ferrous and nonferrous metals in each of four scrap-processing plants located in France, Finland, England, and the Federal Republic of Germany. Reportedly, Venti-Oelde has sold 25 of its systems worldwide including two 10-ton-per-hour installations in the United States, where its representative was Wamsley Associates Inc., Media, Pa.

In early 1981, U.S. automobile scrap shredders included 180 dry types and 20 wet types. By early 1982, 11 operators had gone out of business, and other firms were operating shredders at about 1 to 4 days each week. In early 1982, there were 419 shredders worldwide with a 19.0-million-ton annual capacity, including 171 U.S. shredders rated at an 11.0-million-ton annual capacity.

A spokesperson for the Bureau International de la Recuperation (BIR) estimated that 5 million tons per year of shredder residue, with the calorific value of brown coal, was placed on dumps throughout the world.

The Nationalized Commercial Bank of Greece planned a new 120,000-ton-per-year shipbreaking facility whose output would replace imported scrap. Pakistan increased the import duty on ships received for breaking to 50% from 30% because of a price decline to $98 per ton in 1982 from $174 per ton in 1981. Some shipbreakers favored a centralized buying agency, but this idea was hampered by the Government's strict foreign exchange controls and lack of solidarity among shipbreakers. The Hong Kong shipbreaking industry, once the largest in the Far East, in recent years has scrapped six or less 5,000-ton ships annually. The only remaining breaking site at Junk Bay, Kowloon, will be used for a public housing project by 1985. Cartellization by Taiwan's China Dismantled Vessels Trading Corp. on September 28, 1982, resulted in a $10-per-ton lower buying price than offered by Pakistani buyers. In 1982, Taiwanese breakers, at an average buying price of $110 per lightweight displacement ton, dismantled 224 ships totaling 3.27 million tons, an increase of 119 ships and 1.52 million tons compared with 1981 activities. Although remaining as the world's largest shipbreaker followed by Pakistan, the Republic of Korea, and Japan, the disposal of the Taiwanese large scrap inventories was uncertain; normally 20% of the scrap, one-half of which is in processed condition and is exported and 80% is consumed in Taiwan. According to statistics compiled by several sources, 30 million deadweight tons of ships was sold worldwide to breakers in 1982 with oil tankers representing 25 million tons. According to H. P. Drewry Shipping Consultants, Ltd., London, Greek, Norwegian, and other independent owners disposed of about one-half of the tankers sold for scrap. The International Association of Independent Tanker Owners predicted that 555 excess tankers, approximating 75 million deadweight tons, will enter shipbreaking yards by 1985. In the event that one-half of the predicted tonnage is handled in Far East yards, U.S. exports of No. 1 grades to Asian countries could face significant competition in future years.

Argentina.—An Argentinian scrap merchant purchased the South Georgia whaling station in 1979 and started dismantling it in 1982 to recover scrap and reusable equipment totaling an estimated 35,000 tons valued at $2.5 million. The project was terminated when British armed forces repossessed the island.

Asia.—Ferrous scrap purchases were hampered by political problems in the Republic of Korea, the lack of capital restraining Chinese steel output, and the impact of the world recession on finished goods. South Korean buyers seriously bargained on scrap prices while Taiwan bought more of the attractively priced Australian scrap.

Austria.—Government-owned steel

plants assured the scrap industry guaranteed sales at maximum prices set by the Ministry of Trade. Because of the success in some Scandinavian countries, the Government considered funding to cover the cost of collecting and processing automobile bodies and also encouraged the collection of inferior grades of scrap by small companies who reportedly provided better service than that offered by large firms. The Austrian scrap industry operated three shredder plants and one grinder.

Brazil.—A compromise plan for moving a 140,000-ton surplus of ferrous scrap was established by Cacex, the Bank of Brazil's foreign trade department. The plan permitted the surplus to be sold in Brazil at the prevailing international price of $53 per ton, $7 to $13 per ton less than the existing consumers' buying prices.

Canada.—Scrap sales in eastern Canada in December decreased significantly because Sidbec-Dosco Ltd. was out of the market. One trader bought five carloads of railroad generated scrap at $25 to $45 per ton. Intermetro Ltd., Hamilton, Ontario, shipped the largest cargo of ferrous scrap ever from the Great Lakes. The cargo, comprised of No. 1 and No. 2 heavy melting, 5-foot plate, and shredded grades, totaled 30,350 tons, of which 21,950 tons was loaded at Hamilton and 8,400 tons was loaded at Quebec City. The cargo was destined for the Republic of Korea steel mills.

European Communities (EC).—The ferrous scrap industry was in a difficult situation because of the 11% reduction of steel output in the 29 countries affiliated with the International Iron and Steel Institute. Shredded scrap continued to be the ideal material for electric arc furnace steel production, which had largely replaced the Sieman-Martin open-hearth process. The progressive use of continuous casting decreased home scrap production and troubled some steelmakers not having their own supply of good quality scrap.

Finland.—Newell Manufacturing Co., San Antonio, Tex., sold a Model 60104 TBD shredder to Kuopion Rauta Ja Koneyhtyma of Kuopio. This wet shredder, powered by a 1,500-horsepower diesel engine, will be located 350 kilometers north of Helsinki and was designed to operate in an environment with temperatures of minus 40° C.

France.—Careful management of operations helped most of France's diversified scrap recyclers face the situation of mediocre prices, inventory reductions by consumers, and a decline of ferrous scrap sales at prices suffering a real decline of 17% resulting from inflation and higher operating costs. Scrap price increases in early 1982, ranging from $1.30 to $10.80 per short ton, covered only part of higher operating costs, while freight rates increased 12.5%. The French scrap industry awaited a plan for restructuring the Nation's iron and steel production. Principal exports went to Italy and Spain. In the first half of 1982, French scrap merchants delivered 165,000 tons to that country's steel industry, 235,000 tons to foundries, and exported 1.34 million tons to EC countries.

Germany, Federal Republic of.—For 80 years and through disruptions following two world wars, the ferrous scrap industry has been dominated by a few large tonnage merchants, called A-Handel companies, that are either direct subsidiaries of individual steelmakers or are jointly owned. The 80-year-old ranking system continued to be intact in 1982 and satisfactory with scrap merchants divided into three categories according to size and purpose.

In 1982, A-Handel companies owned most of the country's scrap-processing equipment and dominated the export trade by acting as brokers for smaller merchants or exporting on their own behalf. A-Handel companies did not collect scrap and depended on their supply from supporting B-Handel companies. A-Handel companies were not restricted to supplying only their related steelmakers or buying from subsidiary merchants.

In 1982, B-Handel companies were independent of steelmakers and A-Handel companies, and they included medium-to-large merchants operating their own equipment to process some scrap direct from source with most of their supply coming from C-Handel merchants who merely collected scrap that was sold in 1- to 7-ton lots.

The scrap industry's two merchants associations were Bundesverbond der Deutschen Schrotwirtschaft (BDS) and Deutschen Schrottverband (DSV). BDS represented a total of 230 A-Handel companies and some of the B-Handel concerns. DSV represented most of the B-Handel and the C-Handel companies. Close contacts were maintained between BDS and DSV, who met twice yearly with steelmakers representatives and Government officials for discussions mainly concerned with exports.

The West German ferrous scrap market

comprised four distinct regions in which different conditions affected availability, prices, and outlets. Scrap originating in these regions tended to remain within their borders, apart from what was exported, because of high freight costs. The Ruhr area was the most important region because of its steelmaking and heavy industrial capacity. Price negotiations between merchants and consumers in the Ruhr area influenced markets elsewhere in the Federal Republic of Germany. In the Saar region, the other major scrap consuming area, prices tended to be lower than in the Ruhr area because there were fewer steelworks and other consumers, and freight costs to the Ruhr area were a significant consideration. Nearly all scrap from the Hanover, Saxony, area was sent by Deutsche Erz-und Metall-Union, one of the three largest ferrous scrap companies in the Federal Republic of Germany, to the steelmaker Peine Salzgitter AG in Salzgitter. Most of the ferrous scrap originating in the southern and fourth region was moved through Grunwalder Stahlhandelsgesellschaft, a broker for scrap exported to Italy.

Thyssen Sonnenberg Co. and Klöckner & Co. were also two of the three largest scrap companies in the Federal Republic of Germany. K. H. Seeliger, in Heidelberg, processed 1,000 tons weekly that was sold to local foundries and to Italian, Saar, and other steelmakers through A-Handel brokers. Spezial-Legierungen Metalle Handeliges, a scrap-processing and trading group, was liquidated because of poor trading conditions.

India.—The ferrous scrap industry, already in a prolonged recession, expected a long-term decline in demand lasting several years. Processors held large stocks and had liquidation problems causing a delay in payments for domestic scrap that forced small traders out of business. The main reason for the poor condition of the industry was attributed to excessive imports of cheaper scrap. The Iron and Steel Scrap Association warned the country's finance minister that certain lower grades of scrap were being discarded as waste. In July, the Government imposed a blanket ban on fragmentized scrap from the United Kingdom because of copper, tin, and dirt contents in one shipment to India. The controversy ended in October when shipments were resumed.

Italy.—Scrap purchases were erratic because of the periodic closure of electric steelmaking plants to conform to EC quota limitations. Purchases from the United States were virtually nil because exporters would not quote prices in lire in diluted terms of payment to meet the dollar's fluctuating rate of exchange. Campsider, the scrap-buying consortium that supplied most of Italy's electric steel producers, satisfied its need by strongly increasing the use of domestic recyclables and by increased imports from countries not members of the EC.

Japan.—Despite the 11% increase in the value of the yen in late 1982 and depressed prices of scrap, most consumers did not take advantage of lower prices. Because of the Government-supported equipment modernization programs, the supply of scrap increased from 24 million tons in 1978 to 30 million tons in 1982. Imports from Australia, the Soviet Union, China, and EC countries totaled about 0.5 million tons in the first 11 months of 1982. Exports in the same time period totaled 156,000 tons of ordinary ferrous scrap to the Republic of Korea, Taiwan, Indonesia, Canada, and the United States, and 603,000 tons of alloy steel scrap, of which 404,000 tons went to Taiwan, 154,000 tons to Thailand, 30,000 tons to North Korea, and 15,000 tons to the Republic of Korea. Integrated steelmakers reduced the use of molten metal in BOF because scrap was available at $98 per ton compared with $143 per ton of molten metal from the blast furnace.

Mexico.—Several devaluations of the peso in May hindered imports of ferrous scrap although steel plants and foundries continued to require scrap. Local supplies were further decreased by the longer-than-average use of automobiles and household appliances. The Government encouraged the local purchase of semifinished products and billets rather than buying imported scrap.

In August 1982, shipments of scrap metal from the United States to Mexico were delayed because of the additional devaluation of the Mexican peso from 50 to 120 pesos on a dollar basis and the cancellation of insurance covering shipments. Some scrap dealers in Texas seeking other markets were concerned because of freight rates involved in moving their output to already depressed U.S. markets. In November, some Texas scrap brokers resorted to barter trading because of Mexico's uncertain financial situation and import restrictions.

Netherlands.—Metrec, the Billiton Group's recycling division, reduced its facilities significantly and restructured its Polak en Zoon scrap-processing yards. About 70% of available scrap was exported in early 1982, but merchants were not happy with the unpromising outlook.

Qatar.—A 70,000-ton-per-year automobile shredder plant started operation near Doha to supply the local steelmaker Qasco and markets in India and Pakistan. At startup, the plant had 30,000 tons of discarded automobiles in stock and contracts for 100,000 tons from Saudi Arabia.

Spain.—A lack of domestic scrap made imports essential although a trend was developing to reduce imports. Attention was centered on a plan for restructuring the steel industry.

Sweden.—Imports of ferrous scrap in 1982 were expected to exceed 200,000 tons, mostly from Western Europe. The main reason for the increase was the restructuring of Svenskst Stål AB, the country's major steel producer, following the phaseout of its ore-based steelmaking at the Domnarvet works by replacement with scrap-based electric furnaces. The Swedish steel mills' scrap buying cartel, Jarnsbruksfornodenheter (JBF), distributed its supplies of domestic scrap among its members and fixed the percentage of total consumption that had to be imported. However, most of the importing was handled by the mills themselves.

Swedish scrap dealers were concerned over the JBF refusal to increase the price level by 10% of grade 11, equivalent to No. 1 heavy steel melting scrap. Scrap purchases declined as steel production declined to about 3 million tons per year although there were fewer integrated steelworks and electric furnaces needed more good-quality scrap. Imports of scrap increased, but prices for domestic scrap were lower than in other countries and the ombudsman was asked to settle this problem.

During 1975-81, the Government paid a premium price to the final owner of an old motorcar when it was scrapped, but this policy had little effect on the number of cars processed.

United Kingdom.—The ferrous scrap industry was in a crisis because of the decline in size and the changing nature of the steel industry, overextended export prices, and further price cuts under consideration by the British Steel Corp. (BSC), who purchased scrap only from 20 large dealers. Purchases of stainless steel scrap virtually halted despite a reduction in price from $476 to $391 per ton. Many manufacturers paid merchants to remove their lower grades of metallic scrap. The closure of the Round Oak Steel Works produced a surplus of baled and other scrap that hopefully would be moved to other areas of the country or abroad. The Department of Industry's Iron and Steel Div. urged scrap merchants and customers to arrange voluntary conditions for scrap marketing without resort to Government intervention. Restructuring and adoption of fundamental price changes in the market dictated by international price levels resulted in closure of several scrap companies. Price reductions dictated by BSC encouraged overseas customers to demand similar reductions in their buying prices.

The 600-member British Scrap Federation (BSF) was reorganized using three committees representing special interests and three large scrap firms. BSF members were concerned that lower price levels did not encourage greater exports of scrap totaling only 3.0 million tons in 1982. Spain received over 2.0 million tons worth $136 million, but two Spanish steelmakers suspended payments and owed one United Kingdom exporter $1.7 million, 90% of which was covered by the Export Guarantee Department. Tonnage exported to Sweden was 169,200; to the Federal Republic of Germany, 161,683; to Turkey, 68,653; and to India, 44,779. Major grades of ferrous scrap exports in 1982 included heavy melting, 1,150,000 tons; shredded, 438,503 tons; bales, 239,964 tons; and stainless and alloy steel scrap, 182,818 tons worth $2.35 million, and averaging $128.54 per ton.

Following a 2-year discussion, 12 companies agreed to close 10 of their 22 steel-castings foundries resulting in the elimination of 27,500 tons of annual capacity and 1,800 jobs. Levies amounting to 2% of their turnovers for the next 5 years will be paid by the foundries remaining in operation; the levies, together with Government grants, will compensate the foundries closed to about one-third of their annual turnover.

Gawlick Machinery, Bristol, Conn., and Henry Butcher & Co., London, joined as exclusive agents for the orderly sale, over a 2-year period, of redundant equipment from 14 BSC plants in England, Scotland, and Wales.

J. McIntyre Ltd., Bradford, installed a Ventiwind Sifter system, the fourth in England, to clean ferrous and nonferrous scrap.

The scrap group, Interalloys AB, the

Swedish Arm of the Swan Holdings, purchased the Swedish steelmaker Guillspaangs Electrokenika.

After the takeover of the Thos. W. Ward (Raw Materials Div.) by Rio Tinto Zinc (RTZ), Ward reorganized its scrap business into a northern region with 10 yards and a southern region with 9 yards. Three Scottish yards were shut down by RTZ immediately after the takeover.

BSC's Scottish steelworks increased their scrap purchases, not for increased steel production, but to rebuild their stocks. BSC increased its receipts from northern England claiming that Scottish supplies of high-grade scrap were nearly depleted.

TECHNOLOGY

New recycling projects were developed by the Bureau of Mines in five research centers by staff members in conjunction with NARI, ISIS, and private industry members approved by the Bureau's Materials and Recycling Technology Div.[5]

The Bureau, in cooperation with the American Foundrymen's Society (AFS), analyzed samples, submitted quarterly, of 55 gray, ductile, and malleable iron castings from approximately 40 U.S. foundries to determine the level of 28 tramp elements.[6]

As part of its programs for conserving domestic mineral resources, the Bureau reviewed methods for indentifying scrap metals.[7]

A Bureau pelletizing technique was used by Joslyn Stainless Steels, Fort Wayne, Ind., for in-plant recycling of furnace dusts, mill scale, and grinding swarf.

The Bureau recovered metals from nonmagnetic automobile shredder rejects by water elutriation[8] and extended its scrap automobile research to include Japanese cars because U.S. foundries may face compositional problems.[9]

News regarding scrap preheaters and burners used with electric steelmaking furnaces included a paper on the application of oxy-fuel burners,[10] the retrofitting of three furnaces with six K-TECH burners, designed by Korf Technology Inc., at Georgetown Steel Corp., Georgetown, S.C.;[11] and the licensing, by Nikko Industry Co., Ltd., of Korf Technology Inc., Charlotte, N.C., to design, engineer, and construct scrap preheaters.[12]

The Kevex Corp. announced its new Analyst 8000 Microanalyzer, an energy dispersive X-ray instrument used in conjunction with scanning electron and transmission electron microscopes for the microanalysis of many elements in the periodic table.[13]

Sea-Shear Inc., a subsidiary of Schiavone-Chase, began operating the first seaborne, 1,100-ton guillotine shear on a 250-foot barge.[14]

The U.S. Coast Guard issued a report by the Panel on Ferrous Metal Fires (NMAB393) dealing with tests to determine the susceptibility of ferrous metal turnings and direct-reduced iron to excessive heating during marine transport.[15]

A study by Battelle Columbus Laboratories for the Bureau of Mines and AFS concluded that ferrous scrap can be upgraded by segregation at the source and additional currently used processing techniques in scrapyards, resulting, however, in price increases in the long run.[16]

NARI released a 188-page illustrated book titled "Recycled Metals in the 1980's" that presented statistics and technical data on virtually all important aspects of metal recycling including ferrous scrap.

ISIS issued an 8-page report listing the materials, equipment, and procedures needed for sorting and testing ferrous scrap at processing sites and published three full-color wall posters describing spark and chemical tests for identifying six grades of stainless steel scrap and five grades of high-speed steel scrap. ISIS, through the Center for Material Research at the Johns Hopkins University, reviewed the Japanese process for BOF operations in which scrap accounts for up to 60% of the furnace charge. The center issued a report, for distribution to ISIS members, relating to the identification and analysis of ferrous scrap by use of optical emission and X-ray fluorescence spectroscopy.

New technology in the Federal Republic of Germany included the successful use of 2,830 tons of nonmagnetic shredder residue as fuel in a cement plant with the cost of the pilot plant investigation being shared by shredder operators, the cement plant, and the Government;[17] a closed-circuit process by Romet-Stahl and Ruckstoff of

Düsseldorf to recover steel alloying materials from oily metallic sludges;[18] the increase of the scrap content of the total change, by top blowing and bottom stirring, of a BOF;[19] and the development of a process for melting scrap and sponge iron by Krupp Stahl AG in cooperation with the Krupp Research Institute.[20]

Korf Stahl AG tested an energy optimizing furnace for Companhia Siderúrgica Pains S.A. at Minas Gerais, Brazil. Reportedly, the new furnace permitted the use of up to 60% cold charging scrap without the use of charcoal.[21]

The preheating of scrap charges for Japanese electric arc furnaces comprised 50 total installations using four systems, all of Japanese origin, known as Nippon Kokan K.K. and Toshin Steel, Daido Steel Co. Ltd., Baumco Inc.-Hotaka Engineering Co. Ltd., and Nikko Industry Co., Ltd.[22]

SKF Plasmared technology was selected for the 70,000-ton-per-year facility of Scandust at Landskrona, Sweden, for processing furnace baghouse dusts to recover metallics.[23]

Wolverhampton's Leight Interests set up a new plant named Tyrolysis, in the West Midlands area of England, to process 50,000 tons of tires annually to recover 7,000 tons of scrap steel, 20,000 tons of light fuel oil, and 17,000 tons of a coke-like solid fuel.[24]

A new pilot-scale process developed at McGill University, Montreal, Canada, used vacuum distillation to eliminate copper and tin from ferrous metals. Reportedly, this process offered the unrestricted use of high residual content ferrous scrap instead of No. 1 bundles.[25]

Several shredder operators in Denmark, where 300,000 tons of shredder residue was available, studied its use as a fuel for municipal district heating systems in a 15-mile radius. Three tons of this residue had a calorific value equal to 1 ton of fuel oil.[26]

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[1]Physical scientist, Division of Ferrous Metals.
[2]All quantities are in short tons unless otherwise noted.
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[18]Metal Bulletin. New Method for Recycling Oily Sludges. No. 6682, Apr. 23, 1982, p. 17.
[19]American Metal Market. New Technology to Up Use in BOF. V. 90, No. 223, Nov. 16, 1982, p. 12.
[20]———. Krupp Stahl Developing Cost Efficient Process for Melting Sponge Iron. V. 90, No. 204, Oct. 20, 1982, p. 9.
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[26]Work cited in footnote 17.

Table 2.—U.S. consumer receipts, production, consumption, shipments, and stocks of iron and steel scrap and pig iron in 1982, by grade

(Thousand short tons)

Grade	Receipts of scrap		Production of home scrap				
	From brokers, dealers, other outside sources	From other own-company plants	Recirculating scrap resulting from current operations	Obsolete scrap (includes ingot molds, stools, scrap from old equipment, buildings, etc.)	Consumption of both purchased and home scrap (includes recirculating scrap)	Shipments of scrap	Ending stocks, Dec. 31
MANUFACTURERS OF PIG IRON AND RAW STEEL AND CASTINGS							
Carbon steel:							
Low-phosphorus plate and punchings	260	9	14	3	263	13	41
Cut structural and plate	643	255	347	5	1,328	51	75
No. 1 heavy melting steel	5,360	1,340	8,237	96	13,895	1,456	1,662
No. 2 heavy melting steel	1,237	125	747	3	2,252	76	280
No. 1 and electric furnace bundles	3,785	364	1,587	(1)	5,932	201	715
No. 2 and all other bundles	858	56	15	--	1,072	5	115
Electric furnace 1 foot and under (not bundles)	10	(1)	1	--	22	--	3
Railroad rails	62	(1)	1	--	88	2	2
Turnings and borings	790	27	175	1	995	63	103
Slag scrap (Fe content 70%)	499	115	2,594	--	2,913	222	198
Shredded or fragmentized	1,721	373	54	--	2,126	3	187
No. 1 busheling	830	31	110	1	986	46	92
All other carbon steel scrap	1,284	227	6,025	19	6,877	361	712
Stainless steel scrap	382	33	346	1	746	30	92
Alloy steel (except stainless)	118	127	904	30	1,030	134	365
Ingot mold and stool scrap	98	335	629	878	1,672	396	495
Machinery and cupola cast iron	(1)	--	4	(1)	14	1	14
Cast iron borings	124	17	104	1	137	176	36
Motor blocks	1	--	--	--	2	--	--
Other iron scrap	495	111	364	10	772	256	244
Other mixed scrap	303	92	211	2	577	28	47
Total[2]	18,866	3,637	22,469	1,049	43,698	3,519	5,475
MANUFACTURERS OF STEEL CASTINGS							
Carbon steel:							
Low-phosphorus plate and punchings	435	3	146	(1)	550	3	37
Cut structural and plate	128	7	12	(1)	138	(1)	17
No. 1 heavy melting steel	92	5	39	--	149	1	10
No. 2 heavy melting steel	57	(1)	2	--	60	(1)	6
No. 1 and electric furnace bundles	24	--	--	--	20	--	(1)
No. 2 and all other bundles	3	--	--	--	4	--	(1)
Electric furnace 1 foot and under (not bundles)	67	(1)	17	(1)	80	(1)	6
Railroad rails	3	--	--	--	3	--	(1)
Turnings and borings	34	(1)	19	--	40	6	2
Slag scrap (Fe content 70%)	--	--	(1)	--	(1)	(1)	(1)
Shredded or fragmentized	38	--	2	--	37	(1)	5
No. 1 busheling	16	--	--	--	10	(1)	2
All other carbon steel scrap	246	5	203	--	452	7	26
Stainless steel scrap	11	(1)	14	(1)	24	1	6
Alloy steel (except stainless)	38	1	82	(1)	119	1	26
Ingot mold and stool scrap	2	1	(1)	--	2	(1)	1
Machinery and cupola cast iron	2	--	1	--	3	--	(1)
Cast iron borings	63	1	19	--	69	(1)	6
Motor blocks	(1)	--	--	--	(1)	--	(1)
Other iron scrap	44	2	23	(1)	67	3	8
Other mixed scrap	(1)	--	4	--	4	--	(1)
Total[2]	1,302	27	586	(1)	1,838	25	159

See footnotes at end of table.

Table 2.—U.S. consumer receipts, production, consumption, shipments, and stocks of iron and steel scrap and pig iron in 1982, by grade —Continued

(Thousand short tons)

Grade	Receipts of scrap: From brokers, dealers, other outside sources	Receipts of scrap: From other own-company plants	Production of home scrap: Recirculating scrap resulting from current operations	Production of home scrap: Obsolete scrap (includes ingot molds, stools, scrap from old equipment, buildings, etc.)	Consumption of both purchased and home scrap (includes recirculating scrap)	Shipments of scrap	Ending stocks, Dec. 31
IRON FOUNDRIES AND MISCELLANEOUS USERS							
Carbon steel:							
Low-phosphorus plate and punchings	632	66	90	--	778	9	37
Cut structural and plate	920	96	58	(1)	1,097	1	95
No. 1 heavy melting steel	53	23	55	3	90	32	19
No. 2 heavy melting steel	40	2	30	1	72	1	2
No. 1 and electric furnace bundles	109	24	33	(1)	172	--	5
No. 2 and all other bundles	129	9	--	--	151	(1)	24
Electric furnace 1 foot and under (not bundles)	85	46	1	--	130	--	4
Railroad rails	124	(1)	8	(1)	124	(1)	18
Turnings and borings	296	34	10	1	338	16	42
Slag scrap (Fe content 70%)	15	--	(1)	--	16	(1)	8
Shredded or fragmentized	590	2	(1)	(1)	731	(1)	47
No. 1 busheling	200	17	14	--	226	19	10
All other carbon steel scrap	905	4	117	(1)	1,004	5	54
Stainless steel scrap	9	1	2	(1)	12	(1)	2
Alloy steel (except stainless)	35	(1)	5	1	38	3	10
Ingot mold and stool scrap	76	2	63	3	149	3	51
Machinery and cupola cast iron	875	12	338	13	1,195	5	133
Cast iron borings	486	135	137	(1)	735	38	36
Motor blocks	516	6	356	--	782	5	52
Other iron scrap	524	52	1,394	22	1,998	33	95
Other mixed scrap	734	2	263	4	1,020	4	41
Total[2]	7,353	530	2,973	49	10,858	177	785
TOTAL—ALL TYPES OF MANUFACTURERS							
Carbon steel:							
Low-phosphorus plate and punchings	1,327	77	251	3	1,591	26	115
Cut structural and plate	1,691	359	417	5	2,563	52	187
No. 1 heavy melting steel	5,505	1,368	8,331	99	14,134	1,490	1,690
No. 2 heavy melting steel	1,334	127	780	4	2,384	77	288
No. 1 and electric furnace bundles	3,918	388	1,623	(1)	6,123	201	721
No. 2 and all other bundles	991	65	15	--	1,227	5	139
Electric furnace 1 foot and under (not bundles)	162	46	19	(1)	233	(1)	13
Railroad rails	189	(1)	9	(1)	215	2	20
Turnings and borings	1,120	61	204	2	1,373	86	147
Slag scrap (Fe content 70%)	515	115	2,595	--	2,929	223	205
Shredded or fragmentized	2,349	375	56	(1)	2,893	3	238
No. 1 busheling	1,047	47	124	1	1,223	65	104
All other carbon steel scrap	2,435	238	6,345	19	8,333	374	792
Stainless steel scrap	402	35	361	1	782	31	99
Alloy steel (except stainless)	191	128	991	31	1,187	138	401
Ingot mold and stool scrap	176	337	692	881	1,822	399	546
Machinery and cupola cast iron	877	12	342	13	1,212	5	147
Cast iron borings	674	153	260	1	940	214	79
Motor blocks	517	6	356	--	784	5	52
Other iron scrap	1,063	165	1,781	33	2,837	292	346
Other mixed scrap	1,038	93	477	6	1,601	32	88
Grand total[2]	27,520	4,195	26,028	1,099	56,386	3,721	6,418

[1]Less than 1/2 unit.

[2]Data may not add to totals shown because of independent rounding.

Table 3.—U.S. consumer receipts, production, consumption, shipments, and stocks of pig iron and direct-reduced iron in 1982

(Thousand short tons)

	Receipts	Production	Consumption	Shipments	Stocks, Dec. 31
MANUFACTURERS OF PIG IRON AND RAW STEEL AND CASTINGS					
Pig iron	1,157	43,342	43,281	2,287	559
MANUFACTURERS OF STEEL CASTINGS					
Pig iron	71	--	69	(1)	4
IRON FOUNDRIES AND MISCELLANEOUS USERS					
Pig iron	1,032	--	1,059	2	59
TOTAL—ALL TYPES OF MANUFACTURERS					
Pig iron	2,260	43,342	44,409	2,289	622
Direct-reduced or prereduced iron	332	W	288	--	155

W Withheld to avoid disclosing company proprietary data.
[1]Less than 1/2 unit.

Table 4.—Consumption of iron and steel scrap and pig iron in the United States in 1982, by type of furnace or other use

(Thousand short tons)

Type of furnace or other use	Manufacturers of pig iron and raw steel and castings		Manufacturers of steel castings		Iron foundries and miscellaneous users		Total, all types[1]	
	Scrap	Pig iron	Scrap	Pig iron	Scrap	Pig iron	Scrap	Pig iron
Blast furnace[2]	2,648	--	--	--	--	--	2,648	--
Basic oxygen process[3]	14,059	38,553	--	--	--	--	14,059	38,553
Open-hearth furnace	3,554	3,632	34	3	--	--	3,588	3,635
Electric furnace	22,766	210	1,693	64	3,335	222	27,794	496
Cupola furnace	37	128	94	--	7,197	353	7,328	481
Other (including air furnace)[4]	634	111	9	1	327	28	970	141
Direct castings[5]	--	647	--	--	--	456	--	1,102
Total[1]	43,698	43,281	1,830	69	10,858	1,059	56,386	44,409

[1]Data may not add to totals shown because of independent rounding.
[2]Includes consumption in all blast furnaces producing pig iron.
[3]Includes scrap and pig iron processed in metallurgical blast cupolas and used in oxygen converters.
[4]Includes vacuum melting furnaces and miscellaneous uses.
[5]Includes ingot molds and stools.

Table 5.—Proportion of iron and steel scrap and pig iron used in the United States in 1982, by type of furnace

(Percent)

Type of furnace	Scrap	Pig iron
Basic oxygen process	26.7	73.3
Open-hearth furnace	49.7	50.3
Electric furnace	98.2	1.8
Cupola furnace	93.8	6.2
Other (including air furnace)	87.3	12.7

Table 6.—U.S. iron and steel scrap supply[1] available for consumption in 1982, by region and State

(Thousand short tons)

Region and State	Receipts of scrap		Production of home scrap		Total new supply[2]	Shipments of scrap[3]	New supply available for consumption[2]
	From brokers, dealers, other outside sources	From other own-company plants	Recirculating scrap resulting from current operations	Obsolete scrap (includes ingot molds, stools, scrap from old equipment, buildings, etc.)			
New England and Middle Atlantic:							
Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont	953	60	652	19	1,685	166	1,519
Pennsylvania	3,057	1,098	4,673	238	9,066	1,236	7,830
Total[2]	4,010	1,158	5,326	257	10,750	1,401	9,349
North Central:							
Illinois	2,790	533	2,044	32	5,400	217	5,183
Indiana	1,719	91	5,821	267	7,899	700	7,199
Iowa, Kansas, Michigan, Minnesota, Missouri	4,976	382	1,925	39	7,322	127	7,194
Ohio	3,018	1,117	4,845	223	9,203	761	8,442
Wisconsin	530	10	427	(4)	968	22	946
Total[2]	13,034	2,133	15,063	562	30,791	1,827	28,964
South Atlantic:							
Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia	3,385	146	1,942	125	5,598	158	5,448
South Central:							
Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Oklahoma, Tennessee, Texas	4,950	556	2,475	104	8,085	263	7,823
Mountain and Pacific:							
Arizona, California, Colorado, Hawaii, Montana, Nevada, Oregon, Utah, Washington	2,142	202	1,223	51	3,618	72	3,546
Grand total[2]	27,520	4,195	26,028	1,099	58,842	3,721	55,121

[1]New supply available for consumption is a net figure computed by adding production to receipts and deducting scrap shipped during the year. The plus or minus difference in stock levels at the beginning and end of the year is not taken into consideration.
[2]Data may not add to totals shown because of independent rounding.
[3]Includes scrap shipped, transferred, or otherwise disposed of during the year.
[4]Less than 1/2 unit.

Table 7.—U.S. consumption of iron and steel scrap and pig iron[1] in 1982, by region and State

(Thousand short tons)

Region and State	Pig iron and steel ingots and castings		Steel castings		Iron foundries and miscellaneous users		Total[2]	
	Scrap	Pig iron	Scrap	Pig iron	Scrap	Pig iron	Scrap	Pig iron
New England and Middle Atlantic:								
Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont	810	979	69	4	669	47	1,548	1,031
Pennsylvania	7,563	5,330	209	5	690	202	8,462	5,537
Total[2]	8,373	6,310	278	9	1,359	249	10,010	6,568
North Central:								
Illinois	4,301	2,604	233	(3)	700	146	5,234	2,751
Indiana	6,777	13,518	115	42	403	40	7,295	13,600
Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska	4,417	4,070	225	1	2,664	195	7,306	4,266
Ohio	6,264	7,885	123	7	2,196	249	8,584	8,142
Wisconsin	--	--	205	1	763	49	968	50
Total[2]	21,759	28,078	901	51	6,727	679	29,387	28,808

See footnotes at end of table.

Table 7.—U.S. consumption of iron and steel scrap and pig iron[1] in 1982, by region and State —Continued

(Thousand short tons)

Region and State	Pig iron and steel ingots and castings		Steel castings		Iron foundries and miscellaneous users		Total[2]	
	Scrap	Pig iron	Scrap	Pig iron	Scrap	Pig iron	Scrap	Pig iron
South Atlantic:								
Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia	4,954	W	53	3	560	26	5,566	29
South Central:								
Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Oklahoma, Tennessee, Texas	5,561	[4]6,933	340	3	1,829	90	7,730	7,026
Mountain and Pacific:								
Arizona, California, Colorado, Hawaii, Montana, Nevada, Oregon, Utah, Washington	3,049	1,960	259	3	384	15	3,692	1,978
Grand total[2]	43,698	43,281	1,830	69	10,858	1,059	56,386	44,409

W Withheld to avoid disclosing company proprietary data.
[1]Includes molten pig iron used for ingot molds and direct castings.
[2]Data may not add to totals shown because of independent rounding.
[3]Less than 1/2 unit.
[4]Includes South Atlantic region.

Table 8.—U.S. consumer stocks of iron and steel scrap and pig iron, Dec. 31, 1982, by region and State

(Thousand short tons)

Region and State	Carbon steel (excludes rerolling rails)	Stainless steel	Alloy steel (excludes stainless)	Cast iron (includes borings)	Other grades of scrap	Total scrap stocks[1]	Pig iron stocks
New England and Middle Atlantic:							
Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont	144	21	18	61	3	247	193
Pennsylvania	996	41	196	173	2	1,407	89
Total[1]	1,140	62	214	234	4	1,654	282
North Central:							
Illinois	540	W	5	96	W	643	26
Indiana	491	4	26	271	15	807	24
Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska	416	6	2	85	11	520	16
Ohio	418	7	110	83	8	625	87
Wisconsin	12	W	([2])	6	W	19	3
Total[1]	1,877	19	143	540	35	2,614	156
South Atlantic:							
Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia	424	W	9	90	1	524	11
South Central:							
Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Oklahoma, Tennessee, Texas	785	[3]12	19	199	18	1,033	144
Mountain and Pacific:							
Arizona, California, Colorado, Hawaii, Montana, Nevada, Oregon, Utah, Washington	434	6	16	107	30	590	28
Grand total[1]	4,660	99	401	1,169	88	6,418	622

W Withheld to avoid disclosing company proprietary data.
[1]Data may not add to totals shown because of independent rounding.
[2]Less than 1/2 unit.
[3]Includes South Atlantic region.

Table 9.—U.S. average monthly price and composite price for No. 1 heavy melting scrap in 1982

(Per long ton)

Month	Chicago	Pittsburgh	Philadelphia	Composite price[1]
January	$83.00	$93.73	$84.00	$86.91
February	78.63	91.11	84.00	84.58
March	69.78	83.96	84.00	79.50
April	63.86	74.55	77.00	71.80
May	58.30	62.95	69.00	63.42
June	51.77	59.36	61.00	57.38
July	49.00	57.51	59.00	55.19
August	51.73	58.00	59.00	56.24
September	48.95	57.76	58.90	55.20
October	47.86	54.76	57.00	53.21
November	45.00	51.50	55.40	50.63
December	45.48	52.38	55.00	50.95
Average 1982	57.78	66.47	66.94	63.73
Average 1981[r]	91.76	100.57	87.67	93.33

[r]Revised.
[1]Composite price, Chicago, Pittsburgh, and Philadelphia. American Metal Market, Mar. 4, 1983.

Table 10.—U.S. exports of iron and steel scrap, by country

(Thousand short tons and thousand dollars)

Country	1978		1979		1980		1981		1982	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Canada	795	41,698	861	60,275	790	57,507	737	52,463	307	21,006
Greece	340	25,079	500	52,395	545	57,484	271	25,452	208	16,517
Italy	657	54,522	1,186	124,361	892	101,865	34	2,407	12	2,972
Japan	3,190	238,979	2,922	305,509	2,838	308,784	1,191	117,724	1,530	145,083
Korea, Republic of	1,503	117,742	1,418	152,483	1,736	192,745	1,241	114,736	1,522	115,515
Mexico	450	35,808	814	85,098	1,134	137,273	896	102,329	380	33,822
Spain	744	53,038	1,400	127,592	1,163	114,837	434	34,570	868	61,616
Taiwan	394	41,126	634	70,004	990	125,716	374	59,874	352	57,213
Turkey	258	19,583	242	23,482	318	31,363	364	31,814	639	48,286
Other	708	70,662	1,077	141,207	762	98,367	874	97,274	987	108,273
Total[1]	9,039	698,237	11,054	1,142,406	11,168	1,225,941	6,415	638,644	6,804	610,302

[1]Data may not add to totals shown because of independent rounding.

Table 11.—U.S. exports and imports for consumption of iron and steel scrap, by class

(Thousand short tons and thousand dollars)

Class	1978[1] Quantity	1978[1] Value	1979[1] Quantity	1979[1] Value	1980[1] Quantity	1980[1] Value	1981[1] Quantity	1981[1] Value	1982 Quantity	1982 Value
Exports:										
No. 1 heavy melting scrap	2,362	175,933	2,697	269,845	2,907	297,666	1,606	141,205	1,883	138,973
No. 2 heavy melting scrap	837	56,433	1,117	104,017	1,067	102,137	618	51,630	626	44,032
No. 1 bundles	148	11,231	145	14,455	119	11,542	41	3,476	115	8,619
No. 2 bundles	326	17,055	652	46,889	314	24,852	273	18,993	181	11,310
Stainless steel scrap	115	44,439	112	66,118	125	78,034	63	40,307	131	74,052
Shredded steel scrap	2,684	198,377	2,980	308,383	3,323	345,946	1,923	179,626	2,023	160,169
Borings, shovelings, turnings	750	33,163	889	59,467	769	50,381	486	24,757	577	28,923
Other steel scrap[2]	1,382	128,350	1,828	211,352	1,762	240,886	903	127,937	878	112,130
Iron scrap	434	33,258	632	61,879	783	74,497	501	50,714	389	32,096
Total[3]	9,039	698,237	11,054	1,142,406	11,168	1,225,941	6,415	638,644	6,804	610,302
Ships, boats, other vessels (for scrapping)	2	232	73	5,436	169	18,340	52	3,643	69	4,440
Rerolling material	50	5,528	70	10,222	86	12,768	57	10,831	53	7,969
Grand total[3]	9,090	703,996	11,197	1,158,064	11,423	1,257,049	6,524	653,118	6,925	622,711
Imports for consumption:										
Iron and steel scrap	794	50,220	760	70,804	582	61,192	556	62,126	468	37,572

[1]Starting in 1978, exports of rerolling material are not comparable with those of previous years because of a change of classification by the Bureau of Census.
[2]Includes terneplate and tinplate.
[3]Data may not add to totals shown because of independent rounding.

Table 12.—U.S. exports of rerolling material (scrap), by country[1]

(Thousand short tons and thousand dollars)

Country	1978 Quantity	1978 Value	1979 Quantity	1979 Value	1980 Quantity	1980 Value	1981 Quantity	1981 Value	1982 Quantity	1982 Value
Korea, Republic of	--	--	2	172	4	538	--	--	--	--
Mexico	38	4,176	57	8,614	65	10,848	55	10,267	33	5,290
Pakistan	7	470	--	--	2	185	--	--	--	--
Other	6	882	11	1,436	14	1,197	2	564	20	2,679
Total[2]	50	5,528	70	10,222	86	12,768	57	10,831	53	7,969

[1]Starting in 1978, exports of rerolling material are not comparable with those of previous years because of a change of classification by the Bureau of Census.
[2]Data may not add to totals shown because of independent rounding.

Table 13.—U.S. imports for consumption of iron and steel scrap,[1] by country

Country	1981 Quantity (short tons)	1981 Value (thousands)	1982 Quantity (short tons)	1982 Value (thousands)
Austria	--	--	25	$118
Belgium-Luxembourg	153	$8	36	2
Canada	511,209	52,600	387,069	32,003
Germany, Federal Republic of	939	140	1,100	248
Japan	1,114	2,628	246	192
Mexico	31,112	2,797	62,963	3,693
Netherlands	211	206	1	10
Panama	15	6	6,002	61
Sweden	2,336	676	325	9
United Kingdom	2,423	1,770	3,967	235
Other	6,653	1,295	6,363	1,001
Total	556,165	62,126	468,097	37,572

[1]Includes tinplate.

Table 14.—Iron and steel scrap consumption in selected countries[1]

(Thousand short tons)

Continent, country group, and country	1977	1978	1979	1980	1981
North America:					
Canada[2 3 4 5]	7,683	8,622	9,145	9,395	8,233
United States[2 5 6]	92,138	99,223	98,901	83,710	85,097
Latin America:[7]					
Argentina	1,892	1,523	1,775	[e]1,490	[e]1,710
Brazil	5,044	5,800	[8]6,497	[8]7,119	[e]7,003
Chile	227	177	[e]200	[r] [e]230	[e]205
Colombia	250	183	[e]170	[e]190	[e]185
Mexico	2,690	3,097	[e]3,220	[r] [e]3,260	[e]3,500
Peru	184	150	[e]170	[e]185	[e]140
Uruguay	55	57	[e]60	[e]55	--
Venezuela	583	602	[e]550	[r] [e]665	[e]740
Central America, not further detailed	57	61	[e]60	[e]60	[e]55
Europe:					
European Economic Community:					
Belgium[2]	3,728	4,182	4,467	4,065	4,133
Denmark[3 9 10]	862	1,068	[r]998	894	758
France	8,282	9,018	8,941	8,748	8,040
Germany, Federal Republic of[5]	22,262	23,359	23,993	22,401	[2]21,632
Ireland	60	87	[11]93	[11]3	[e]65
Italy[3]	16,629	17,897	17,928	[11]19,825	[e]18,000
Luxembourg	1,555	1,942	1,968	1,738	1,458
Netherlands	1,857	2,030	2,166	2,025	1,961
United Kingdom	17,070	16,902	16,761	10,248	[e]13,000
European Free Trade Association:					
Austria	1,789	1,926	2,013	[11]1,903	1,690
Finland	898	[3]832	[3]819	[3]848	807
Norway[2 4 5]	[3]485	[e]490	607	526	[e]500
Portugal	396	491	[e]520	560	[e]450
Sweden[2 3]	2,679	2,872	3,045	[5]2,835	[e]2,500

See footnotes at end of table.

Table 14.—Iron and steel scrap consumption in selected countries[1] —Continued

(Thousand short tons)

Continent, country group, and country	1977	1978	1979	1980	1981
Europe —Continued					
Council for Mutual Economic Assistance:					
Bulgaria[e]	750	720	805	860	[e]830
Czechoslovakia[2 4 5]	8,216	8,173	8,438	[e]8,490	8,244
German Democratic Republic[2 3 4 5]	4,730	5,040	5,545	5,833	5,816
Hungary[2 4 5]	2,467	2,566	2,595	2,528	2,425
Poland	11,083	12,518	11,597	11,817	9,598
Romania[e]	3,890	4,080	4,190	4,300	4,250
U.S.S.R.[e]	52,800	54,450	53,020	52,690	52,900
Other:					
Greece[e]	180	300	330	[r]310	300
Spain	[3 4 5]8,111	[3 4 5]8,726	7,961	[11]9,195	[e]9,400
Yugoslavia[3 4 5]	1,921	2,249	2,272	2,287	2,324
Africa: South Africa, Republic of[2 12]	[r]2,855	[r]3,317	2,778	3,605	3,024
Asia:					
China[e]	7,000	8,000	8,000	8,000	7,700
India[e]	4,300	4,400	4,400	4,080	4,100
Japan[5]	38,147	43,445	50,292	48,291	44,616
Korea, Republic of[e]	1,800	1,860	1,800	2,200	2,700
Taiwan[e 13]	550	600	[r]800	[r]1,200	900
Turkey[2 5]	[14]1,279	[14]1,017	[e]1,100	[e]1,100	[e]1,100
Oceania:					
Australia	[15]2,105	[15]2,448	[16]2,639	[r e]2,470	[e]2,480
New Zealand	[13]181	[e]182	[15]160	[r e]155	[e]160
Total	[r]341,720	[r]366,682	[r]373,789	[r]352,389	344,729

[e]Estimated. [r]Revised.

[1]Unless otherwise noted, figures represent reported actual consumption of iron and steel scrap utilized in the production of pig iron, ferroalloys, crude steel, foundry products, and rerolled steel, as well as in other unspecified uses by the steel industry and by other unspecified industries as reported by the United Nations Economic Commission for Europe in its Annual Bulletin of Steel Statistics for Europe, v. 9, 1981, New York, 1982, 87 pp., which is the source of all reported data unless otherwise noted. (All estimates included are made by the U.S. Bureau of Mines.)

[2]Excludes scrap consumed by steel rerollers.

[3]Excludes scrap consumed in iron foundries.

[4]Excludes scrap consumed within the steel industry for purposes other than the manufacture of pig iron, ferroalloys, crude steel, foundry products, and rerolled steel.

[5]Excludes scrap consumed outside the steel industry.

[6]U.S. Bureau of Mines.

[7]Except where individually noted as an estimate or another specific source: 1977—Instituto Latinoamericano del Fierro y el Acero. Statistical Yearbook of Steelmaking and Iron Ore Mining in Latin America, 1977. Santiago, 1979, 178 pp.; 1978—Instituto Latinamericano del Fierro y el Acero. Siderúrgia Latinoamericano, No. 243, July 1980, p. 56. Source does not provide details on what is included; presumably figures represent total steel industry scrap consumption, excluding scrap used outside the steel industry.

[8]Iron and Steel Statistics Bureau (United Kingdom). International Steel Statistics, Brazil, 1980. London, 1981, p. 4.

[9]Excludes scrap consumed by pig iron producers.

[10]Includes scrap used in production of steel castings in shipyards.

[11]Organization for Economic Cooperation and Development. The Iron and Steel Industry in 1980. Paris, 1982, p. 15.

[12]Iron and Steel Statistics Bureau (United Kingdom). International Steel Statistics, South Africa, 1980, p. 4; 1981, p. 4.

[13]Organization for Economic Cooperation and Development. The Iron and Steel Industry in 1978. Paris, 1980, 40 pp.

[14]Excludes a substantial tonnage derived from shipbreaking (possibly of the order of several million tons annually for electric furnace equipped steel mills).

[15]Organization for Economic Cooperation and Development. The Iron and Steel Industry in 1979. Paris, 1981, 32 pp.

[16]Iron and Steel Statistics Bureau (United Kingdom). International Steel Statistics, Australia, 1980. London, 1981, p. 4.

Table 15.—Iron and steel scrap exports, by continent and country[1]

(Thousand short tons)

Continent, country group, and country	1977	1978	1979	1980	1981
North America:					
Canada	768	963	1,139	865	632
United States[2]	[3]6,175	[3]9,089	[3]11,124	11,168	6,415
Latin America:					
Mexico	[2]2	([2] [4])	[2]1	[2]4	[e]1
Europe:					
European Economic Community:					
Belgium-Luxembourg	552	585	606	592	637
Denmark	63	89	100	110	204
France	3,702	4,038	3,887	3,651	3,510
Germany, Federal Republic of	2,735	3,048	[r]3,305	3,392	3,756
Greece	1	([4])	([4])	([4])	1
Ireland	9	60	79	93	80
Italy	12	8	14	9	25
Netherlands	1,021	1,311	1,259	1,316	1,380
United Kingdom	1,034	1,725	1,475	3,092	3,712
European Free Trade Association:					
Austria	9	9	17	14	14
Finland	3	1	3	([4])	([4])
Norway	14	40	46	42	35
Portugal	4	11	6	6	6
Sweden	83	86	19	15	15
Switzerland	68	97	110	71	141
Council for Mutual Economic Assistance:					
Bulgaria	67	184	143	171	94
Czechoslovakia[5]	89	126	137	109	113
German Democratic Republic[5]	1	15	[r]57	54	21
Hungary	78	46	41	34	35
Poland	1	15	12	[r]16	52
Romania[5]	2	3	1	([4])	([4])
U.S.S.R.[2]	2,412	1,849	2,190	[r]2,756	2,956
Other:					
Iceland	2	--	[r]5	3	3
Spain	([4])	1	([4])	1	([4])
Yugoslavia	46	87	52	50	65
Africa:					
Morocco	[2]21	[2]50	[2]98	[r] [2]38	[e]35
South Africa, Republic of	[5]3	[5]8	[r] [5]1	[r] [5]7	[e]5
Asia:					
China[5]	--	([4])	([4])	11	10
Hong Kong	250	315	412	302	371
India	[2]60	[2]31	[2]12	[r] [e]10	[e]10
Indonesia	--	7	--	1	--
Japan	233	181	166	175	206
Korea, Republic of	1	9	14	10	28
Malaysia	[2]12	[2]15	[2]15	[2]12	[e]10
Philippines	([2] [4])	[2]3	[2]3	[2]2	[e]2
Singapore[2]	8	4	2	6	2
Taiwan[2]	40	172	79	14	141
Thailand	--	--	--	1	2
Oceania:					
Australia[2]	713	755	63	[e]100	708
New Zealand[2]	2	2	5	49	3
Total	20,296	[r]25,038	[r]26,698	[r]28,372	25,436

[e]Estimated. [r]Revised.

[1]Unless otherwise noted, source is United Nations Economic Commission for Europe. Annual Bulletin of Steel Statistics for Europe, v. 9, 1981, New York, 1982, 87 pp.

[2]Official trade returns of subject country.

[3]Includes rerolling material.

[4]Less than 1/2 unit.

[5]Partial figure; compiled from import statistics of trading partner countries.

Table 16.—Iron and steel scrap imports, by continent and country[1]

(Thousand short tons)

Continent, country group, and country	1977	1978	1979	1980	1981
North America:					
Canada	644	1,052	1,156	1,119	924
United States[2]	625	794	761	582	556
Latin America:					
Argentina	[2]177	[2]18	[2]7	[2]2	[e]2
Brazil	([2] [3])	([2] [3])	([2] [3])	[2]24	[e]25
Chile	[2]11	[2]8	[e]10	[e]10	[e]10
Colombia	[2]13	[2]23	[2]25	[2]14	[e]15
Cuba	[4]81	[4]92	[4]80	[4]95	[e]100
Mexico	[2]389	[2]531	[r] [2]393	[2]257	[e]250
Peru	--	--	--	[r] [2]36	[e]35
Venezuela	[e]66	[e]55	[2]50	[2]36	[e]30
Europe:					
European Economic Community:					
Belgium-Luxembourg	543	1,079	1,069	947	1,054
Denmark	14	290	313	239	198
France	316	434	465	503	383
Germany, Federal Republic of	1,569	1,705	1,769	1,658	1,473
Greece	103	218	254	263	317
Ireland	2	10	6	9	4
Italy	6,421	7,238	7,596	8,168	6,107
Netherlands	126	182	136	170	262
United Kingdom	110	47	49	28	23
European Free Trade Association:					
Austria	88	127	149	158	187
Finland	69	24	98	117	68
Norway	20	11	8	58	26
Portugal	105	731	161	[r]164	94
Sweden	36	130	143	84	272
Switzerland	64	96	197	151	125
Council for Mutual Economic Assistance:					
Bulgaria	--	--	[4]1	([3] [4])	--
Czechoslovakia[4]	49	54	47	62	59
German Democratic Republic	[r]547	602	780	1,001	764
Hungary	2	3	7	4	159
Poland	37	10	7	250	58
Romania	--	9	11	62	--
U.S.S.R.	[5]20	[5]21	[5]22	[6]23	[e]24
Other:					
Spain	2,197	2,811	3,805	4,835	4,415
Yugoslavia	451	443	292	437	[2]528
Africa:					
Egypt	[2]127	[2]46	[2]18	[2]41	[e]40
Morocco	([3])	1	([3])	([3])	([3])
South Africa, Republic of	[2]33	[2]19	[2]9	[2]31	[e]20
Asia:					
China[4]	([3])	19	6	2	2
Hong Kong[2]	100	139	116	103	104
India	[2]82	[2]119	[2]160	[e]130	[e]100
Indonesia[2]	52	89	33	43	69
Iran	[e]11	NA	NA	NA	NA
Japan	1,587	3,559	3,688	3,291	1,974
Korea, Republic of[2]	1,732	1,867	1,742	2,130	2,546
Malaysia	[2]3	[2]8	[2]7	[2]5	[e]5
Pakistan	[e]165	187	139	368	[e]200
Philippines	[2]68	[2]87	[2]105	[2]10	[e]100
Singapore[2]	25	103	120	190	86
Taiwan	[2]629	[2]686	[2]839	[2]1,358	971
Thailand[2]	489	884	678	373	460
Turkey	331	356	399	381	579
Oceania:					
Australia[2]	1	1	1	1	1
New Zealand[2]	18	19	1	69	5
Total	[r]20,348	[r]27,037	[r]27,928	[r]30,092	25,809

[e]Estimated. [r]Revised. NA Not available.
[1]Unless otherwise noted, source is United Nations Economic Commission for Europe. Annual Bulletin of Steel Statistics for Europe 1981, v. 9, New York, 1982, 87 pp.
[2]Official trade returns of subject country.
[3]Less than 1/2 unit.
[4]Partial figures, compiled from export statistics of trading partner countries.
[5]Officially reported, but may be incomplete figure.
[6]Partial figures, compiled from incomplete returns of subject country and export statistics of trading partner countries.

Iron and Steel Slag

By William I. Spinrad, Jr.[1]

Domestic production, sales, and use of iron and steel slag decreased in 1982 compared with that of 1981 because of reduced U.S. iron and steel production and declines in consumption by U.S. construction industries. Air-cooled blast-furnace slag comprised the largest portion of total blast-furnace slag sold or used. In 1982, Atlantic Cement Co., Inc., dedicated its 800,000-short-ton-per-year slag plant at Sparrows Point, Md. Heckett Co. and Standard Slag Co. permanently closed plants located in Los Angeles, Calif., and Youngstown, Ohio, respectively, and International Mill Service Co. shut down its plant at Phoenix Steel Corp. in Phoenixville, Pa., for an indefinite period.

The construction industry was the major user of iron and steel slag products in 1982. Air-cooled blast-furnace slag was used mainly for road base, as asphaltic concrete aggregate, and as fill. Steel slag was typically used as fill and for road base. Reported growth areas for slag in the 1980's are as an additive in portland cement and as a lightweight concrete aggregate. The average unit value for blast-furnace slag increased 3% from 1981 to 1982. Steel slag increased 1% in unit value over the same period.

Domestic Data Coverage.—Sales, use, and transportation data for iron and steel slag were compiled from voluntary responses received from an annual survey of U.S. processors conducted by the Bureau of Mines. In 1982, of the 75 operations canvassed, 69, or 92%, responded representing 88% of the total sales or use data shown in table 1. Data for the remaining six nonrespondents were estimated by using reported prior year sales and use levels adjusted by trends in the industry and other guidelines.

DOMESTIC PRODUCTION

Domestic iron and steel slag production, which is not reported, undoubtedly fell in 1982 because of major declines in U.S. iron and steel production. In 1982, pig iron production declined 41% and raw steel production declined 40% from 1981 levels. The quantity of steel slag sold or used also decreased because of declines in most forms of construction that use slag. Blast-furnace slag sold or used in 1982 decreased 6% in quantity and 3% in value compared with that of 1981, to 14.8 million tons valued at $64.9 million. Fifty-nine percent was marketed in Pennsylvania, Indiana, and Ohio. Of the total blast-furnace slag sold or used, 92% was air-cooled, 4% was granulated, and 4% was expanded. Steel slag sold or used totaled 4.7 million tons valued at $14.6 million in 1982, down 17% in quantity and 16% in value from that of 1981. Of all iron and steel slag products shipped to market, 82% traveled by truck with the remainder traveling by rail or water. The reported marketing range for slag is between 50 and 70 miles from its source.

Atlantic Cement dedicated its new 800,000-ton-per-year slag plant at Sparrows Point, Md., on June 15, 1982. This facility, which processes slag from Bethlehem Steel Corp.'s "L" blast furnace, is reported to be the only U.S. plant to employ full water granulation for processing blast-furnace slag into cementitious material.

In 1982, Heckett permanently shut down its Los Angeles, Calif., plant; International Mill shut down its plant at Phoenix Steel in Phoenixville, Pa., for an indefinite period; and Standard Slag permanently closed its Republic plant in Youngstown, Ohio.

Table 1.—Iron and steel slags sold or used in the United States[1]

(Thousand short tons and thousand dollars)

Year	Iron blast-furnace slag: Air-cooled		Granulated		Expanded		Total iron slag[2]		Steel slag		Total slag	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1978	25,119	73,148	1,372	3,608	1,914	9,641	28,404	86,398	8,457	14,510	36,861	100,908
1979	25,009	78,415	855	3,037	1,648	10,794	27,512	92,246	8,252	18,476	35,764	110,722
1980	17,113	65,313	772	2,938	1,156	8,028	19,041	76,279	6,158	16,270	25,199	92,549
1981	14,461	60,164	456	1,823	800	4,953	15,717	66,941	5,770	17,494	21,487	84,435
1982	13,617	56,816	597	3,237	539	4,800	14,752	64,854	4,764	14,641	19,516	79,495

[1]Value based on selling price at plant.
[2]Data may not add to totals shown because of independent rounding.

CONSUMPTION AND USES

The principal domestic consumer of iron and steel slag in 1982 was the construction industry. Of the 13.6 million tons of air-cooled blast-furnace slag sold or used, 46% was used as road base material, 12% as asphaltic concrete aggregate, 12% as fill, and 10% as railroad ballast. Other uses, shown in table 5, included concrete aggregate, mineral wool, and concrete products. Expanded blast-furnace slag was used mainly in concrete products. Other end uses for expanded blast-furnace slag and end uses for granulated blast-furnace slag, while not separately tabulated because of company proprietary data, are categorized by type in table 6. Steel slag uses, shown in table 7, included fill, road base material, and asphaltic concrete aggregate, comprising 37%, 32%, and 11% of total end use, respectively. The remaining 20% was used for railroad ballast, ice control, and other uses.

Reported growth areas for slag in the 1980's are expected to be an additive in portland cement and as a lightweight concrete aggregate.

PRICES

The average unit value, f.o.b. plant, for total blast-furnace slag in 1982 increased 3% from that of 1981, to $4.40 per ton. By type, expanded slag increased 44%, to $8.91 per ton, and granulated and air-cooled slag increased 36% and less than 1%, to $5.42 and $4.17 per ton, respectively. Steel slag unit value increased 1%, compared with that of 1981, to $3.07 per ton.

Weighted average selling prices and price ranges for iron and steel slags, by major end use, are shown in table 9. High prices in some use categories indicate that some users demanded specifications that required additional processing.

FOREIGN TRADE

U.S. export and import information for iron and steel slag cannot be determined because slag is classified in combined categories and cannot be broken out. U.S. exports of slag are classified under the schedule headings "Mineral Substances and Articles of Mineral Substances Not Specifically Provided For" and "Waste and Scrap Not Specifically Provided For," while U.S. imports of slag are classified as either "Metal Bearing Ores and Metal Bearing Materials" or "Waste and Scrap Not Specifically Provided For." It is known, however, that granulated blast-furnace slag is imported from Japan and France. The slag imported from Japan is reportedly produced by Nippon Steel Corp. and marketed on the west coast in 17,000-ton shipload lots under the trade name "NGS," and the imported French variety, trade named "Galex," is received and marketed on the east and gulf coasts. These imported slags are used in the production of high-grade cement. Blast-furnace slag is also known to be exported to and imported from Canada periodically.

WORLD REVIEW

Japan.—A current world leader in steel production, Japan produces and utilizes more than 46 million tons of slag per year. Blast-furnace slag accounts for more than two-thirds of this production with basic oxygen furnace (BOF) slag and electric furnace slag comprising the balance. Over one-half of the blast-furnace slag produced is used for roads and railroad ballast and one-quarter is used in cement manufacture. Total utilization of all slag produced is a goal of this industry through research into improved slag recovery methods. One profitable method of producing water-granulated slag, known as the Rasa system and developed by Rasa Corp., Tokyo, is currently being used by more than 49 plants at reported operating costs of less than $1 per ton.

Nippon Kokan (NKK), Japan's second largest steelmaker, was scheduled to begin a new slag-processing facility in February 1983 at their Keihin works in Kawasaki City. This facility will produce a specially treated granulated slag to be incorporated in a new corrosion-resistant coating developed by NKK. The coating, which will be produced at the rate of 2,200 tons per month, will be made from the specially treated slag, a cement compound, and a latex polymer. This coating shows strong adhesion to most substances, including concrete, rubber, slate, steel, and wood; excels in corrosion resistance; and shows high wear and fatigue resistance.

NKK's BOF slag recycling and heat recovery facility, completed in November 1981 and rated at 22,000 tons of BOF slag per month, is now processing 13,000 tons per month and generating 6 tons of steam per hour. The facility is comprised of three units. One produces slag pellets less than 3 millimeters in diameter from high-pressure air; a second unit produces steam power using high-temperature air and slag particle heat; and a third unit utilizes hot exhaust air from the second unit's boiler to dry up to 9,900 tons of mill scale monthly. The slag pellet product, trade named "NK Grit," can be used as an abrasive or used in construction materials.

United Kingdom.—A recent study indicated that of approximately 6 million tons of blast-furnace slag produced annually in the United Kingdom, only 1.5% was used as an extender for cement because of the limited manufacture of granulated slag and because of other competitive markets. However, granulated slag is being used increasingly as an extender in cement and as an addition to concrete mixes because of certain economic and technical advantages. For example, rises in energy costs have caused sufficiently high increases in cement costs that use of such slag extenders provides direct cost reductions. Also, use of slag materials in these applications results in less energy consumption during the cement-making process. Technically, use of slag extenders has also imparted property improvements for certain engineering and environmental requirements. Currently, there are only three British standards for extenders or extended cements, but the British Standards Institute is preparing others to broaden their uses in the future. In the United Kingdom, granulated blast-furnace slag is produced either by rapid water quenching or pelletizing by use of a water-cooled rotation drum. The slag is either added dry to portland cement clinker during grinding or blending, or added wet with the aggregate at the concrete or mortar batching plant.[2]

TECHNOLOGY

Kobe Steel Ltd., Tokyo, Japan, is developing a new slag quenching process that will turn blast-furnace slag into a sand-like material suitable for use in cement and concrete. Initially, molten blast-furnace slag, upon entering sluicing chutes, is blasted with a stream of high-pressure water. The resulting slurry is then passed through a screw classifier to settle the solid portion. These solids are discharged on a conveyor belt and then dried. Fines from the first stage enter a tank where they are precipitated by the use of thickeners, and then passed through another screw classifier for continued processing. The resulting dried solids, with a final moisture content of between 15% and 20%, are then finely crushed.[3]

A new specification was written by the American Society of Testing and Materials in 1982 for ground iron blast-furnace slag use in concrete and mortars. The specification covers three strength grades of finely ground granulated slag that may be used for blending with portland cement or as a separate ingredient in concrete or mortar mixtures. The material may also be useful with a variety of special grouts and mortars, and when used with an appropriate activator, as the principal cementitious material in some applications.[4]

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[1]Physical scientist, Division of Ferrous Metals.

[2]Bennet, K. Current and Potential Use of Cement Extending Materials in the UK. Chem. & Ind. (London), No. 21, Nov. 6, 1982, pp. 829-834.

[3]Chemical Engineering. Miscellaneous Technology. V. 98, No. 17, Aug. 23, 1982, p. 105.

[4]American Society for Testing and Materials. Standard Specifications for Ground Iron Blast-Furnace Slag for Use in Concrete and Mortars. C 989-82 in 1983 Annual Book of ASTM Standards, v. 04-02.

Table 2.—Iron blast-furnace slags sold or used in the United States, by region and State[1]

(Thousand short tons and thousand dollars)

Region and State	1981				1982			
	Air-cooled, screened and unscreened		Total, all types		Air-cooled, screened and unscreened		Total, all types	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
North Central:								
Illinois, Indiana, Michigan	2,642	9,202	W	W	4,139	13,572	W	W
Ohio	2,311	11,217	W	W	1,947	9,153	W	W
Total	4,953	20,419	5,495	23,637	6,086	22,725	6,505	25,538
Middle Atlantic:								
Pennsylvania	3,891	18,197	W	W	3,270	16,413	W	W
Maryland, New York, West Virginia	1,570	4,849	W	W	1,320	5,214	W	W
Total[2]	5,461	23,047	6,175	26,607	4,590	21,627	5,306	26,852
West: Colorado, Texas, Utah	2,356	9,016	2,356	9,016	1,637	5,621	1,637	5,621
South: Alabama and Kentucky	1,299	6,476	1,299	6,476	1,006	5,881	1,006	5,881
Pacific: California	391	1,205	391	1,205	299	962	299	962
Grand total[2]	14,461	60,164	15,717	66,941	13,617	56,816	14,752	64,854

W Withheld to avoid disclosing company proprietary data; included in "Total."
[1]Value based on selling price at plant.
[2]Data may not add to totals shown because of independent rounding.

Table 3.—Locations and processing methods of iron slag and sources of steel slag

State, city, and company	Processing method of iron slag			Steel slag	Sources of steel slag		
	Air-cooled	Ex-panded	Granu-lated		Open hearth	Basic oxygen process	Elec-tric
Alabama:							
Alabama City:							
Vulcan Materials Co	1	--	--	1	--	1	--
Birmingham:							
Jim Walter Resources, Inc	1	--	--	--	--	--	--
Fairfield:							
Vulcan Materials Co	1	--	--	1	--	1	--
Total	3	--	--	2	--	2	--
California:							
Fontana:							
Heckett Co	1	--	--	1	--	1	--
Los Angeles:							
Heckett Co	--	--	--	1	--	--	1
Total	1	--	--	2	--	1	1
Colorado: Pueblo:							
Fountain Sand and Gravel Co	1	--	--	1	--	1	--
Delaware: Claymont:							
International Mill Service Co	--	--	--	1	--	1	--
Georgia:							
Atlanta:							
International Mill Service Co	--	--	--	1	--	--	1
Cartersville:							
International Mill Service Co	--	--	--	1	--	--	1
Total	--	--	--	2	--	--	2
Illinois:							
Alton:							
International Mill Service Co	--	--	--	1	--	--	1
Chicago:							
Heckett Co	--	--	--	1	--	1	1
Illinois Slag & Ballast Co	1	--	--	--	--	--	--
Granite City:							
International Mill Service Co	--	--	--	3	--	1	--
St. Louis Slag Products Co., Inc	1	--	--	--	--	--	--
Peoria:							
International Mill Service Co	--	--	--	1	--	--	1
Total	2	--	--	6	--	2	3
Indiana:							
Burns Harbor:							
Levy Co., Inc	3	1	--	1	--	1	--
East Chicago:							
Heckett Co	--	--	--	1	1	1	--
Vulcan Materials Co	1	--	--	--	--	--	--
Total	4	1	--	2	1	2	--
Kentucky:							
Ashland:							
Standard Slag Co	1	--	--	--	--	--	--
Owensboro:							
Heckett Co	--	--	--	1	--	--	1
Total	1	--	--	1	--	--	1
Maryland:							
Baltimore:							
Maryland Slag Co	1	1	--	--	--	--	--
Sparrows Point:							
Atlantic Cement Co., Inc	--	--	1	--	--	--	--
Total	1	1	1	--	--	--	--

Table 3.—Locations and processing methods of iron slag and sources of steel slag —Continued

State, city, and company	Processing method of iron slag: Air-cooled	Ex-panded	Granu-lated	Steel slag	Sources of steel slag: Open hearth	Basic oxygen process	Elec-tric
Michigan:							
Detroit:							
Edward C. Levy Co	1	1	--	1	--	1	1
Ecorse:							
Edward C. Levy Co	--	--	--	1	--	1	1
Trenton:							
Edward C. Levy Co	1	--	--	1	--	1	--
Total	2	1	--	3	--	3	2
Minnesota: Newport:							
International Mill Service Co	--	--	--	1	--	--	1
New Jersey: Perth Amboy:							
International Mill Service Co	--	--	--	1	--	--	1
New York: Buffalo:							
Buffalo Crushed Stone Corp	1	--	--	--	--	--	--
North Carolina: Charlotte:							
Heckett Co	--	--	--	1	--	--	1
Ohio:							
Canton:							
Heckett Co	--	--	--	1	--	--	1
Cleveland:							
Standard Slag Co	1	--	--	--	--	--	--
Standard Slag Co	1	--	--	--	--	--	--
Stein, Inc	--	--	--	1	--	1	1
Hamilton:							
American Materials Corp	1	--	--	--	--	--	--
Lorain:							
Stein, Inc	--	--	--	1	--	--	1
United States Steel Corp	1	--	--	--	--	--	--
Lordstown:							
Standard Slag Co	--	--	1	--	--	--	--
Mansfield:							
Heckett Co	--	--	--	1	--	--	1
Middletown:							
American Materials Corp	1	--	--	--	--	--	--
McGraw Construction Co	--	--	--	1	1	1	--
Mingo Junction:							
International Mill Service Co	--	--	--	1	--	1	--
Standard Slag Co	1	--	--	--	--	--	--
New Boston:							
Standard Slag Co	1	--	--	--	--	--	--
Warren:							
Heckett Co	--	--	--	1	--	--	1
Standard Slag Co	1	--	--	--	--	--	--
Total	8	--	1	7	1	3	5
Oklahoma: Sand Springs:							
International Mill Service Co	--	--	--	1	--	1	--
Pennsylvania:							
Bala-Cynwyd:							
Warner Co	1	--	1	--	--	--	--
Belle Vernon:							
Duquesne Slag Products Co	1	--	--	--	--	--	--
Bethlehem:							
Bethlehem Mines Corp	1	--	--	--	--	--	--
Sheridan Slag Corp	--	1	--	--	--	--	--
Birdsboro:							
Birdsboro Slag Products Co	1	--	--	--	--	--	--
Burgettstown:							
Duquesne Slag Products Co	--	--	1	--	--	--	--
Butler:							
Heckett Co	--	--	--	1	--	--	1
Coatesville:							
International Mill Service Co	--	--	--	1	--	--	1
Johnstown:							
Heckett Co	--	--	--	1	1	--	--
Standard Slag Co	1	--	--	--	--	--	--

Table 3.—Locations and processing methods of iron slag and sources of steel slag —Continued

State, city, and company	Processing method of iron slag: Air-cooled	Processing method of iron slag: Ex-panded	Processing method of iron slag: Granu-lated	Steel slag	Sources of steel slag: Open hearth	Sources of steel slag: Basic oxygen process	Sources of steel slag: Elec-tric
Pennsylvania —Continued							
Lebanon:							
Sheridan Slag Corp	1	--	--	--	--	--	--
McKees Rocks:							
Phillips Contracting	--	--	1	--	--	--	--
Midland:							
International Mill Service Co	--	--	--	1	--	--	1
Morrisville:							
Heckett Co	--	--	--	1	1	--	1
Penn Hills:							
R. M. Chambers Inc	--	--	--	1	1	--	--
Phoenixville:							
International Mill Service Co	--	--	--	1	--	--	1
Riddlesburg:							
New Enterprise Stone & Lime Co., Inc	1	--	--	--	--	--	--
Steelton:							
Hempt Bros. Inc	1	--	--	1	1	--	--
West Aliquippa:							
Duquesne Slag Products Co	1	--	--	--	--	--	--
West Mifflin:							
Duquesne Slag Products Co	1	--	--	--	--	--	--
Duquesne Slag Products Co	1	--	1	1	1	--	--
Wheatland:							
Dunbar Slag Co. Inc	1	--	--	1	1	1	--
Total	12	1	4	10	6	1	5
South Carolina: Darlington:							
APAC-Carolina, Inc	--	--	--	1	--	--	1
Texas:							
Baytown:							
Heckett Co	--	--	--	1	--	--	1
Beaumont:							
International Mill Service Co	--	--	--	1	--	--	1
Houston:							
Houston Slag Materials Co	1	--	--	1	--	--	1
Lone Star:							
Gifford-Hill Co. Inc	1	--	--	--	--	--	--
Midlothian:							
International Mill Service Co	--	--	--	1	--	--	1
Total	2	--	--	4	--	--	4
Utah: Provo:							
Heckett Co	1	--	--	1	1	--	--
Washington: Seattle:							
Heckett Co	--	--	--	1	--	--	1
West Virginia:							
Weirton:							
International Slag Co	--	--	--	1	1	--	--
Standard Slag Co	1	--	--	--	--	--	--
Total	1	--	--	1	1	--	--
Grand total	40	4	6	49	10	17	28

Table 4.—Shipments of iron and steel slag in the United States in 1982, by method of transportation

Method of transportation	Quantity (thousand short tons)	Percent of total
Truck	16,034	82
Rail	2,176	11
Waterway	472	3
Not transported (used at plantsite)	835	4
Total	[1]19,516	100

[1]Data do not add to total shown because of independent rounding.

Table 5.—Air-cooled iron blast-furnace slag sold or used in the United States, by use[1]

(Thousand short tons and thousand dollars)

Use	1981		1982	
	Quantity	Value	Quantity	Value
Concrete aggregate	1,382	6,900	1,036	4,777
Concrete products	320	1,494	327	1,453
Asphaltic concrete aggregate	2,133	10,037	1,626	7,610
Road base	5,252	20,402	6,269	23,676
Fill	1,868	7,046	1,584	6,054
Railroad ballast	2,266	8,243	1,417	4,780
Mineral wool	604	3,055	601	3,199
Roofing, built-up and shingles	249	1,278	251	1,388
Sewage treatment	W	W	W	W
Soil conditioning	--	--	W	W
Glass manufacture	W	W	157	2,408
Other[2]	388	1,710	348	1,470
Total[3]	14,461	60,164	13,617	56,816

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Value based on selling price at plant.
[2]Includes ice control, miscellaneous, and uses indicated by symbol W.
[3]Data may not add to totals shown because of independent rounding.

Table 6.—Granulated and expanded iron blast-furnace slags sold or used in the United States, by use[1]

(Thousand short tons and thousand dollars)

Use	1981				1982			
	Granulated		Expanded		Granulated		Expanded	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Lightweight concrete aggregate	--	--	W	W	W	W	W	W
Concrete products	--	--	408	2,537	--	--	W	W
Cement manufacture	--	--	W	W	W	W	W	W
Road base	W	W	--	--	W	W	W	W
Fill	W	W	W	W	W	W	--	--
Soil conditioning	--	--	--	--	W	W	W	W
Other[2]	456	1,823	392	2,416	597	3,237	539	4,800
Total	456	1,823	800	4,953	597	3,237	539	4,800

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Value based on selling price at plant.
[2]Includes miscellaneous, and uses indicated by symbol W.

Table 7.—Steel slag sold or used in the United States, by use[1]

(Thousand short tons and thousand dollars)

Use	1981 Quantity	1981 Value	1982 Quantity	1982 Value
Asphaltic concrete aggregate	649	2,386	545	2,231
Road base	2,151	5,949	1,523	4,085
Fill	1,617	5,238	1,750	5,699
Railroad ballast	678	1,977	403	1,045
Other[2]	676	1,945	543	1,582
Total[3]	5,770	17,494	4,764	14,641

[1]Excludes tonnage returned to furnace for charge material. Value based on selling price at plant.
[2]Includes ice control and miscellaneous uses.
[3]Data may not add to totals shown because of independent rounding.

Table 8.—Value per ton at the plant for iron and steel slags sold or used in the United States

Year	Iron blast-furnace slag: Air-cooled	Iron blast-furnace slag: Granulated	Iron blast-furnace slag: Expanded	Iron blast-furnace slag: Total iron slag	Steel slag	Total slag
1978	$2.91	$2.63	$5.04	$3.04	$1.72	$2.74
1979	3.14	3.55	6.55	3.35	2.24	3.10
1980	3.82	3.81	6.94	4.01	2.64	3.67
1981	4.16	4.00	6.19	4.26	3.03	3.93
1982	4.17	5.42	8.91	4.40	3.07	4.07

Table 9.—Average selling price and range of selling prices at the plant for iron and steel slags in the United States in 1982, by use

(Dollars per short ton)

Use	Iron blast-furnace slag: Air-cooled Average	Air-cooled Range	Granulated Average	Granulated Range	Expanded Average	Expanded Range	Steel slag Average	Steel slag Range
Concrete aggregate	4.61	1.80- 5.87	W	W	--	--	--	--
Lightweight concrete aggregate	--	--	--	--	W	W	--	--
Concrete products	4.44	2.75- 5.87	--	--	W	W	--	--
Cement manufacture	--	--	W	W	W	W	--	--
Asphaltic concrete aggregate	4.68	3.22- 7.45	--	--	--	--	4.09	1.50-8.50
Road base	3.78	1.60- 6.24	W	W	W	W	2.68	.90-9.40
Fill	3.82	.50- 5.95	W	W	--	--	3.25	1.23-6.06
Railroad ballast	3.37	2.91- 8.70	--	--	--	--	2.59	1.24-7.60
Mineral wool	5.32	2.60-10.99	--	--	--	--	--	--
Roofing, built-up and shingles	5.53	3.21-13.76	--	--	--	--	--	--
Sewage treatment	W	W	--	--	--	--	--	--
Soil conditioning	W	W	W	W	W	W	--	--
Glass manufacture	15.38	12.00-18.00	--	--	--	--	--	--
Other	4.22	1.46-12.69	--	--	--	--	2.91	1.00-7.01

W Withheld to avoid disclosing company proprietary data; included with "Other."

Kyanite and Related Materials

By Michael J. Potter[1]

Kyanite, andalusite, and sillimanite are anhydrous aluminum silicate minerals that are alike in both composition and use patterns and have the same chemical formula, $Al_2O_3 \cdot SiO_2$. Related materials include synthetic mullite, dumortierite, and topaz, also classified as aluminum silicates, although the last two additionally contain substantial proportions of boron and fluorine, respectively. All of these kyanite-group substances can serve as raw materials for manufacturing special high-performance, high-alumina refractories, but no record in recent years exists of significant utilization of either dumortierite or topaz for this purpose in the United States.

Although published statistics are incomplete, the United States, the Republic of South Africa, and India appear to be the leading world producers of kyanite-group minerals. The U.S.S.R. and perhaps a few other industrialized nations are also presumed to produce significant quantities of these materials.

U.S. kyanite output in 1982 was estimated to have shown a decrease compared with that of 1981. Export and import data since 1977 for kyanite and mullite-containing materials are no longer collected as a separate category by the Bureau of the Census.

High-alumina refractories, including those based on kyanite-type minerals, have been favored in iron and steelmaking, particularly in ladle and pouring pits and the associated practice of continuous casting.[2]

Domestic Data Coverage.—Domestic production data for kyanite and synthetic mullite are developed by the Bureau of Mines by means of two separate, voluntary, domestic surveys. In the kyanite survey, out of the three active mines canvassed, none responded. These mines were operated by two companies. An estimate of total production was made by the Bureau of Mines using reported prior year production levels adjusted by the trend of the minerals economy.

In the synthetic mullite survey, out of the five canvassed operations, four responded and accounted for 78% of the total production data shown in table 1. Production for the remaining one nonrespondent was estimated using prior year reported production levels adjusted by the trend of the minerals economy.

Legislation and Government Programs.—The allowable depletion rates for kyanite, established by the Tax Reform Act of 1969 and unchanged through 1982, were 22% for domestic production and 14% for foreign operations.

DOMESTIC PRODUCTION

Kyanite was produced in the United States in 1982 at three open pit mines, two in Virginia and one in Georgia. Kyanite Mining Corp. operated the Willis Mountain and East Ridge Mines in Buckingham County, Va. C-E Minerals, Inc., operated the Graves Mountain Mine in Lincoln County, Ga.

The tonnage of domestic kyanite in 1982 was estimated to have decreased compared with that of 1981 because of the lagging minerals economy.

There are three types of synthetic mullite. Fused synthetic mullite is made by melting Bayer process alumina and silica, or bauxite and kaolin in an electric furnace at around 3,450° F. High-temperature sintered synthetic mullite is prepared by sintering mixtures of alumina and kaolin, bauxite and kaolin, or alumina, kaolin, and kyanite above 3,180° F. Low-temperature sintered synthetic mullite is made by sintering siliceous bauxite or mixtures of bauxite and kaolin above 2,820° F.

Output of synthetic mullite in 1982 was largely of the high-temperature sintered variety, and the four producers of this material were A. P. Green Refractories Co. at Philadelphia, Pa.; C-E Minerals, at Americus, Ga.; Didier Taylor Refractories Corp. at Greenup, Ky.; and Harbison-Walker Refractories Co. at Eufaula, Ala. Electric-furnace-fused mullite was produced by The Carborundum Co. at Niagara Falls, N.Y.

The mullite operation of C-E Minerals, which produces "Mulcoa 70" synthetic mullite and other mullite products, was discussed in a journal article. Also included were the geology, mining, and processing of the kaolin-bauxite deposits in the Southeastern United States.[3]

Table 1.—Synthetic mullite production in the United States

Year	Quantity (short tons)	Value (thousands)
1978	38,080	$5,442
1979	40,660	6,675
1980	40,540	8,012
1981	42,000	9,050
1982	27,000	5,950

CONSUMPTION AND USES

Kyanite and related materials were consumed mostly in the manufacture of high-alumina or mullite-class refractories and in lesser quantities as ingredients in ceramic compositions. Domestic kyanite, already ground to minus 35 mesh as required by the flotation process used in its separation and recovery, was marketed either in this raw form or, after heat treatment, as mullite, sometimes further reduced in particle size before use. In the 35- to 48-mesh range, kyanite was used mostly in monolithic refractory applications such as for high-temperature mortars or cements, ramming mixes, and castable refractories, or with clays and other ingredients in refractory compositions for making kiln furniture, insulating brick, firebrick, and a wide variety of other articles. More finely ground material, minus 200 mesh, was used in body mixes for sanitary porcelains, wall tile, investment-casting molds, and miscellaneous special-purpose ceramics.

PRICES

Engineering and Mining Journal, December 1982, listed prices for kyanite, f.o.b. Georgia, ranging from $85 to $137 per short ton for bulk shipments and $9 more per ton for bagged material.

Price ranges quoted for kyanite-group materials in Ceramic Industry magazine, January 1983, follow:

	Per short ton
Andalusite	$120-$172
Mullite, calcined kyanite	150- 180
Mullite, fused	986-1,500

The December 1982 issue of Industrial Minerals (London) quoted kyanite-group prices approximately equivalent to the following:[4]

	Per short ton
Andalusite, Transvaal, 52% to 54% Al_2O_3, bulk, c.i.f. main European port	$102
Andalusite, Transvaal, 60% Al_2O_3, c.i.f. main European port	131
Sillimanite, South African, 70% Al_2O_3, bags, c.i.f. main European port	276
U.S. kyanite, 59% to 62% Al_2O_3, 35-325 Tyler mesh, raw and/or calcined, 18-ton lots, c.i.f. main European port	$131- 225
U.S. kyanite, f.o.b. plant, carlots:	
Raw	70- 146
Calcined	123- 168

FOREIGN TRADE

Export and import data of kyanite and mullite-containing materials have not been collected as a separate category by the Bureau of the Census since 1977.

WORLD REVIEW

Australia.—The first stage of a kyanite separation circuit was commissioned by Allied Eneabba Pty., Ltd., at its mineral sands operation at Eneabba in Western Australia. Production by yearend was projected to be 1,000 tons of kyanite concentrate for testing purposes. A second stage was under construction for production of up to 5,000 tons per year, with output eventually rising to 10,000 tons per year. A stockpile of kyanite-rich tailings accumulated over the years was expected to supplement the head feed grade. Production was to be marketed to the refractories industry with a guaranteed minimum of 60% Al_2O_3, although exact specifications will depend on individual customer requirements.[5]

India.—According to the Geological Survey of India, some 3.3 million tons of kyanite reserves were established in the Singhbhum District of Eastern Bihar State and Bhandara District of Western Maharashtra State.[6]

South Africa, Republic of.—An $8 million[7] agreement for the export of andalusite refractory brick to Europe was concluded by Cullinan Refractories Ltd. Some 20,000 tons of brick was slated to be shipped over the next 2 years for use in the European steel industry.[8]

A paper discussed aluminosilicate minerals in the Republic of South Africa with emphasis on andalusite.[9] Topics covered regarding andalusite were ore deposits, beneficiation, brick manufacture, properties of andalusite brick, and applications of brick in blast furnace stove checkers, torpedo ladles, steel ladles, and in other industries besides iron and steel. Industrial aluminosilicate minerals, including andalusite and sillimanite, were also discussed in another paper.[10]

Zimbabwe.—Deposits in the northeastern part of Zimbabwe were reported to probably contain very significant reserves of high-quality kyanite.[11] Development has been hindered because of the remoteness of the deposits.

Table 2.—Kyanite, sillimanite, and related materials: World production, by country[1]

(Short tons)

Country[2] and commodity	1978	1979	1980	1981[p]	1982[e]
Australia: Sillimanite[3]	626	626	729	365	500
Brazil: Kyanite[4]	1,954	1,929	1,930	1,984	2,000
France: Kyanite-andalusite[e]	[r]33,100	[r]33,100	[r]33,100	33,100	33,100
India:					
Andalusite	248	--	--	--	--
Kyanite	34,058	44,874	51,282	42,200	38,600
Sillimanite	14,849	17,752	14,315	11,303	11,000
Korea, Republic of: Andalusite	67	66	90	99	90
South Africa, Republic of:					
Andalusite	123,503	147,905	216,622	199,818	175,700
Sillimanite	10,516	21,577	17,851	17,090	12,500
Spain: Andalusite	5,607	5,903	7,133	7,200	6,600
United States:					
Kyanite	W	W	W	W	W
Synthetic mullite	38,080	40,660	40,540	42,000	[5]27,000

[e]Estimated. [p]Preliminary. [r]Revised. W Withheld to avoid disclosing company proprietary data.
[1]Owing to incomplete reporting, this table has not been totaled. Table includes data available through Mar. 30, 1983.
[2]In addition to the countries listed, a number of other nations produce kyanite and related materials, but output is not reported quantitatively and no reliable basis is available for estimation of output levels.
[3]In addition, sillimanite clay (also called kaolinized sillimanite) is produced, but output is not reported quantitatively, and available information is inadequate for the formulation of reliable estimates of output levels.
[4]Series revised to reflect output of marketable products; crude production (as reported in previous editions of this chapter) was as follows, in short tons: 1978—7,615; 1979—9,031; 1980—20,168; 1981—20,000 (estimated); 1982—20,000 (estimated).
[5]Reported figure.

TECHNOLOGY

A magnetic roll separator of novel design was announced by Bateman Engineering, Inc., of Lakewood, Colo.[12] The machine, known as the Elb-Yaniv Permroll separator, can handle material of 325 mesh up to 1 or 2 inches. There are reportedly a number of applications, including beneficiation of andalusite and kyanite.

[1]Physical scientist, Division of Industrial Minerals.

[2]Industrial Minerals (London). Comment: Refractory Evolution. No. 181, October 1982, p. 7.

[3]Dickson, T. Bauxite and Kaolin Grogs of the S.E. USA. Ind. Miner. (London), No. 175, April 1982, 3 pp.

[4]Where necessary, values have been converted from pounds sterling (£) per metric ton to U.S. dollars per short ton at the rate of £1.00=US$1.60.

[5]Industrial Minerals (London). World of Minerals. No. 179, August 1982, p. 9.

[6]———. Company News and Mineral Notes. No. 175, April 1982, p. 131.

[7]Where necessary, values have been converted from South African rand (R) to U.S. dollars at the rate of R1.00=US$1.03.

[8]Industrial Minerals (London). Company News and Mineral Notes. No. 172, January 1982, p. 49.

[9]Carroll, J., and G. W. Matthews. Sillimanite Minerals as Refractories Raw Materials. Pres. at Minerals in the Refractories Industry, Pittsburgh, Pa., Sept. 12-14, 1982, 29 pp.

[10]Heckroodt, R. O. The Industrial Alumino-Silicate Minerals of South Africa. Pres. at 5th "Ind. Miner." Internat. Cong., Madrid, Spain, Apr. 25-28, 1982, pp. P/1-P/5.

[11]Clarke, G. M. Zimbabwe's Industrial Minerals—Optimism for the Future. Ind. Miner. (London), No. 172, January 1982, p. 31.

[12]Mining Journal. New Hi Magnetic Separator. V. 299, No. 7667, July 30, 1982, p. 79.

Lead

By William D. Woodbury[1]

Domestic mine output of recoverable lead rose in 1982 and reflected a full year of production with no strikes or unexpected interruptions. The production was, however, the second lowest since 1969, and two major mines were closed during the year. Total primary refinery output of lead from domestic and foreign raw materials, including lead in antimonial lead, increased only slightly. Production of lead from scrap materials continued to decline for the third consecutive year, especially in the second half of 1982, owing to a shortage of available scrap at acceptable profit margins. Virtually the entire secondary industry operated at various levels of curtailment, including intermittent operations and temporary closure of many plants, and secondary refined production was the lowest since 1972.

The U.S. producer prices declined throughout the year, except for a temporary leveling during the third quarter, and the yearly average of 25.5 cents per pound was the lowest since 1976. London Metal Exchange (LME) quotations for lead generally paralleled the U.S. price within 1 cent per pound throughout the year.

Table 1.—Salient lead statistics

(Metric tons unless otherwise specified)

	1978	1979	1980	1981	1982
United States:					
Production:					
Domestic ores, recoverable lead content	529,661	525,569	550,366	445,535	512,425
Value thousands	$393,516	$609,929	$515,189	$358,821	$288,528
Primary lead (refined):					
From domestic ores and base bullion	501,643	529,970	508,163	440,238	459,865
From foreign ores and base bullion	63,530	45,641	39,427	55,085	52,295
Antimonial lead (primary lead content)	2,914	2,596	851	3,008	4,622
Secondary lead (lead content)	769,236	801,368	675,578	641,105	571,276
Exports (lead content):					
Lead ore and concentrates	54,231	32,902	27,615	33,043	29,104
Lead materials excluding scrap	8,225	10,646	164,458	23,320	55,629
Imports, general:					
Lead in ore and matte	52,985	39,998	44,095	58,545	35,807
Lead in base bullion	4,307	1,681	296	449	19
Lead in pigs, bars, and reclaimed scrap	226,926	198,344	88,995	107,185	99,587
Stocks Dec. 31 (lead content):					
At primary smelters and refineries	98,665	89,322	125,994	140,207	125,537
At consumers and secondary smelters	125,234	153,195	126,214	123,216	97,209
Consumption of metal, primary and secondary	1,432,744	1,358,335	1,070,303	1,167,101	1,075,408
Price: Common lead, average, cents per pound[1]	33.65	52.64	42.46	36.53	25.54
World:					
Production:					
Mine thousand metric tons	[r]3,372.3	[r]3,405.5	3,410.8	[p]3,343.3	[e]3,450.5
Smelter[2] do	[r]3,144.1	[r]3,208.6	3,122.7	[p]3,056.1	[e]3,229.9
Secondary smelter do	[r]1,988.7	[r]2,107.1	1,959.3	[p]1,972.6	[e]1,845.1
Price: London, common lead, average, cents per pound	29.86	54.52	41.21	33.30	24.66

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Quotation on a nationwide, delivered basis.
[2]Primary metal production only. Includes secondary metal production where inseparably included in country total.

During the year, strict new regulations went into effect with respect to the use of lead in gasoline in the United States, and a reported technologically advanced lead-acid system was introduced for replacement automotive batteries.

World mine production increased slightly during 1982 to the highest level in 5 years, but the production of refined metal dropped to about the same level as in 1976. The increased total world mine production was virtually all in Australia, Canada, Peru, and the United States.

Domestic Data Coverage.—Domestic data for lead are developed by the Bureau of Mines from eight separate, voluntary surveys of U.S. operations. Typical of these surveys is the combined monthly and annual secondary producer canvass covering 88 plants. Of the 517 survey requests sent, 80% responded, representing 82% of the total secondary production shown in tables 1, 11, and 12. Production for the remaining nonrespondents was estimated using reported prior year production levels adjusted by trends in employment, changes in capacities, and other guidelines.

Legislation and Government Programs.—Three major actions by U.S. Government agencies in the last quarter of 1982 had significant impacts on the domestic lead industry. On November 1, 1982, revised Environmental Protection Agency (EPA) regulations became effective concerning the use of lead in gasoline. The new standard is 1.10 grams per gallon absolute limit for all leaded gasoline, including imports, with no exceptions for small refiners after July 1, 1983. EPA estimated that the new regulations would decrease by 115 billion grams, or 34%, the amount of airborne lead over the next 8 years, compared with the preceding standard if it had remained in effect.

On December 6, 1982, an additional countervailing duty of 3.389% ad valorem was imposed on imports of Mexican litharge and red lead oxides by the International Trade Commission (ITC), after an investigation of several months by the U.S. Department of Commerce had determined there was an illegal subsidy by the Mexican Government. The ITC subsequently determined there was harm to the competitive position of U.S. producers.

Also early in December, the Occupational Safety and Health Administration (OSHA) indefinitely postponed the date when primary and secondary lead smelters and battery manufacturers had to submit compliance programs relative to the 1978 engineering-controlled, in-plant air-lead standards. OSHA's original deadline of June 29, 1982, had been delayed by two successive 60-day judicial stays. Completely revised standards were expected during 1983.

The U.S. Government stockpile during the year remained at 545,000 tons, about 55% of the current authorized goal.

DOMESTIC PRODUCTION

MINE PRODUCTION

U.S. mine production of recoverable lead was the second lowest since 1969, reflecting the general worldwide recession. Eight lead mines in Missouri yielded over 92% of total domestic production and together with lead-producing mines in Idaho and Colorado produced over 99% of the total U.S. mine output.

The Buick Mine in Iron County, Mo., equally owned by AMAX Lead Co. of Missouri and Homestake Lead Mining Co., continued to be the largest single producing unit, milling 2.05 million tons of ore at an average grade of 7.6% lead, up 28% over that of 1981 according to the company's annual report. Buick produced 150,000 tons of lead in concentrates. Total reserves of the mine were estimated to be over 36 million tons at an average grade of 5.8% lead. Metal production was up 40% over that of 1981, partly because of higher average grades.

St. Joe Lead Co., the largest integrated producer of lead in the United States, completed its first full year as a wholly owned subsidiary of Fluor Corp. in 1982. The company operated four lead mine and milling complexes in southeastern Missouri, producing 188,700 tons of lead in concentrates during its fiscal year ending October 31, 1982, according to Fluor's annual report, an increase of 24% over that of 1981. The mills treated 4.16 million tons of ore averaging 4.6% lead during the year. St. Joe Lead had proven domestic reserves of 56.5 million tons of ore containing 5.0% lead. It was expected to have a production capacity of 20,000 tons per day of ore by the second half of 1983 when the new Viburnum No. 35 Mine at Bixby, Mo., was scheduled to come onstream. On April 30, 1982, St. Joe permanently closed its Indian Creek Div. for economic reasons, but the new mine at Bixby will have more than double the capacity of Indian Creek when fully productive.

The Milliken Mine in Reynolds County, Mo., operated by Ozark Lead Co., a subsidiary of the Standard Oil Co. of Ohio's (Sohio) Kennecott Minerals Co., continued to be the second largest domestic lead mine and produced 80,650 tons of lead in concentrates, according to Sohio's 1982 annual report, an increase of 16% over that of 1981. A major expansion project was completed, including a new shaft that began operation late in the year and raised mine production capacity to 82,000 tons of lead per year. The concentrates from Milliken were purchased on contract by ASARCO Incorporated for processing at its Glover, Mo., smelter-refinery.

The Magmont Mine in Iron County, Mo., jointly owned by Cominco American Incorporated and Dresser Industries, Inc., dropped from the third largest domestic lead mine to fourth in 1982 and produced slightly over 1 million tons of ore at an average grade of 6.5% lead, which yielded about 80,800 tons of lead concentrates at an average grade of 78.9%, according to Cominco's annual report. Magmont ore production and grades were down slightly in 1982 because mining was concentrated in the lower grade East extension while development work continued on the new West ore body, which was expected to contribute to production in 1983.

Hecla Mining Co. reported that its Lucky Friday unit in Shoshone County, Idaho, produced 191,304 tons of silver ore with a grade of 9.8% lead in 1982, the second highest ore production in the mine's history. Progress continued on the new deep shaft, which by yearend was 5,800 feet deep. Completion to 6,200 feet was expected by May 1983, and ore was expected to be hoisted before the end of 1983. Production through the new shaft, designed so that it may function to an ultimate depth of 7,500 feet, will permit a 35% increase in mine capacity and also enhance further exploration and new development. Ore reserves at the end of 1982 were 457,000 tons at an average grade of 12.2% lead. The Lucky Friday Mine produced 18,275 tons of contained lead in 1982. The nearby Star Morning unit, the deepest mine in the United States at 8,100 feet, was permanently closed in June 1982 by Hecla for economic reasons. Salvage operations were completed in October, and the mine was allowed to flood. During the first 6 months of the year, the Star unit produced 5,815 tons of contained lead, which was divided equally with Hecla's partner, Bunker Hill Ltd., the successor to The Bunker Hill Co. Hecla's Leadville unit, known as the Sherman Mine, which it operated on a 60% equity basis for Leadville Corp. in Lake County, Colo., ceased production in January 1982 but continued exploration work until June, when it was placed on a care and maintenance basis. The mine could reopen in 1983, as promising additional mineralized zones were identified, according to Hecla.

Development work continued at the new West Fork Mine of Asarco 23 miles from its smelter at Glover, Mo., but was suspended in September. The production and service shafts were completed, the ventilation shaft was 35% complete, and 1,400 feet of lateral drifts had been excavated. Construction of the mill and other surface facilities continued and was expected to be completed by June 1983, at which time the project was to be placed on standby until some time in 1985. When completed, the West Fork unit will be capable of processing 3,450 tons of ore per day containing 46,000 tons of lead on an annual basis. The measured reserves were 15 million tons, assaying 5.5% lead and 1.2% zinc, according to Asarco.

SMELTER AND REFINERY PRODUCTION

Primary.—Domestic production of primary lead from the four primary refineries in 1982, including lead in antimonial lead, was 4% greater than that of 1981 as the industry produced at 87% of capacity. During the year, the St. Joe lead smelter-refinery at Herculaneum, Mo., the Nation's largest at a rated capacity of 204,000 tons per year, produced 195,000 tons of lead, an increase of 28% over that of 1981. At Boss, Mo., the AMAX-Homestake smelter-refinery produced 106,000 tons of lead from the concentrates produced at their Buick Mine and Cominco-Dresser's Magmont Mine. Their production was up 16% over that of 1981.

Asarco reported that its three smelters at East Helena, Mont., El Paso, Tex., and

Glover, Mo., produced 222,000 tons of lead bullion in 1982. The El Paso and East Helena operations, which custom toll concentrates from domestic and foreign sources, shipped bullion to Asarco's Omaha refinery where 84,400 tons of refined lead metal was produced. Foreign concentrates came from Peru, Honduras, Canada, Australia, and Mexico in order of significance. The Glover smelter-refinery complex produced 123,600 tons of lead from Missouri and Illinois ores. Utilizing a newly installed blast furnace completed in 1981, a concerted effort to reduce concentrate stocks at Glover resulted in production considerably in excess of the rated capacity. The company's total output of refined metal was 31% greater than that of 1981.

At yearend, total operating domestic primary lead smelting-refining capacity was 595,000 tons, compared with 714,000 during 1981, as a result of the Bunker Hill closure.

Secondary.—During the year, permanent closure was announced for five plants with a combined capacity of 59,000 tons, but this was offset by 67,000 tons of new capacity that came onstream. In the fourth quarter, two of the most modern plants in the world started production, a 66,000-ton replacement at Los Angeles, Calif., for GNB Batteries Inc.'s old facility there and a 27,000-ton whole battery smelter at St. Helens, Oreg., owned by Bergsoe Metals Corp. At least three major producers filed for reorganization under Chapter 11 of the Federal bankruptcy laws. However, refined metal capacity remained over 1.2 million tons at yearend.

CONSUMPTION AND USES

Domestic consumption of lead declined slightly in 1982, primarily because of a drop in demand for all types of lead-acid storage batteries. According to Battery Council International (BCI) shipments of replacement automotive batteries, the largest single end use, actually increased slightly during 1982 to 54.2 million units, but shipments of original equipment automotive batteries declined over 16% to 8.4 million units. The decline in the use of lead in pigments was partially offset by a moderate increase in consumption for leaded gasoline. There was a general decline in demand for lead metal products, and total consumption during 1982 was only 5,000 tons greater than in 1980, which had been the lowest year since 1963. Storage batteries continued to account for about two-thirds of the lead consumed during the year, but the lead content of each starting-lighting-ignition (SLI) automotive unit continued to decline, averaging about 20 pounds.

Consumption of pig lead in the domestic manufacture of lead oxides and pigments in 1982 decreased 6% from that of 1981. The decline was attributed to the overall reduced demand for storage battery oxides and a 24% decrease in the consumption of lead in chemicals for paints, ceramics, glass, plastics, and other pigments.

STOCKS

Total yearend domestic producer and consumer stocks declined 15% to 223,000 tons from yearend 1981 and, relative to consumption in 1982, represented a 10-week inventory. The levels were down in all reported categories at both primary and secondary plants. World stocks of lead and antimonial lead in countries reporting to the International Lead and Zinc Study Group (ILZSG) were approximately 560,000 tons at yearend, about 11% of total world demand for the year, representing an 8% increase over that of 1981.[2]

PRICES

The U.S. producer price for lead opened the year in a quoted range of 32 to 34 cents per pound, according to Metals Week, and continued declining through the first 6 months of the year. The decline began in August 1981 when the high weighted-average transactions price was just under 44 cents per pound. In July 1982, the U.S. producer price average rose about 2.4 cents per pound in anticipation of a possible normal heavy surge in buying for fall production by battery manufacturers. The average producer price fell considerably during August, however, as the demand did not materialize and ended the year in a quoted range of 20.5 to 23 cents. Asarco, one of the major U.S. producers, published a price of 19.5 cents per pound from December 10 through December 21. The weighted-average U.S. producer price for the year of 25.5 cents per pound was the lowest since 1976 and, in terms of 1981 constant dollars, was the lowest since 1962. Most sales during the year were transacted at or near the low end of the quoted range, as several forms of discounts were offered by major producers to be competitive with Asarco, the price leader.

Published price quotations for U.S. secondary lead were only competitive through July, at which time there began a prolonged shortage of recyclable material at acceptable prices. The spread between primary and secondary lead prices gradually increased to 4 to 6 cents per pound in mid-November when secondary quotations were no longer published by Metals Week. In the second half of the year the price for secondary lead was established by premiums on the alloyed metals above the current average lead price.

LME average cash prices during 1982 were about 0.9 cent per pound below the U.S. price. The cost of shipping, duty, handling, and inland freight to U.S. destinations was estimated to be about 4 to 6 cents per pound, and a spread of 2.5 to 3 cents per pound is usually sufficient to preclude abnormal amounts of U.S. exports of pig lead to LME. However, since LME prices stayed relatively close to U.S. prices, LME stocks increased over 75,000 tons during the year to a record 126,400 tons, largely from U.S. producers.

The quoted domestic prices for lead oxides in 1982 were based on the selling prices for pig lead in a given period, plus conversion charges. However, premium adjustments were also made by individual producers to reflect differences in manufacturing technique, freight considerations, quality requirements, and other factors. The average total premium in 100-pound units during 1982 for litharge was estimated to be 9 cents per pound above the U.S. producer price for pig lead. Red lead was about 12 cents per pound above the price of pig lead.

FOREIGN TRADE

In 1982, the United States had net exports of 15,600 tons of lead metal in all forms, as compared with net imports of about 23,000 tons in 1981. Lead content of exported scrap, which was recorded by gross weight, was assumed to be 60% metal. The change in trade balance was attributed to a nearly fivefold increase in exports of unwrought lead to Belgium-Luxembourg and the Netherlands destined for LME warehouses in Antwerp and Rotterdam. Imports for consumption of lead in concentrates during 1982 decreased significantly and were virtually all from Honduras and Peru, traditional suppliers under long-term contracts to domestic producers. Exports of lead in concentrates decreased slightly, and over one-half went to Canada, which in return supplied over one-half of U.S. refined pig lead imports in 1982. Mexico was also a significant exporter of refined pig lead to the United States. Canada, Mexico, and Peru continued as the primary sources of imports in all forms, and Australia contributed also to the supply of refined pig lead. These four countries plus Honduras accounted for 98% of total U.S. imports of contained lead for domestic consumption in 1982.

Imports of lead chemicals and pigments in 1982 decreased about 15% from 1981 receipts and were down in all categories except for chrome yellow used in maintaining highway markings. Mexico accounted for all but 100 tons of U.S. imports of litharge and red lead, while Canada supplied 42% of all other categories, primarily chrome yellow. Peru supplied virtually all the lead arsenate imported, and China, over 90% of the lead nitrate. The Federal Republic of Germany, the Netherlands, and Japan contributed 30% in all categories excluding litharge and red lead.

U.S. import duty regulations in effect during 1982 are given in table 2, on a lead-content basis.

Table 2.—U.S. import duties for lead materials, January 1, 1982

Item	TSUS No.	Most favored nation (MFN)	Least developed developing countries	Non-MFN
Ore	602.10	0.75 cent per pound (lead content).	Free[1] or current MFN rate.	1.5 cents per pound (lead content).
Lead bullion	[2]624.02	3.5% ad valorem (lead content).	do	10.5% ad valorem (lead content).
Other unwrought	[2]624.03	3.0% ad valorem[3] (lead content).	Current MFN rate only	10.0% ad valorem (lead content).
Waste and scrap	[2]624.04	3.2% ad valorem (lead content).	Free[1] or 2.3% ad valorem.	11.5% ad valorem (lead content).

[1]Free if eligible under General System of Preferences.
[2]The minimum duty shall not be less than 1.0625 cents per pound of lead.
[3]Temporary reduction until July 1, 1983, unless rescinded.

WORLD REVIEW

According to ILZSG statistics, reported consumption of refined lead and antimonial lead metal in the market economy countries dropped slightly during 1982 to approximately 3.8 million tons, about 90,000 tons less than in 1981.[3] Estimated total world refined lead production, excluding remelt scrap, declined, but total world mine production increased slightly to the highest level since 1973. Estimated total world consumption of lead was about 5.17 million tons in 1982, compared with about 5.22 million tons estimated for 1981.

ILZSG, at its 27th annual session in Geneva, October 14 to 21, 1982, forecast continued world growth in lead mine production in 1983 and a slight recovery in metal production and consumption to about 1981 levels. Net exports to centrally planned economy countries were forecast to be a little higher than in 1982, and production of metal was expected to exceed demand by over 50,000 tons.

Australia.—Exports of lead concentrates and bullion increased over 10% during 1982, mostly to Japan and the United Kingdom, respectively. At Mount Isa, Queensland, Mount Isa Mines Holdings Ltd. (MIM), completed production expansion of its lead and silver mine, the world's largest, by 30,000 tons to 180,000 tons of contained lead per year, and mill modernization was completed. A portion of the increased production was to be toll refined in Japan. The only announced closing during the year was Plenty River Mining Pty. Ltd.'s 250,000-ton-per-year mill at the recently opened pit mine in Attutra, Northern Territory, which had a production capacity of 10,000 tons of lead per year. The operation was affected by the general worldwide recessionary prices, but the opencut mine continued to operate and stockpiled the ore.

Early in the year, St. Joe Minerals Corp. of the United States, in its first major expansion under Fluor ownership, agreed to invest up to $16.8 million for a share of the Sorby Hills lead-zinc-silver deposit in the Bonaparte Gulf, Western Australia. The project had been a 50-50 joint venture between MIM and ELF Aquitaine Pty. Ltd., which was the operator. St. Joe agreed to take over from Aquitaine as the operator through its subsidiary, St. Joe Bonaparte, for up to 35% interest. Sorby Hill's reserves were estimated at 13 million tons containing 5.4% lead. Fluor was constructing a new zinc-lead-silver mill for Electrolytic Zinc Co. of Australasia Ltd. (EZ Industries) at the new Elura Mine near Cobar in New South Wales. The mill was to have a capacity of 1.1 million tons of ore per year and was scheduled for completion in 1983. In the first half of the year, North Broken Hill Holdings Ltd. suspended work on the $50 million program to develop the deep Fitzpatrick lode in the North Mine at Broken Hill, New South Wales. MIM announced during the year that it was considering the construction of a 30,000-ton lead refinery somewhere in the southwest Pacific region.

Exploration or development continued at a number of other sites including Hilton, Hilton North, Thalanga, Lady Loretta, and Dugald River, all in Queensland; the Currawong Prospect, Benambra, Victoria; and Woodcutters near Darwin, and Pillara and Napier Range in Western Australia. Work also continued during the year at EZ Industries zinc-lead-silver Elura Mine in New South Wales, which was expected to come onstream during 1983 and, by 1984, produce 40,000 tons of lead. Elura's proven reserves were 27 million tons assaying 5.6% lead.

Canada.—Cominco Ltd.'s Polaris Mine on Little Cornwallis Island, 130 kilometers south of the Magnetic North Pole, achieved sustained production in February, 10 weeks ahead of schedule, and stockpiled concentrates until the late summer shipping season. Noranda Mines Ltd.'s No. 12 Mine at Bathurst, New Brunswick, Canada's largest zinc and lead mine, operated by its subsidiary Brunswick Mining and Smelting Corp. Ltd., increased its production owing to its 1981 expansion. Cominco's Sullivan Mine at Kimberley, British Columbia, with a capacity of 90,000 tons of lead in concentrates per year, closed during July but achieved its highest ore production since 1964. A Cominco subsidiary, Pine Point Mines Ltd., announced in November an indefinite shutdown starting January 2, 1983, for its large mine in the Northwest Territories. Cyprus Anvil Mining Corp. closed its Faro Mine, the nation's third largest lead mine, indefinitely on June 4 owing to sustained economic losses. These five mines represented 89% of Canada's estimated lead mine capacity in 1982.

Although Asarco's 10,000-ton-per-year Buchans Mine in Newfoundland remained closed during 1982, development of recently discovered ore zones below and at the extremity of existing workings continued during the year, and it was expected to reopen in 1983 if economic conditions improve. Westmin Resources Ltd. continued with development and pilot milling of its ore body near the existing Lynx and Myra Mines on Vancouver Island, British Columbia, and the new shaft was scheduled for completion in January 1983. Nanisivik Mines Ltd., which increased production at its Baffin Island Mine, Northwest Territories, during 1982 continued exploring below the main ore body and reconnaissance exploration in the northern part of the island. Additional reserves were confirmed by Cominco in the major new high-grade ore body at the Pine Point Mine, Northwest Territories.

Greece.—Late in the year, the Greek Government authorized the construction of a 40,000-ton-per-year lead smelter and zinc refinery at Amphipolis, near Seres, at an estimated cost of $323 million. The plant was to be built by Aegean Metallurgical Industries S.A., a subsidiary of the Hellenic Industrial Development Bank, to process concentrates solely for domestic use. The concentrates were expected to come from new mines in the North and the Olympias and Stratonian Mines operated by minority shareholders in the smelter-refinery project.

India.—Development work continued at Hindustan Zinc Ltd.'s (HZL) new Sargipalli lead mine in Orissa, which was expected to start up in 1983 with a production of 6,000 tons per year of lead by 1984. Development work continued on HZL's Rajpura-Dariba zinc-lead mine project in Rajasthan despite severe power shortages during the year. Production startup was expected in 1983, reaching capacity of 10,000 tons per year of lead in 1984. These new projects were expected to make the country self-sufficient in lead and zinc concentrates by 1984. HZL was expanding its smelter at Visakhapatam, Andhra Pradesh, from 10,000 to 22,000 tons per year, which was expected to be completed by mid-1983.

Italy.—In late 1982, a new state-private consortium was proposed to consolidate the nonferrous scrap reprocessing facilities of Tonolli Grezzi S.p.A. and the state-owned nonferrous metals producer, Societa per Azioni Minero-Metallurgiche (SAMIM). The conglomerate, to be known as SAMETON, would operate nine existing plants including SAMIM's lead refinery at Sán Gavino, Sardinia, and Tonolli's large secondary lead smelters at Paderno Dugnano and Marcianese. None of SAMIM's mining operations, nor its smelter at Porto Vesme, Sardinia, were apparently included.

Mexico.—The Real de Angeles Mine in the southeast of the State of Zacatecas came onstream in July 1982. The mine is the world's largest open pit silver mine, with byproduct lead capacity of 30,000 tons, and was developed at a cost of $170 million by Minera Real de Angeles, a Mexican company owned by Frisco S.A. de C.V. and Comision de Fomento Minero (a government agency), each with a 33% interest, and Placer Development Ltd. (34%) of Vancouver, Canada. The project was mostly financed by a $110 million International Bank for Reconstruction and Development (World Bank) loan. Estimated reserves were 59 million tons containing 1% lead.

Yugoslavia.—At Vares, Energoinvest's new zinc-lead open pit mine completed the first stage of development to 400,000-ton-per-year capacity for ore to yield 4,000 tons of lead beginning in 1983. The second stage of the project was scheduled to be completed by 1985, when effective capacity was expected to be about 600,000 tons per year of ore. Plans were also announced to double production at the Zletovo and Sasa lead-zinc mines in Macedonia, which accounted for about 30% of Yugoslavian lead concentrate production in 1982.

TECHNOLOGY

As part of an ongoing research program to advance hydrometallurgical technology, the Bureau of Mines investigated the recovery of metals from complex sulfide ores, concentrates, and waste materials. Based on previous research on chlorine-oxygen and ferrous chloride-oxygen pressure leaching systems, the Bureau of Mines recently applied the chlorine-oxygen system to complex lead sulfide mattes, materials that are currently not fully utilized at lead smelters. The metals were converted from insoluble sulfides to soluble chlorides, and recoveries ranged from 92% to 98%. The copper and lead were recovered by electrowinning, and the nickel, cobalt, and cadmium, as mixed hydroxides.[4] Additional cooperative work with four lead companies investigated the effects of impurities in electrolytes on electrowinning of lead from lead chloride after ferric chloride leaching from galena in the Bureau's previously developed process.[5] A new technique was also developed by the Bureau to recover 95% of the cadmium, zinc, and lead from lead smelter flue dusts by sulfation roasting followed by water leaching, an electrolytic conversion process, and subsequent electrowinning.[6] These three metals comprise an estimated 70% to 75% of typical lead smelter flue dusts, and this technique offers an alternative to conventional reverberatory fuming where possible formation of toxic arsine gas is a problem.

In pyrometallurgical research performed by the Bureau of Mines, the behavior of lead and the associated accessory elements, indium, thallium, and antimony, as a function of slag composition was investigated under equilibrium lead smelting conditions. The slag ratios of iron oxide, calcium oxide, and magnesium oxide to silicon dioxide were varied to determine minimal loss of lead to slags and interelement effects.[7] The Bureau of Mines also developed a computerized mathematical model to predict the distribution of accessory elements throughout a metallurgical process. The model is specific for determining bismuth distribution during the lead smelting process according to thermodynamic, kinetic, and other process parameters.[8]

In an apparent technological breakthrough for lead-acid SLI automotive battery systems, GNB Batteries of St. Paul, Minn. introduced its Cathanode battery. The Cathanode is a hybrid system using calcium-lead alloy negative plates and low-antimony lead positive plates. The unit reportedly can generate equal cold crank amperage at one-third the weight or volume of the conventional SLI battery, or a power increase of over 50% at equal weight or volume. The concept offered considerable promise for use in downsized general purpose vehicles or large-size diesel equipment.[9]

A comprehensive coverage of lead-related investigations and an extensive review of current world literature on the extraction and uses of lead and its products were published in quarterly issues of Lead Abstracts, Lead Development Association, London, England. A progress report of the projects supported by the International Lead and Zinc Research Organization, Inc. (New York), was published in Lead Research Digest, No. 40, 1982.

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[1]Physical scientist, Division of Nonferrous Metals.

[2]International Lead and Zinc Study Group (London). Lead and Zinc Statistics. Monthly Bull., v. 23, No. 7, July 1983, pp. 15-17.

[3]Work cited in footnote 2.

[4]Pool, D. L., B. J. Scheiner, and S. D. Hill. Recovery of Metal Values From Lead Smelter Matte by Chlorine-Oxygen Leaching. BuMines RI 8615, 1982, 19 pp.

[5]Fleck, D. C., R. G. Sandberg, and M. M. Wong. Effects of Impurities in Electrolytes on Electrowinning of Lead From Lead Chloride. BuMines RI 8742, 1983, 8 pp.

[6]Miller, V. R., T. L. Hebble, and D. L. Paulson. Recovery of Cadmium, Zinc, and Lead From Lead Smelter Flue Dusts. BuMines RI 8659, 1982, 12 pp.

[7]Johnson, E. A., L. L. Oden, and J. N. Koch. Laboratory Investigations on the Behavior of Accessory Elements in Lead Blast Furnace Smelting. BuMines RI 8753, 1983, 17 pp.

[8]Lucas, M. A., C. M. Flynn, Jr., and T. G. Carnahan. Mathematical Modeling of Accessory Element Distribution in Metallurgical Processes—Computerization of a Lead Smelter Plant. BuMines RI 8768, 1983, 46 pp.

[9]GNB Batteries Inc. Cathanode—A New Dimension in High Performance Batteries. May 1982, 34 pp.

Table 3.—Mine production of recoverable lead in the United States, by State

(Metric tons)

State	1978	1979	1980	1981	1982
Alaska	--	--	31	W	W
Arizona	416	354	162	993	359
California	W	W	W	W	W
Colorado	15,151	7,554	10,272	11,431	W
Idaho	44,761	42,636	38,607	38,397	W
Illinois	W	W	W	W	W
Kentucky	W	--	--	--	--
Missouri	461,762	472,054	497,170	389,721	474,460
Montana	132	258	295	194	661
Nevada	653	24	26	W	W
New Mexico	W	W	--	W	W
New York	990	458	876	968	974
Oregon	--	(1)	--	W	--
Tennessee	--	(1)	--	--	--
Texas	W	--	--	--	--
Utah	2,541	W	W	1,662	W
Virginia	1,803	1,596	1,563	1,607	--
Washington	W	(1)	W	--	W
Wisconsin	W	W	--	--	--
Total	529,661	525,569	550,366	445,535	512,425

W Withheld to avoid disclosing company proprietary data; included in "Total."
[1]Less than 1/2 unit.

Table 4.—Production of lead and zinc in the United States in 1982, by State and class of ore from old tailings, etc., in terms of recoverable metal

(Metric tons)

State	Lead ore			Zinc ore			Lead-zinc ore		
	Gross weight (dry basis)	Lead	Zinc	Gross weight (dry basis)	Lead	Zinc	Gross weight (dry basis)	Lead	Zinc
Alaska	--	--	--	--	--	--	--	--	--
Arizona	W	W	--	--	--	--	--	--	--
California	--	--	--	--	--	--	--	--	--
Colorado	W	W	--	--	--	--	W	W	W
Idaho	W	W	--	--	--	--	W	W	W
Illinois	--	--	--	--	--	--	--	--	--
Kentucky	--	--	--	W	--	W	--	--	--
Missouri	8,530,735	474,460	63,680	--	--	--	--	--	--
Montana	--	--	--	--	--	--	--	--	--
Nevada	--	--	--	--	--	--	--	--	--
New Jersey	--	--	--	94,007	--	16,800	--	--	--
New Mexico	--	--	--	--	--	--	--	--	--
New York	--	--	--	609,152	974	49,351	--	--	--
Pennsylvania	--	--	--	461,156	--	24,762	--	--	--
Tennessee	--	--	--	4,445,879	--	119,022	--	--	--
Utah	--	--	--	--	--	--	--	--	--
Washington	--	--	--	--	--	--	--	--	--
Total	8,534,351	474,553	63,680	[1]5,610,194	974	[2]209,935	[1]308,726	12,238	[2]16,204
Percent of total lead-zinc	XX	93	21	XX	(3)	70	XX	2	[2]5

State	Copper-lead, copper-zinc, and copper-lead-zinc ores			All other sources[4]			Total		
	Gross weight (dry basis)	Lead	Zinc	Gross weight (dry basis)	Lead	Zinc	Gross weight (dry basis)	Lead	Zinc
Alaska	--	--	--	W	W	--	W	W	--
Arizona	--	--	--	W	W	--	36,378,494	359	--
California	--	--	--	W	W	--	W	W	--
Colorado	--	--	--	W	W	W	W	W	W
Idaho	--	--	--	W	W	W	W	W	W
Illinois	--	--	--	(5)	W	W	(5)	W	W
Kentucky	--	--	--	--	--	--	W	--	W
Missouri	--	--	--	--	--	--	8,530,735	474,460	63,680
Montana	--	--	--	2,901,423	661	W	2,901,423	661	W

See footnotes at end of table.

Table 4.—Production of lead and zinc in the United States in 1982, by State and class of ore from old tailings, etc., in terms of recoverable metal —Continued

(Metric tons)

State	Copper-lead, copper-zinc, and copper-lead-zinc ores			All other sources[4]			Total		
	Gross weight (dry basis)	Lead	Zinc	Gross weight (dry basis)	Lead	Zinc	Gross weight (dry basis)	Lead	Zinc
Nevada	--	--	--	W	W	--	W	W	--
New Jersey	--	--	--	--	--	--	94,007	--	16,800
New Mexico	--	--	--	W	W	--	W	W	--
New York	--	--	--	--	--	--	609,152	974	49,351
Pennsylvania	--	--	--	--	--	--	461,156	--	24,762
Tennessee	1,603,935	--	2,284	--	--	--	6,049,814	--	121,306
Utah	--	--	--	W	W	--	W	W	--
Washington	--	--	--	W	W	--	W	W	--
Total	1,603,935	--	2,284	41,475,733	24,660	8,171	57,532,939	512,425	300,274
Percent of total lead-zinc	XX	--	1	XX	5	3	XX	100	100

W Withheld to avoid disclosing company proprietary data; included in "Total." XX Not applicable.
[1]Zinc ore in Kentucky included with lead-zinc ores to avoid disclosing company proprietary data.
[2]Zinc from zinc ore in Kentucky included with zinc from lead-zinc ores to avoid disclosing company proprietary data.
[3]Less than 1/2 unit.
[4]Lead and zinc recovered from copper, gold, silver, and fluorspar ores and from mill tailings and miscellaneous cleanups.
[5]Excludes tonnages of fluorspar from which lead and zinc were recovered as byproducts.

Table 5.—Mine production of recoverable lead in the United States, by month

(Metric tons)

Month	1981	1982
January	42,647	40,254
February	40,893	43,206
March	43,396	48,365
April	26,741	44,048
May	27,846	41,807
June	17,403	42,344
July	31,825	36,775
August	38,236	42,646
September	47,994	41,433
October	47,499	44,655
November	39,760	41,809
December	41,295	45,083
Total	445,535	512,425

Table 6.—Twenty-five leading lead-producing mines in the United States in 1982, in order of output

Rank	Mine	County and State	Operator	Source of lead
1	Buick	Iron, Mo	AMAX Lead Co. of Missouri	Lead ore.
2	Milliken	Reynolds, Mo	Ozark Lead Co	Do.
3	Fletcher	do	St. Joe Lead Co	Do.
4	Magmont	Iron, Mo	Cominco American, Inc	Do.
5	Viburnum No. 29	Washington, Mo	St. Joe Lead Co	Do.
6	Viburnum No. 28	Iron, Mo	do	Do.
7	Brushy Creek	Reynolds, Mo	do	Do.
8	Lucky Friday	Shoshone, Idaho	Hecla Mining Co	Silver ore.
9	Leadville unit	Lake, Colo	ASARCO Incorporated	Lead-zinc ore.
10	Star unit	Shoshone, Idaho	Helca Mining Co	Do.
11	Indian Creek	Washington, Mo	St. Joe Lead Co	Lead ore.
12	Sunnyside	San Juan, Colo	Standard Metals Corp	Gold ore.
13	Balmat	St. Lawrence, N.Y	St. Joe Lead Co	Zinc ore.
14	Bulldog Mountain	Mineral, Colo	Homestake Lead Mining Co	Silver ore.
15	Troy unit	Lincoln, Mont	ASARCO Incorporated	Do.
16	Clayton	Custer, Idaho	Clayton Silver Mines	Do.
17	Galena	Shoshone, Idaho	ASARCO Incorporated	Do.
18	Black Pine	Granite, Mont	Black Mining Co	Do.
19	St. Cloud	Sierra, N. Mex	St. Cloud Mining Co	Do.
20	Tiger	Pinal, Ariz	McFarland & Hullinger	Gold-silver tailings.
21	Rosiclare	Hardin and Pope, Ill	Ozark Mahoning Co	Fluorspar.
22	Sierrita	Pima, Ariz	Duval Corp	Copper ore.
23	Inverness	Hardin, Ill	Inverness Mining Co	Fluorspar.
24	Dome Venture	Yuma, Ariz	Contract Mining Co	Lead ore.
25	Comet	Jefferson, Mont	Concorde Mines Ltd	Gold-silver ore.

Table 7.—Refined lead produced at primary refineries in the United States, by source material

(Metric tons unless otherwise specified)

	1978	1979	1980	1981	1982
Refined lead:					
From primary sources:					
Domestic ores and base bullion	501,643	529,970	508,163	440,238	459,865
Foreign ores and base bullion	63,530	45,641	39,427	55,085	52,295
Total	565,173	575,611	547,590	495,323	512,160
From secondary sources	1,244	2,862	2,117	1,745	657
Grand total	566,417	578,473	549,707	497,068	512,817
Calculated value of primary refined lead[1] thousands	$419,277	$668,004	$512,590	$398,908	$288,377

[1]Value based on average quoted price and excludes value of refined lead produced from scrap at primary refineries.

Table 8.—Antimonial lead produced at primary lead refineries in the United States

Year	Production (metric tons)	Antimony content		Lead content by difference (metric tons)			
		Metric tons	Percent	From domestic ore	From foreign ore	From scrap	Total
1978	5,006	710	14.2	2,384	530	1,382	4,296
1979	3,402	271	8.0	2,491	105	535	3,131
1980	881	27	3.1	711	140	3	854
1981	3,557	503	14.1	1,989	1,019	46	3,054
1982	W	W	W	1,895	2,727	34	4,656

W Withheld to avoid disclosing company proprietary data.

Table 9.—Stocks and consumption of new and old lead scrap in the United States in 1982

(Metric tons, gross weight)

Type of scrap	Stocks Jan. 1	Receipts	Consumption: New scrap	Consumption: Old scrap	Consumption: Total	Stocks Dec. 31
Smelters, refiners, others:						
Soft lead[1]	1,601	28,623	--	28,670	28,670	1,554
Hard lead	1,415	19,421	--	19,690	19,690	1,146
Cable lead	2,178	4,336	--	3,747	3,747	2,767
Battery-lead plates	38,498	653,545	--	664,169	664,169	27,874
Mixed common babbitt	165	3,875	--	3,905	3,905	135
Solder and tinny lead	1,707	15,292	--	16,766	16,766	233
Type metals	1,662	6,375	--	6,807	6,807	1,230
Drosses and residues	11,585	67,068	66,953	--	66,953	11,700
Total	58,811	798,535	66,953	743,754	810,707	46,639

[1]Includes remelt lead from cable sheathing plus other soft lead scrap processing.

Table 10.—Secondary metal recovered[1] from lead and tin scrap in the United States in 1982, by type of product

(Metric tons)

	Lead	Tin	Antimony	Other	Total
Refined pig lead	231,081	--	--	--	231,081
Remelt lead	9,394	--	--	--	9,394
Total	240,475	--	--	--	240,475
Refined pig tin	--	1,054	--	--	1,054
Remelt tin	--	13	--	--	13
Total	--	1,067	--	--	1,067
Lead and tin alloys:					
Antimonial lead	284,367	1,015	13,248	723	299,353
Common babbitt	4,355	197	557	5	5,114
Genuine babbitt	8	40	3	1	52
Solder	19,350	2,723	400	25	22,498
Type metals	5,714	222	778	26	6,740
Cable lead	986	--	10	--	996
Miscellaneous alloys	595	101	60	3	759
Total	315,375	4,298	15,056	783	335,512
Tin content of chemical products	--	282	--	--	282
Grand total	555,850	5,647	15,056	783	577,336

[1]Most of the figures herein represent actual reported recovery of metal from scrap.

Table 11.—Secondary lead recovered in the United States

(Metric tons unless otherwise specified)

	1978	1979	1980	1981	1982
As metal:					
At primary plants	1,244	2,862	2,117	1,745	657
At other plants	281,340	349,359	313,061	280,409	239,819
Total	282,584	352,221	315,178	282,154	240,476
In antimonial lead:					
At primary plants	1,382	535	3	46	34
At other plants	408,528	378,295	306,683	304,330	284,333
Total	409,910	378,830	306,686	304,376	284,367
In other alloys	76,742	70,317	53,714	54,575	46,433
Grand total:					
Quantity	769,236	801,368	675,578	641,105	571,276
Value[1] thousands	$570,662	$930,019	$632,397	$516,313	$321,663

[1]Value based on average quoted price of common lead.

Table 12.—Lead recovered from scrap processed in the United States, by kind of scrap and form of recovery

(Metric tons)

	1981	1982
KIND OF SCRAP		
New scrap:		
Lead-base	58,829	46,449
Copper-base	4,232	3,541
Tin-base	13	14
Total	63,074	50,004
Old scrap:		
Battery-lead plates	481,355	437,197
All other lead-base	81,762	72,550
Copper-base	14,913	11,524
Tin-base	1	1
Total	578,031	521,272
Grand total	641,105	571,276
FORM OF RECOVERY		
As soft lead:		
At primary plants	1,745	657
At other plants	280,409	239,819
Total	282,154	240,476
In antimonial lead[1]	304,376	284,367
In other lead alloys	40,061	30,741
In copper-base alloys	14,501	15,683
In tin-base alloys	13	9
Total	358,951	330,800
Grand total	641,105	571,276

[1]Includes 46 tons of lead recovered in antimonial lead from secondary sources at primary plants in 1981 and 34 tons in 1982.

Table 13.—Lead consumption in the United States, by product

(Metric tons)

SIC Code	Product	1981	1982
	Metal products:		
3482	Ammunition: Shot and bullets	49,514	44,237
	Bearing metals:		
35	Machinery except electrical	1,660	1,216
36	Electrical and electronic equipment	26	96
371	Motor vehicles and equipment	2,464	2,020
37	Other transportation equipment	2,772	2,801
	Total bearing metals	6,922	6,133
3351	Brass and bronze: Billets and ingots	13,306	11,352
36	Cable covering: Power and communication	12,072	15,181
15	Calking lead: Building construction	5,522	4,056
	Casting metals:		
36	Electrical machinery and equipment	993	802
371	Motor vehicles and equipment	1,247	657
37	Other transportation and equipment	12,634	23,603
3443	Nuclear radiation shielding	3,708	([1])
	Total casting metals	18,582	25,062
	Pipes, traps, and other extruded products:		
15	Building construction	8,509	8,255
3443	Storage tanks, process vessels, etc	320	424
	Total pipes, traps, and other extruded products	8,829	8,679

See footnotes at end of table.

Table 13.—Lead consumption in the United States, by product —Continued

(Metric tons)

SIC Code	Product	1981	1982
	Sheet lead:		
15	Building construction	12,283	9,989
3443	Storage tanks, process vessels, etc	,938	125
3693	Medical radiation shielding	6,134	5,045
	Total sheet lead	19,355	15,159
	Solder:		
15	Building construction	6,167	6,740
341	Metal cans and shipping containers	7,749	7,459
367	Electronic components and accessories	5,606	5,967
36	Other electrical machinery and equipment	2,583	2,702
371	Motor vehicles and equipment	7,600	5,632
	Total solder	29,705	28,500
	Storage battery grids, post, etc.:		
36911	Storage batteries: SLI automotive	313,531	284,758
36912	Storage batteries: Industrial and traction	28,664	27,824
	Total storage battery grids, post, etc	342,195	312,582
	Storage battery oxides:		
36911	Storage batteries: SLI automotive	407,053	372,082
36912	Storage batteries: Industrial and traction	20,904	19,659
	Total storage battery oxides	427,957	391,741
371	Terne metal: Motor vehicles and equipment	3,971	3,288
27	Type metal: Printing and allied industries	7,838	2,766
34	Other metal products[2]	7,939	7,094
	Total metal products	953,707	875,830
	Pigments:		
285	Paints	16,316	13,375
32	Glass and ceramic products	44,339	34,526
28	Other pigments[3]	19,510	12,965
	Total pigments	80,165	60,866
2911	Chemicals: Petroleum refining	111,367	119,234
	Miscellaneous uses	21,862	19,478
	Grand total	1,167,101	1,075,408

[1]Included with "Other transportation" to avoid disclosing company proprietary data.
[2]Includes lead consumed in foil, collapsible tubes, annealing, galvanizing, plating, and fishing weights.
[3]Includes color, lead content of leaded zinc oxide, and other pigments.

Table 14.—Lead consumption in the United States, by month[1]

(Metric tons)

Month	1981	1982
January	101,211	98,691
February	93,444	87,923
March	99,062	97,168
April	93,264	94,522
May	90,520	84,678
June	92,622	88,432
July	79,448	72,418
August	95,446	96,674
September	103,066	88,321

See footnotes at end of table.

Table 14.—Lead consumption in the United States, by month[1] —Continued

(Metric tons)

Month	1981	1982
October	117,043	98,252
November	94,358	81,539
December	107,617	86,790
Total[2]	1,167,101	1,075,408

[1]Monthly totals include monthly reported consumption plus the monthly distribution for companies that report on an annual basis only.
[2]Includes lead that went directly from scrap to fabricated products and lead contained in leaded zinc oxide.

Table 15.—Lead consumption in the United States in 1982, by State[1]

(Metric tons)

State	Refined soft lead	Lead in antimonial lead	Lead in alloys	Lead in copper-base scrap	Total
California	59,502	34,430	5,597	686	100,215
Colorado	618	104	29	--	751
Connecticut	9,998	11,858	--	395	22,251
District of Columbia	23	--	--	--	23
Florida	10,356	7,598	667	--	18,621
Georgia	34,671	15,206	2,304	6	52,187
Illinois	16,758	22,682	3,667	836	43,943
Indiana	90,895	18,241	8,378	426	117,940
Kansas	24,095	9,251	2,392	14	35,752
Kentucky	11,306	11,000	3	--	22,309
Maryland	149	711	1	2	863
Massachusetts	1,037	196	19	280	1,532
Michigan	8,376	9,491	228	--	18,095
Missouri	13,253	11,359	1,305	1,084	27,001
Nebraska	627	77	1,111	1,100	2,915
New Jersey	93,622	3,724	4,171	449	101,966
New York	15,362	2,288	5,340	873	23,863
Ohio	8,097	8,366	1,814	209	18,486
Pennsylvania	82,440	44,353	21,529	1,099	149,421
Rhode Island	2,921	54	5	--	2,980
Tennessee	675	10,747	103	112	11,637
Virginia and West Virginia	187	1,194	1	--	1,382
Washington	10,267	264	--	--	10,531
Wisconsin	5,979	10,471	23	42	16,515
Alabama and Mississippi	5,894	3,588	576	1,537	11,595
Arkansas and Oklahoma	2,461	1,254	--	--	3,715
Hawaii and Oregon	5,509	5,128	--	--	10,637
Iowa and Minnesota	10,577	11,637	2,907	--	25,121
Louisiana and Texas	122,642	23,570	2,613	--	148,825
Montana and Idaho	316	--	--	--	316
New Hampshire, Maine, Vermont, Delaware	11,214	13,913	--	59	25,186
North Carolina and South Carolina	27,290	20,027	1,131	--	48,448
Utah, Nevada, Arizona	--	--	386	--	386
Total	687,117	312,782	66,300	9,209	1,075,408

[1]Includes lead that went directly from scrap to fabricated products and lead contained in leaded zinc oxide.

Table 16.—Lead consumption in the United States in 1982, by class of product and type of material

(Metric tons)

Product	Soft lead	Lead in antimonial lead	Lead in alloys	Lead in copper-base scrap	Total
Metal products	77,677	56,472	28,149	9,209	171,507
Storage batteries	413,746	255,298	35,279	--	704,323
Pigments	60,864	--	2	--	60,866
Chemicals	119,234	--	--	--	119,234
Miscellaneous	15,596	1,012	2,870	--	19,478
Total	687,117	312,782	66,300	9,209	[1]1,075,408

[1]Includes lead that went directly from scrap to fabricated products and lead contained in leaded zinc oxide.

Table 17.—Production and shipments of lead pigments[1] and oxides in the United States

Product	1981			1982		
	Production (metric tons)	Shipments		Production (metric tons)	Shipments	
		Metric tons	Value[2]		Metric tons	Value[2]
White lead, dry	1,022	1,029	$1,297,317	1,331	1,186	$1,624,947
Red lead	14,688	15,077	16,327,054	13,324	13,669	11,084,454
Litharge	46,891	47,141	35,342,133	52,112	51,402	45,724,111
Leady oxide	444,625	--	--	413,139	--	--

[1]Excludes basic lead sulfate; withheld to avoid disclosing company proprietary data.
[2]At plant, exclusive of container.

Table 18.—Lead content of lead pigments[1] and oxides produced by domestic manufacturers, by source

(Metric tons)

Product	Lead in pigments from pig lead	
	1981	1982
White lead	818	1,174
Red lead	13,366	12,125
Litharge	43,608	48,465
Leady oxide	423,723	390,493
Total	481,515	452,257

[1]Excludes basic lead sulfate; withheld to avoid disclosing company proprietary data.

Table 19.—Distribution of red lead shipments, by industry

(Metric tons)

Industry	1978	1979	1980	1981	1982
Paints	5,993	5,300	3,241	3,172	2,395
Ceramics	--	--	2,597	2,307	W
Storage batteries	W	W	6,068	7,573	W
Other	13,234	12,846	995	2,025	11,274
Total	19,227	18,146	12,901	15,077	13,669

W Withheld to avoid disclosing company proprietary data; included with "Other."

Table 20.—Distribution of litharge shipments, by industry

(Metric tons)

Industry	1978	1979	1980	1981	1982
Ceramics	33,865	37,620	36,560	34,732	30,980
Chrome pigments	--	--	3,015	4,247	6,591
Oil refining	W	W	170	227	W
Paints	3,200	3,038	3,362	3,765	3,052
Rubber	2,153	1,520	943	1,107	787
Other	62,887	58,792	784	3,063	10,267
Total	102,105	100,970	44,834	47,141	51,677

W Withheld to avoid disclosing company proprietary data; included with "Other."

Table 21.—U.S. imports for consumption of lead pigments and compounds

Kind	1981 Quantity (metric tons)	1981 Value (thousands)	1982 Quantity (metric tons)	1982 Value (thousands)
White lead	187	$344	83	$174
Red lead	993	822	686	466
Litharge	11,026	8,812	9,931	5,695
Chrome yellow	1,204	2,919	1,255	2,610
Other lead pigments	297	487	94	413
Other lead compounds	1,479	1,849	855	1,255
Total	15,186	15,233	12,904	10,613

Table 22.—Stocks of lead at primary smelters and refineries in the United States, December 31

(Metric tons)

Stocks	1978	1979	1980	1981	1982
Refined pig lead	17,001	45,448	54,728	78,836	73,455
Lead in antimonial lead	556	646	122	666	W
Lead-base bullion	5,818	5,683	5,398	4,872	4,252
Lead in ore and matte	75,290	37,545	65,746	55,833	47,830
Total	98,665	89,322	125,994	140,207	125,537

W Withheld to avoid disclosing company proprietary data.

Table 23.—Stocks of lead at consumers and secondary smelters in the United States, December 31, by type of material

(Metric tons, lead content)

Year	Refined soft lead	Lead in antimonial lead	Lead in alloys	Lead in copper-base scrap	Total
1978	72,065	44,417	7,564	1,188	125,234
1979	95,655	49,188	7,346	1,006	153,195
1980	72,601	44,820	7,851	942	126,214
1981	69,636	46,194	6,523	863	123,216
1982	51,036	40,118	5,346	709	97,209

Table 24.—Average monthly and annual quoted prices of lead[1]

(Cents per pound)

Month	1981 U.S. producer	1981 London Metal Exchange	1982 U.S. producer	1982 London Metal Exchange
January	33.79	31.95	29.67	29.37
February	30.42	31.24	28.70	28.01
March	35.06	33.06	27.64	27.75
April	37.52	34.38	26.06	26.05
May	36.41	31.58	26.09	26.05
June	37.97	32.30	24.76	23.59
July	40.99	35.55	27.18	25.03
August	43.89	37.34	25.82	23.70
September	40.32	34.61	25.32	23.35
October	37.05	32.47	23.19	22.54
November	33.88	30.18	21.61	20.96
December	31.07	30.56	20.47	20.30
Average	36.53	33.30	25.54	24.66

[1]Metals Week. Quotations for United States on a nationwide, delivered basis.

Table 25.—U.S. exports of lead, by country

Country	1981 Quantity (metric tons)	1981 Value (thousands)	1982 Quantity (metric tons)	1982 Value (thousands)
Ore and concentrates:				
Belgium-Luxembourg	291	$343	4,056	$948
Brazil	4,983	2,875	--	--
Bulgaria	7,808	5,010	--	--
Canada	15,420	8,554	16,778	6,885
Dominican Republic	69	21	--	--
Finland	799	690	--	--
Germany, Federal Republic of	2,450	1,056	--	--
India	--	--	3,555	743
Italy	--	--	245	60
Mexico	776	232	641	324
Netherlands	18	6	--	--
Philippines	19	17	57	17
Spain	328	112	3,711	1,122
United Kingdom	49	31	--	--
Other	33	11	61	36
Total	33,043	18,958	29,104	10,135
Unwrought lead and lead alloys:				
Australia	8	9	3	22
Austria	64	82	16	74
Belgium-Luxembourg	4,316	2,832	17,403	11,370
Canada	2,996	2,597	1,963	1,051
Chile	2	14	6	12
Colombia	--	--	24	82
Costa Rica	4	7	1	1
Dominican Republic	31	65	49	39
Ecuador	62	59	1	6
Egypt	30	126	1,136	1,172
El Salvador	2	9	--	--
France	12	14	3	7
Germany, Federal Republic of	65	37	292	112
Greece	--	--	3,066	1,473
Haiti	21	30	27	21
Honduras	10	34	83	77
Hong Kong	1	2	2	22
Israel	22	28	18	17
Italy	13	17	908	676
Jamaica	--	--	54	56
Japan	876	1,088	99	280
Korea, Republic of	1,478	972	111	89
Kuwait	23	41	21	45
Mexico	234	390	125	211
Netherlands	4,037	4,138	21,980	18,530
Netherlands Antilles	25	29	--	--
Nicaragua	28	32	4	10
Panama	150	107	40	110
Peru	--	--	24	52
Philippines	159	168	172	152
Saudi Arabia	81	156	80	95
Singapore	132	104	43	39
South Africa, Republic of	163	171	2	3
Spain	27	218	21	22
Switzerland	--	--	10	17
Taiwan	174	134	1,816	808
Thailand	238	180	320	265
Trinidad and Tobago	106	125	22	29
United Arab Emirates	11	34	2	4
United Kingdom	856	652	208	481
Venezuela	282	698	742	919
Zambia	27	27	--	--
Other	r38	r101	92	498
Total	16,804	15,527	50,989	38,949
Wrought lead and lead alloys:				
Argentina	--	--	1	4
Australia	20	23	1	7
Belgium-Luxembourg	1,740	587	186	51
Brazil	10	25	--	--
Canada	2,746	2,889	1,407	1,280
Colombia	2	4	4	7
Dominican Republic	7	46	4	6
Ecuador	--	--	3	7
France	7	14	7	84
Germany, Federal Republic of	43	59	120	1,002
Honduras	([1])	1	6	17
Hong Kong	31	146	2	16
India	77	263	30	145
Israel	16	111	2	6
Italy	2	2	96	88

See footnotes at end of table.

Table 25.—U.S. exports of lead, by country —Continued

Country	1981 Quantity (metric tons)	1981 Value (thousands)	1982 Quantity (metric tons)	1982 Value (thousands)
Wrought lead and lead alloys —Continued				
Japan	143	$266	238	$402
Korea, Republic of	30	24	([1])	1
Mexico	1,375	4,988	1,421	4,985
Netherlands	15	18	549	400
Netherlands Antilles	21	46	([1])	4
Panama	13	27	5	14
Philippines	42	162	38	36
Saudi Arabia	42	94	269	420
Singapore	2	6	2	41
South Africa, Republic of	2	9	1	2
Spain	20	80	147	472
Taiwan	20	335	14	96
United Kingdom	9	41	12	29
Venezuela	50	101	34	88
Other	31	[r]102	41	159
Total	6,516	10,469	4,640	9,869
Scrap:				
Belgium-Luxembourg	768	240	657	247
Brazil	1,771	748	481	28
Canada	18,477	6,027	18,343	4,658
Denmark	1,187	583	353	270
Egypt	--	--	200	120
France	17	3	--	--
Germany, Federal Republic of	3,268	1,336	2,724	1,342
Hong Kong	102	31	58	11
India	1,147	533	231	99
Ireland	32	152	--	--
Italy	17	24	194	162
Japan	1,819	963	766	355
Korea, Republic of	1,991	617	3,754	877
Mexico	10,847	2,591	7,011	2,393
Mozambique	199	175	--	--
Netherlands	2,784	1,489	437	440
Norway	47	53	--	--
Philippines	36	40	142	29
South Africa, Republic of	3,764	1,709	8,298	2,796
Spain	45	49	91	52
Sweden	147	50	23	30
Taiwan	8,732	2,996	7,200	1,947
United Kingdom	2,040	1,844	769	1,344
Venezuela	98	70	([1])	1
Other	84	[r]65	20	53
Total	59,419	22,388	51,752	17,254
Grand total	115,782	67,342	136,485	76,207

[r]Revised.
[1]Less than 1/2 unit.

Table 26.—U.S. exports of lead, by year

Year	Blocks, pigs, anodes, etc.: Unwrought Quantity (metric tons)	Unwrought Value (thousands)	Unwrought alloys Quantity (metric tons)	Unwrought alloys Value (thousands)	Wrought lead and lead alloys: Sheets, plates, rods, other forms Quantity (metric tons)	Sheets, plates, rods, other forms Value (thousands)	Foil, powder, flakes Quantity (metric tons)	Foil, powder, flakes Value (thousands)	Scrap Quantity (metric tons)	Scrap Value (thousands)
1980	147,356	$143,458	9,144	$10,292	7,522	$10,507	436	$578	119,651	$62,221
1981	14,484	12,591	2,320	2,936	5,966	9,719	550	750	59,419	22,388
1982	47,250	35,917	3,739	3,032	4,078	9,056	562	813	51,752	17,254

Table 27.—U.S. imports[1] of lead, by country

Country	1980 Quantity (metric tons)	1980 Value (thousands)	1981 Quantity (metric tons)	1981 Value (thousands)	1982 Quantity (metric tons)	1982 Value (thousands)
Ore, flue dust, and residues, n.s.p.f. (lead content):						
Argentina	61	$56	3,932	$3,023	--	--
Australia	2,971	2,309	2,160	1,228	7,694	$2,875
Bolivia	571	477	--	--	--	--
Canada	8,520	6,901	23,500	17,149	4,780	2,259
Chile	2,236	1,927	2,084	1,719	--	--
Colombia	211	154	122	64	105	32
Honduras	3,974	3,943	11,617	9,271	8,677	4,850
Mexico	781	665	961	864	--	--
Peru	17,980	13,169	14,149	8,397	14,549	5,481
South Africa, Republic of	6,790	5,514	--	--	--	--
Other	--	--	20	14	2	1
Total	44,095	35,115	58,545	41,729	35,807	15,498
Base bullion (lead content):						
Canada	247	219	59	58	19	25
Mexico	27	30	--	--	--	--
Peru	--	--	390	278	--	--
Other	22	260	(2)	4	(2)	3
Total	296	509	449	340	19	28
Pigs and bars (lead content):						
Argentina	--	--	300	220	--	--
Australia	11,338	12,365	10,893	8,023	7,256	3,786
Belgium-Luxembourg	846	5,567	286	1,666	146	783
Canada	34,929	31,649	50,849	39,298	49,834	27,701
Denmark	619	591	354	341	449	351
Germany, Federal Republic of	446	4,342	1,433	8,899	927	5,836
Mexico	28,636	27,987	33,723	25,183	23,473	12,422
Netherlands	56	590	--	--	--	--
Peru	3,298	2,974	2,907	2,146	8,296	3,816
Spain	1,036	1,313	--	--	9	86
United Kingdom	468	1,085	989	2,269	748	1,902
Other	61	45	186	499	51	39
Total	81,733	88,508	101,920	88,544	91,189	56,722
Reclaimed scrap, etc. (lead content):						
Australia	4,747	3,458	2,605	1,611	3,992	1,301
Bahamas	26	7	83	12	37	8
Barbados	--	--	22	5	--	--
Canada	1,639	1,570	1,792	1,394	3,481	1,205
Chile	--	--	87	28	18	4
Dominican Republic	86	32	--	--	--	--
Guatemala	8	5	77	29	--	--
Haiti	13	3	--	--	--	--
Mexico	551	405	456	344	852	398
Panama	18	8	--	--	--	--
Spain	108	637	92	380	--	--
Other	66	20	r51	r28	18	8
Total	7,262	6,145	5,265	3,831	8,398	2,924
Grand total	133,386	130,277	166,179	134,444	135,413	75,172

rRevised.
[1]Data are "general imports"; that is, they include lead imported for immediate consumption plus material entering the country under bond.
[2]Less than 1/2 unit.

Table 28.—U.S. imports for consumption of lead, by country

Country	1980 Quantity (metric tons)	1980 Value (thousands)	1981 Quantity (metric tons)	1981 Value (thousands)	1982 Quantity (metric tons)	1982 Value (thousands)
Ore, flue dust, and residues, n.s.p.f. (lead content):						
Argentina	61	$56	3,932	$3,023	--	--
Australia	365	322	648	457	--	--
Bolivia	571	477	--	--	--	--
Canada	2,985	2,873	1,913	1,353	29	$10
Chile	2,236	1,927	2,084	1,719	--	--
Colombia	211	154	122	64	106	32
Honduras	3,973	3,943	11,617	9,271	8,677	4,850
Mexico	781	665	961	864	--	--
Peru	18,141	13,292	5,909	3,431	10,131	3,891
South Africa, Republic of	291	218	--	--	--	--
Other	--	--	20	14	2	1
Total	29,615	23,927	27,206	20,196	18,945	8,784
Base bullion (lead content):						
Canada	247	219	59	58	19	25
Mexico	27	30	--	--	--	--
Peru	--	--	390	278	--	--
Other	22	260	(1)	4	(1)	3
Total	296	509	449	340	19	28
Pigs and bars (lead content):						
Argentina	--	--	300	220	--	--
Australia	10,884	11,464	9,080	6,505	10,882	5,674
Belgium-Luxembourg	846	5,567	286	1,666	146	783
Canada	34,929	31,649	50,849	39,298	49,834	27,701
Denmark	619	591	354	341	449	351
Germany, Federal Republic of	446	4,342	1,433	8,899	927	5,836
Mexico	28,657	28,009	33,723	25,183	23,513	12,444
Netherlands	56	590	--	--	--	--
Peru	3,298	2,974	2,907	2,146	8,296	3,816
Spain	1,036	1,313	--	--	9	86
United Kingdom	468	1,085	989	2,269	748	1,903
Other	61	45	187	499	51	39
Total	81,300	87,629	100,108	87,026	94,855	58,633
Reclaimed scrap, etc. (lead content):						
Australia	353	218	--	--	428	132
Bahamas	26	7	83	12	37	8
Canada	1,639	1,570	1,792	1,394	3,481	1,205
Chile	--	--	87	28	18	4
Dominican Republic	86	32	--	--	--	--
Guatemala	8	5	77	29	--	--
Mexico	551	405	456	344	852	398
Panama	18	8	--	--	--	--
Spain	108	637	92	380	--	--
Other	79	23	r74	r33	18	8
Total	2,868	2,905	2,661	2,220	4,834	1,755
Sheets, pipe, shot, and other forms:						
Canada	280	544	203	343	313	335
Germany, Federal Republic of	57	119	51	85	40	111
Italy	--	--	20	33	24	52
Mexico	588	647	177	164	45	73
United Kingdom	8	36	4	17	3	12
Other	17	162	19	84	42	111
Total	950	1,508	474	726	467	694
Grand total	115,029	116,478	130,898	110,508	119,120	69,894

rRevised.
1Less than 1/2 unit.

Table 29.—U.S. imports for consumption of lead, by class

(Thousand metric tons and thousand dollars)

Year	Ore (lead content)		Base bullion (lead content)		Pigs and bars (lead content)		Sheets, plates, strip, other forms	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1979	44	33,026	2	1,691	183	209,451	(1)	328
1980	30	23,927	(1)	509	81	87,629	(1)	888
1981	27	20,196	(1)	340	100	87,026	(1)	564
1982	19	8,784	(1)	28	95	58,633	(1)	646

Year	Waste and scrap (lead content)		Dross, skimmings, residues, n.s.p.f. (lead content)		Powder and flakes		Total value
	Quantity	Value	Quantity	Value	Quantity	Value	
1979	4	3,207	(1)	575	(1)	288	248,566
1980	2	2,144	1	761	1	620	116,478
1981	2	1,568	1	652	(1)	162	110,508
1982	4	1,473	1	282	(1)	48	69,894

[1]Less than 1/2 unit.

Table 30.—U.S. imports for consumption of miscellaneous products containing lead[1]

Year	Gross weight (metric tons)	Lead content (metric tons)	Value (thousands)
1980	968	388	$11,144
1981	1,090	520	7,813
1982	1,423	639	10,596

[1]Babbitt metal, solder, white metal, and other lead-containing combinations.

Table 31.—Lead: World mine production, by country[1]

(Thousand metric tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Algeria	[r]1.5	[r]2.2	1.8	3.6	3.6
Argentina	30.3	[r]31.8	32.6	34.8	[3]29.7
Australia[4]	400.3	421.6	397.4	388.6	[3]464.6
Austria	4.6	4.5	4.3	4.3	4.3
Bolivia	18.0	15.4	17.7	16.8	[3]12.4
Brazil	31.2	27.9	27.8	28.4	18.0
Bulgaria	117.0	116.0	106.0	100.0	100.0
Burma	9.9	14.5	14.2	15.6	20.0
Canada	319.8	310.7	296.7	332.1	341.0
Chile	.4	.3	.3	.2	.2
China	145.0	155.0	155.0	155.0	155.0
Colombia	.1	.2	.2	.1	.1
Congo (Brazzaville)	4.2	[e]3.5	[e]3.5	7.7	[3]7.7
Czechoslovakia	4.0	4.0	3.3	3.4	3.4
Ecuador	.2	.2	.2	.2	.2
Finland	.8	1.0	1.1	1.9	1.9
France	32.5	29.5	28.8	19.9	20.0
Germany, Federal Republic of	23.2	25.2	23.1	21.6	21.0
Greece	20.3	21.7	20.5	21.0	21.0
Greenland	30.6	31.9	34.3	30.0	31.7
Guatemala	.1	.1	.1	.1	.1
Honduras	21.8	16.4	13.3	12.6	[3]15.1
Hungary	1.1	1.0	1.1	1.0	1.0
India	12.8	16.0	12.7	15.3	12.0
Iran[e]	30.0	15.0	15.0	10.0	11.0
Ireland	47.8	71.0	59.0	30.5	30.0

See footnotes at end of table.

Table 31.—Lead: World mine production, by country[1] —Continued

(Thousand metric tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Italy	30.5	28.1	22.9	20.6	20.0
Japan[5]	56.5	46.9	44.7	46.9	[3]45.9
Korea, North[e]	105.0	100.0	100.0	100.0	100.0
Korea, Republic of	16.1	11.1	11.4	13.6	10.0
Mexico[6]	170.6	173.5	145.5	157.4	[3]145.8
Morocco	100.2	115.7	115.4	116.2	110.0
Namibia	38.6	46.0	47.7	46.9	[3]32.9
Nicaragua	.4	--	--	--	--
Nigeria	.1	.1	.1	.2	.2
Norway	3.6	3.6	2.6	3.6	3.6
Peru[7]	182.7	174.0	176.9	192.7	205.0
Philippines	1.4	1.9	1.8	1.1	--
Poland	63.9	61.9	60.0	50.4	57.5
Romania	33.3	33.3	33.5	33.5	33.5
Spain	71.3	72.3	87.1	83.0	80.0
Sweden	81.9	81.6	72.2	84.1	84.0
South Africa, Republic of	--	--	86.1	98.9	[3]90.3
Thailand	1.7	8.7	10.6	17.0	18.0
Tunisia	8.0	10.0	8.3	5.7	5.0
Turkey	9.5	7.5	5.8	8.1	8.0
U.S.S.R.[e]	410.0	[r]415.0	420.0	425.0	430.0
United Kingdom	4.6	4.7	2.4	[e]2.4	2.4
United States[8]	529.7	525.6	550.4	445.5	[3]512.4
Yugoslavia	129.4	129.8	121.4	118.6	115.0
Zambia	15.8	17.6	14.0	17.2	16.0
Total	[r]3,372.3	[r]3,405.5	3,410.8	3,343.3	3,450.5

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through May 25, 1983.
[2]In addition to the countries listed, Egypt and Uganda may produce lead, but available information is inadequate to make reliable estimates of output levels.
[3]Reported figure.
[4]Content by analysis.
[5]Content of concentrates.
[6]Recoverable metal content of lead in concentrates for export plus lead content of domestic smelter products (refined lead, antimonial lead, mixed bars, and other unspecified items).
[7]Recoverable metal content of lead in concentrates for export plus lead content of domestic smelter products (refined lead, antimonial lead, and bismuth-lead bars).
[8]Recoverable.

Table 32.—Lead: World smelter production, by country[1]

(Thousand metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Argentina: Primary (refined)	19.7	32.0	23.2	19.0	17.0
Australia, primary:					
Bullion for export	152.0	169.5	160.2	161.6	[2]170.0
Refined	204.0	215.6	200.5	207.7	[2]218.8
Total	356.0	385.1	360.7	369.3	[2]388.8
Austria:					
Primary	5.8	6.0	5.4	3.3	3.0
Secondary	9.3	10.8	11.5	12.8	13.0
Total	15.1	16.8	16.9	16.1	16.0
Belgium:					
Primary[e 3]	[r]46.5	33.7	53.9	60.2	52.8
Secondary[4]	30.0	27.0	30.0	28.0	28.0
Total	[r]76.5	60.7	83.9	88.2	80.8
Brazil:					
Primary (refined)	47.2	55.1	44.5	34.7	[2]21.9
Secondary (refined)[4]	33.2	43.0	40.4	31.1	[2]26.3
Total	80.4	98.1	84.9	65.8	48.2

See footnotes at end of table.

Table 32.—Lead: World smelter production, by country[1] —Continued

(Thousand metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Bulgaria:					
Primary (refined)	115.0	115.0	115.0	115.0	115.0
Secondary (refined)[4]	5.0	4.0	4.0	4.0	4.0
Total[e]	120.0	119.0	119.0	119.0	119.0
Burma: Primary[e]	5.0	6.2	6.0	4.1	7.8
Canada:					
Primary (refined)	194.1	183.8	162.5	168.5	[2]173.5
Secondary (refined)[4]	51.8	68.6	72.1	69.6	[2]68.4
Total	245.9	252.4	234.6	238.1	[2]241.9
China:					
Primary (refined)[e]	140.0	150.0	150.0	150.0	150.0
Secondary (refined)[e]	20.0	20.0	20.0	20.0	20.0
Total	160.0	170.0	170.0	170.0	170.0
France:					
Primary	[2]125.9	[2]129.1	[2]126.0	126.0	120.0
Secondary	[2]25.5	[2]30.8	[2]35.7	34.0	30.0
Total	151.4	159.9	161.7	160.0	150.0
German Democratic Republic: Secondary (refined)[e 4]	[r]45.0	[r]42.0	42.0	45.0	45.0
Germany, Federal Republic of:					
Primary	[r]105.2	[r]103.4	111.9	107.5	110.7
Secondary (refined)[4]	[r]199.8	[r]213.2	189.5	254.8	256.3
Total	[r]305.0	[r]316.6	301.4	362.3	367.0
Greece: Primary (refined)	15.6	15.6	20.0	21.0	21.0
Guatemala: Primary	.1	.1	.1	.1	.1
India: Primary (refined)	[r]10.0	9.8	14.8	14.3	14.4
Italy:					
Primary	31.1	26.8	42.1	38.0	35.0
Secondary (refined)[4]	85.1	101.0	91.6	92.0	90.0
Total	116.2	127.8	133.7	130.0	125.0
Japan:					
Primary	188.9	187.8	185.8	190.7	[2]192.8
Secondary (refined)[4]	105.0	106.4	129.8	141.6	[2]118.6
Total	293.9	294.2	315.6	332.3	[2]311.4
Korea, North: Primary (refined)[e]	75.0	70.0	70.0	70.0	70.0
Korea, Republic of: Primary (refined)	7.2	7.6	5.5	9.3	[2]161.1
Mexico:					
Primary	166.1	173.0	145.0	156.7	[2]145.3
Secondary (refined)[4]	49.3	50.0	50.0	50.0	50.0
Total	215.4	223.0	195.0	206.7	195.3
Morocco: Primary (refined)	28.5	35.3	40.3	40.0	35.0
Namibia: Primary	39.5	41.7	42.7	41.7	40.6
Netherlands: Primary	.5	(5)	(5)	(5)	--
Peru: Primary (refined)	74.3	85.1	82.0	79.2	77.0
Poland:					
Primary (refined)[e]	61.7	59.2	56.0	48.0	55.0
Secondary (refined)[e 4]	25.0	25.0	26.0	21.0	23.8
Total[e]	86.7	84.2	82.0	69.0	78.8
Portugal: Primary	.1	--	--	--	--
Romania: Primary (refined)	34.0	35.0	35.0	35.0	36.0
South Africa, Republic of: Secondary[4]	23.6	23.3	35.4	25.4	30.0
Spain:					
Primary[e 3]	83.4	87.2	84.3	80.2	80.0
Secondary (refined)[e 4]	38.8	39.8	39.7	37.8	37.0
Total	122.2	127.0	124.0	118.0	117.0

See footnotes at end of table.

Table 32.—Lead: World smelter production, by country[1] —Continued

(Thousand metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Sweden: Primary	26.9	22.6	20.3	17.6	17.6
Tunisia: Primary (refined)	16.1	16.2	19.8	18.4	16.0
Turkey: Primary	3.0	5.9	6.5	4.8	4.8
U.S.S.R.:					
Primary (refined)[e]	410.0	[r]415.0	420.0	425.0	430.0
Secondary (refined)[e 4]	210.0	215.0	215.0	220.0	220.0
Total	620.0	[r]630.0	[r]635.0	645.0	650.0
United Kingdom:					
Primary	30.4	32.3	30.0	26.5	[2]34.1
Secondary (refined)[4]	223.0	244.2	211.4	198.0	168.4
Total	253.4	276.5	241.4	224.5	202.5
United States:					
Primary (refined)	[r]568.1	[r]578.2	548.4	498.3	516.8
Secondary (refined)[4]	769.2	801.4	675.6	641.1	571.3
Total	[r]1,337.3	[r]1,379.6	1,224.0	1,139.4	1,088.1
Yugoslavia:					
Primary	100.3	92.0	85.0	74.0	75.0
Secondary	40.1	41.6	39.6	46.4	45.0
Total	140.4	133.6	124.6	120.4	120.0
Zambia: Primary (refined)	12.9	12.8	10.0	9.7	[2]11.8
Grand total	[r]5,132.8	[r]5,315.7	5,082.0	5,028.7	5,075.0
Of which:					
Primary	[r]3,144.1	[r]3,208.6	3,122.7	3,056.1	3,229.9
Secondary	[r]1,988.7	[r]2,107.1	1,959.3	1,972.6	1,845.1

[e]Estimated. [p]Preliminary. [r]Revised.

[1]Table includes data available through June 15, 1983. Figures presented represent, to the extent possible, production of crude (or unrefined) lead, including bullion and impure lead derived from scrap. The figures for secondary crude lead for a number of countries are undoubtedly high, but insufficient information is available to separate impure secondary lead from lead merely re-refined. Countries for which this is the case have been footnoted. (See footnote 4.) For those countries for which crude lead production is not reported, but where available information suggests that there is little if any import or export of bullion for refining, refined lead output has been reported, noted parenthetically, because it is believed that the difference between crude for smelter output and refined output is negligible.

[2]Reported figure.

[3]Data not reported, derived from reported primary refined lead output minus imports of lead bullion plus exports of lead bullion and checked against use of lead content of domestically produced ores plus lead content of imported ores (estimated) minus lead content of exported ores (estimated).

[4]A significant part of the total entered may be merely re-refined and, as such, probably should not be included here, but a substantial part of the total presumably was recovered from sufficiently impure materials to qualify as a secondary smelter product. Available information is inadequate to permit differentiation, and the total has been included, although it is recognized that this produces an overly large figure.

[5]Revised to zero.

Table 33.—Lead: World refined production, by country[1]

(Thousand metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Argentina:					
Primary	19.7	32.0	23.2	19.0	17.0
Secondary[e]	10.0	[r]18.0	18.5	15.6	15.0
Total[e]	29.7	[r]50.0	41.7	34.6	32.0
Australia:					
Primary	204.0	215.6	200.5	207.7	218.8
Secondary	35.1	42.0	32.6	31.5	28.3
Total	239.1	257.6	233.1	239.2	247.1

See footnotes at end of table.

Table 33.—Lead: World refined production, by country[1] —Continued

(Thousand metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Austria:					
Primary	r5.6	r6.0	5.4	3.3	3.0
Secondary	r9.3	r10.8	11.5	12.8	13.0
Total	r14.9	r16.8	16.9	16.1	16.0
Belgium:					
Primary	r74.0	65.2	75.9	71.9	65.7
Secondary	r51.0	r48.2	52.0	36.0	36.0
Total	r125.0	r113.4	127.9	107.9	101.7
Brazil:					
Primary	r47.2	55.1	44.5	34.7	21.9
Secondary	33.2	43.0	40.4	31.1	26.3
Total	r80.4	98.1	84.9	65.8	48.2
Bulgaria:					
Primary[e]	115.0	115.0	115.0	115.0	115.0
Secondary[e]	5.0	4.0	4.0	4.0	4.0
Total[e]	120.0	119.0	119.0	119.0	119.0
Burma:					
Primary[e]	5.1	6.0	5.7	4.1	7.8
Secondary[e]	.2	.2	.2	.2	.2
Total[e]	5.3	6.2	5.9	4.3	8.0
Canada:					
Primary	194.1	183.9	162.5	168.5	173.5
Secondary	51.8	68.5	72.1	69.7	68.4
Total	245.9	252.4	234.6	238.2	241.9
China:					
Primary[e]	140.0	150.0	150.0	150.0	150.0
Secondary[e]	20.0	20.0	20.0	20.0	20.0
Total[e]	160.0	170.0	170.0	170.0	170.0
Colombia: Secondary[e]	2.0	2.5	3.0	3.0	3.0
Cyprus: Secondary[e]	2.5	2.5	2.5	2.5	2.5
Czechoslovakia: Secondary	19.0	19.0	20.0	21.0	21.0
Denmark: Secondary	26.2	29.8	24.5	26.5	26.5
Finland: Secondary	3.0	3.0	3.2	4.5	[2]4.4
France:					
Primary	208.5	219.7	218.8	228.0	220.0
Secondary	82.3	90.6	92.0	93.0	90.0
Total	290.8	310.3	310.8	321.0	310.0
German Democratic Republic: Secondary[e]	r45.0	r42.0	42.0	45.0	45.0
Germany, Federal Republic of:					
Primary	189.9	194.8	191.1	189.5	190.3
Secondary	179.1	178.5	159.2	158.8	158.0
Total	369.0	373.3	350.3	348.3	348.3
Greece:					
Primary	15.6	15.6	21.1	21.0	21.0
Secondary	5.6	6.0	4.0	4.0	4.0
Total	21.2	21.6	25.1	25.0	25.0
Hungary: Secondary	.1	.1	.1	.1	.1
India:					
Primary	10.1	9.8	14.9	14.3	14.4
Secondary	10.9	10.8	10.7	11.1	8.8
Total	21.0	20.6	25.6	25.4	23.2
Ireland: Secondary[e]	2.1	5.0	7.0	6.8	12.8

See footnotes at end of table.

Table 33.—Lead: World refined production, by country[1] —Continued

(Thousand metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Italy:					
Primary	31.1	26.8	42.0	38.0	30.0
Secondary	85.1	101.0	91.6	92.0	90.0
Total	116.2	127.8	133.6	130.0	120.0
Jamaica: Secondary[e]	2.0	2.0	2.0	1.0	1.0
Japan:					
Primary	186.1	176.3	175.1	175.4	183.3
Secondary	105.0	106.4	129.8	141.6	118.5
Total	291.1	282.7	304.9	317.0	301.8
Korea, North:					
Primary[e]	70.0	65.0	65.0	65.0	65.0
Secondary[e]	5.0	5.0	5.0	5.0	5.0
Total[e]	75.0	70.0	70.0	70.0	70.0
Korea, Republic of:					
Primary	7.2	7.6	5.5	9.3	10.0
Secondary[e]	1.0	5.8	1.3	7.2	6.0
Total[e]	8.2	13.4	6.8	16.5	16.0
Malaysia: Secondary[e]	2.0	2.1	5.2	3.5	3.6
Mexico:					
Primary	159.3	167.1	140.3	150.5	145.3
Secondary	49.3	50.0	50.0	50.0	50.0
Total	208.6	217.1	190.3	200.5	195.3
Morocco:					
Primary	28.5	35.2	40.3	40.0	35.0
Secondary	1.5	1.5	2.1	2.1	2.0
Total	30.0	36.7	42.4	42.1	37.0
Namibia: Primary	39.5	41.7	42.7	41.7	40.6
Netherlands:					
Primary	18.2	16.4	13.9	7.0	10.5
Secondary	13.7	[r]13.7	13.8	12.7	16.0
Total	31.9	[r]30.1	27.7	19.7	26.5
New Zealand: Secondary[e]	[r]8.0	[r]9.0	7.0	7.0	7.0
Nigeria: Secondary[e]	--	1.5	2.0	2.0	2.0
Norway: Secondary	.9	.4	.4	--	--
Pakistan: Secondary[e]	1.5	1.5	1.0	1.0	1.0
Peru:					
Primary	74.2	[r]85.7	79.9	79.2	75.5
Secondary[e]	5.0	5.0	5.0	5.0	5.0
Total[e]	79.2	[r]90.7	84.9	84.2	80.5
Philippines: Secondary	3.5	1.9	4.8	4.0	4.0
Poland:					
Primary	61.7	59.2	58.0	47.0	55.0
Secondary[e]	25.0	25.0	24.0	22.0	23.8
Total[e]	86.7	84.2	82.0	69.0	78.8
Portugal:					
Primary	.1	--	--	--	--
Secondary	.2	(3)	1.0	.9	.9
Total	.3	(3)	1.0	.9	.9
Romania:					
Primary[e]	34.0	30.9	34.9	35.0	35.0
Secondary[e]	8.8	10.0	6.0	6.0	6.0
Total[e]	42.8	40.9	40.9	41.0	41.0
South Africa, Republic of: Secondary	23.6	23.3	35.4	25.4	24.0

See footnotes at end of table.

Table 33.—Lead: World refined production, by country[1] —Continued

(Thousand metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Spain:					
Primary	83.4	87.2	83.3	77.0	70.0
Secondary	38.8	39.8	37.4	39.6	30.0
Total	122.2	127.0	120.7	116.6	100.0
Sweden:					
Primary	26.9	22.7	20.3	17.6	17.6
Secondary	18.1	18.9	22.0	10.0	10.0
Total	45.0	41.6	42.3	27.6	27.6
Switzerland: Secondary[e]	5.0	5.0	7.0	7.2	7.0
Taiwan: Secondary[e]	14.0	20.0	16.8	17.0	15.0
Thailand: Secondary	1.1	.8	1.7	1.8	1.8
Trinidad and Tobago: Secondary[e]	2.0	2.0	2.0	2.0	2.0
Tunisia:					
Primary	16.1	16.2	19.2	17.5	15.3
Secondary[e]	.5	.6	.6	.5	.5
Total[e]	16.6	16.8	19.8	18.0	15.8
Turkey:					
Primary	2.0	4.9	6.5	4.8	4.8
Secondary	1.0	1.0	1.2	1.2	1.2
Total	3.0	5.9	7.7	6.0	6.0
U.S.S.R.:					
Primary[e]	410.0	[r]415.0	420.0	425.0	430.0
Secondary[e]	210.0	215.0	215.0	220.0	220.0
Total[e]	620.0	[r]630.0	635.0	645.0	650.0
United Kingdom:					
Primary	122.8	124.1	113.4	135.4	125.0
Secondary	223.0	244.2	211.4	198.0	168.4
Total	345.8	368.3	324.8	333.4	293.4
United States:					
Primary	[r]568.1	[r]578.2	548.4	498.3	516.8
Secondary	769.2	801.4	675.6	641.1	571.3
Total	[r]1,337.3	[r]1,379.6	1,224.0	1,139.4	1,088.1
Venezuela: Secondary[e]	9.0	10.0	10.0	10.0	10.0
Yugoslavia:					
Primary	100.3	92.0	84.7	73.9	71.0
Secondary	16.4	19.0	17.0	12.5	10.2
Total	116.7	111.0	101.7	86.4	[2]81.2
Zambia: Primary	12.9	12.8	10.0	9.9	9.5
Grand total	[r]5,523.8	[r]5,721.0	5,456.6	5,321.0	5,164.1
Of which:					
Primary	[r]3,281.2	[r]3,333.7	3,232.0	3,174.5	3,163.6
Secondary	[r]2,242.6	[r]2,387.3	2,224.6	2,146.5	2,000.5

[e]Estimated. [p]Preliminary. [r]Revised.

[1]Table includes data available through June 14, 1983. Data included represent the total output of refined lead by each country, whether derived from ores and concentrates (primary) or scrap (secondary), and include the lead content of antimonial lead, but exclude, to the extent possible, simple remelting of scrap, particularly new scrap, unless otherwise noted.

[2]Reported figure.

[3]Less than 1/2 unit.

Lime

By J. W. Pressler[1]

Lime output in 1982, including that for Puerto Rico, was 14.1 million short tons, a decrease of 25% compared with that of 1981, and the lowest since 1962. Total value was $698 million, a 21% decrease compared with that of 1981.

In 1982, output of agricultural lime decreased 36%, chemical and industrial lime decreased 27%, refractory lime decreased 23%, and construction lime decreased 3% from 1981 levels.

Domestic Data Coverage.—Domestic production data for lime are developed by the Bureau of Mines from two separate, voluntary surveys of U.S. operations. Typical of these surveys is the annual Lime survey. Of the 148 operations to which the annual survey request was sent, 100% responded, representing 100% of the total production shown in tables 1 and 2.

Table 1.—Salient lime statistics in the United States[1]

(Thousand short tons unless otherwise specified)

	1978	1979	1980	1981	1982
Number of plants	155	154	153	150	147
Sold or used by producers:					
Quicklime	16,845	17,553	15,972	16,142	11,701
Hydrated lime	2,582	2,599	2,544	2,279	2,037
Dead-burned dolomite	1,016	793	494	435	337
Total	20,443	20,945	19,010	18,856	14,075
Value[2] thousands	$749,667	$862,459	$842,922	$884,197	$696,207
Average value per ton	$36.67	$41.18	$44.34	$46.89	$49.46
Lime sold	15,062	15,423	13,809	14,271	10,856
Lime used	5,381	5,522	5,201	4,585	3,219
Exports[3]	45	45	42	28	23
Imports for consumption[3]	610	640	480	504	348

[1]Excludes regenerated lime. Excludes Puerto Rico.
[2]Selling value, f.o.b. plant, excluding cost of containers.
[3]U.S. Bureau of the Census.

DOMESTIC PRODUCTION

Lime producers sold or used 14.1 million tons in 1982, compared with 18.9 million tons in 1981. Commercial sales of lime decreased 24% in 1982 to 10.9 million tons. Captive lime used by producers continued its long decline with a 30% reduction in 1982 to 3.2 million tons. This was a 56% decrease from the record year of 1971.

In 1982, production of quicklime decreased 27% to 12.0 million tons. Production of hydrated lime decreased 10% to 2.1 million tons. Production of dead-burned dolomite decreased 23%, 86% below the 1956 record level of 2.4 million tons.

In 1982, five States—Ohio, Missouri, Kentucky, Pennsylvania, and Texas—accounted for 48% of the total output. Compared with that of 1981, production decreased 40% in Ohio, 23% in Pennsylvania, 21% in Missouri, 19% in Texas, and 6% in Kentucky.

Table 2.—Lime sold or used by producers in the United States, by State[1]

(Thousand short tons and thousand dollars unless otherwise specified)

State	1981 Plants	1981 Hydrated	1981 Quicklime	1981 Total[2]	1981 Value	1982 Plants	1982 Hydrated	1982 Quicklime	1982 Total[2]	1982 Value
Alabama	5	124	1,095	1,219	59,454	5	109	799	907	42,380
Arizona	6	--	538	538	29,913	5	--	326	326	17,080
Arkansas, Louisiana, New Mexico, Oklahoma	8	147	386	533	30,416	8	125	260	385	22,481
California	12	W	W	472	26,834	12	W	W	364	23,000
Colorado, Nevada, Wyoming	13	67	382	449	19,921	12	53	258	311	15,761
Connecticut	1	11	5	16	1,190	1	2	6	8	568
Florida	3	W	W	191	11,343	3	W	W	103	5,828
Hawaii, Idaho, Oregon, Washington	8	27	409	436	23,658	8	24	387	412	21,239
Illinois, Indiana, Missouri	8	452	3,198	3,650	156,684	8	401	2,223	2,623	116,619
Iowa, Kansas, Nebraska, North Dakota, South Dakota	9	53	306	359	14,021	10	41	246	288	13,221
Kentucky, New York, Tennessee, West Virginia	8	64	2,280	2,344	100,752	7	64	2,067	2,130	102,898
Maryland	1	4	5	9	441	1	4	3	7	396
Massachusetts	2	14	156	170	10,793	2	15	120	135	9,414
Michigan	8	W	W	807	36,800	8	W	W	571	26,823
Minnesota	4	--	155	155	3,818	4	--	133	133	4,694
Montana	3	--	194	194	7,621	3	--	45	45	2,331
Ohio	15	119	2,648	2,767	127,751	14	98	1,568	1,666	76,370
Pennsylvania	10	335	1,355	1,690	85,418	10	297	1,000	1,297	70,902
Puerto Rico	1	32	2	34	3,884	1	35	2	37	1,906
Texas	10	573	819	1,393	67,158	10	532	592	1,125	62,277
Utah	4	W	W	333	16,679	4	W	W	286	15,121
Virginia	7	100	704	804	35,984	7	113	529	641	29,118
Wisconsin	5	98	229	326	17,548	5	85	227	312	17,685
Other[3]	(4)	91	1,713	(4)	(4)	(4)	74	1,248	(4)	(4)
Total[2]	151	2,311	16,579	18,890	888,081	148	2,072	12,039	14,112	698,112

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Excludes regenerated lime. Includes Puerto Rico.
[2]Data may not add to totals shown because of independent rounding.
[3]Includes States indicated by symbol W and exports.
[4]Included with data for each individual State.

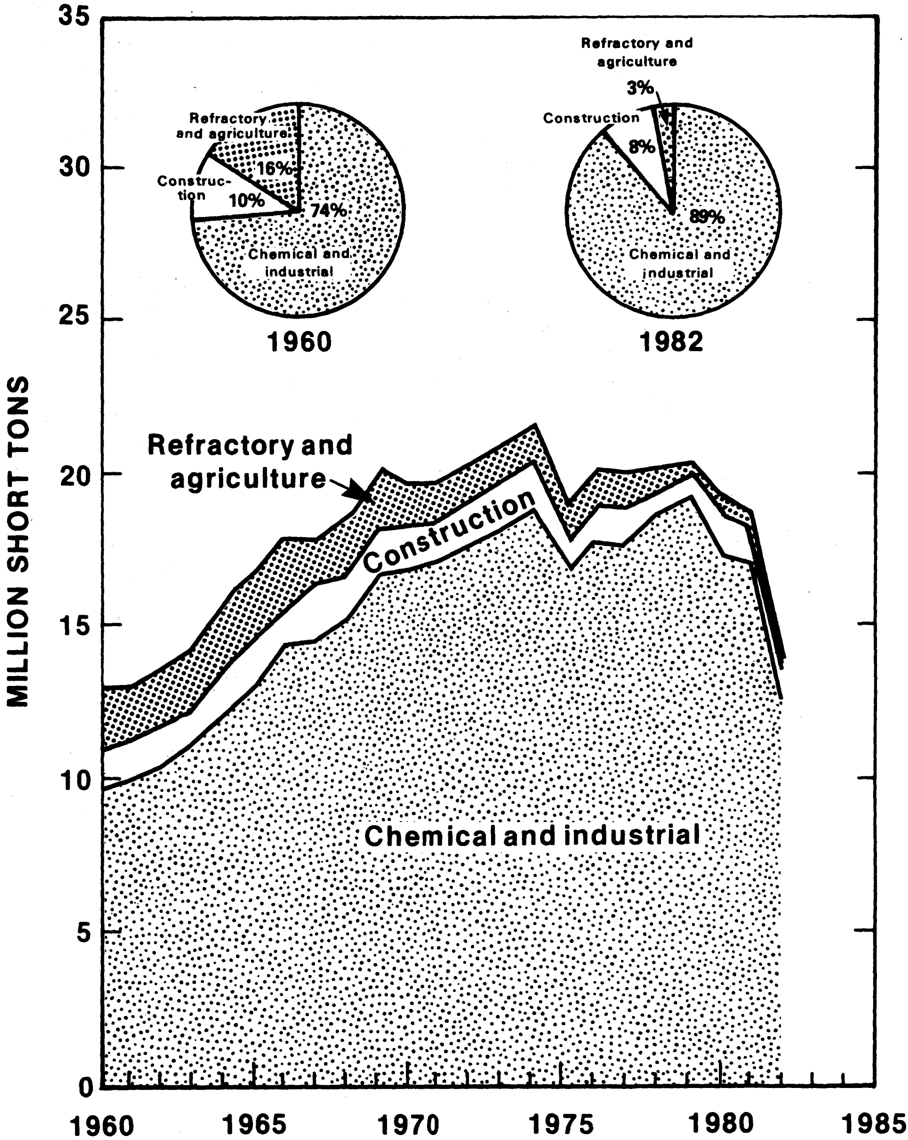

Figure 1.—Trends in major uses of lime.

Leading producing companies in 1982 were Dravo Lime Co. with one plant each in Alabama, Kentucky, Louisiana, and Texas; Marblehead Lime Co., with two plants in Illinois and one each in Indiana, Michigan, Pennsylvania, and Utah; Mississippi Lime Co. in Missouri; Martin Marietta Corp., Chemical Div., in Alabama and two plants in Ohio; Genstar Cement & Lime Co. with two plants in California, two in Nevada, and one each in Arizona, Utah, and Virginia; Allied Chemical Corp. in New York; Bethlehem Steel Corp. with two plants in Pennsylvania; Rangaire Corp. with one plant each in Arkansas, Pennsylvania, Texas, and Virginia; Black River Lime Co. in Kentucky; and Allied Products Co. with two plants in Alabama. These 10 companies, operating 31 plants, accounted for 51% of the total 1982 lime production.

In 1982, the four largest lime plants, each producing more than 400,000 tons, accounted for 22% of the total lime output. Sixteen plants produced more than 200,000 tons each and accounted for 44% of the total.

Leading individual plants in 1982 were Mississippi Lime's Ste. Genevieve plant in Missouri, Dravo Lime's Maysville plant in Kentucky, Allied Chemical's Syracuse plant in New York, Black River Lime's Carntown plant in Kentucky, and Marblehead Lime's Buffington plant in Indiana.

A total of 389 lime kilns were operated during 1982. Twelve sugar companies operated 41 plants with 56 shaft kilns and 1 rotary kiln, and produced 701,000 tons of lime valued at $32.6 million in 1982. The balance of the lime industry, not including the paper and pulp industry, operated 332 kilns during 1982: 176 vertical kilns, 176 rotary kilns, 12 Calcimatic traveling-hearth kilns, 4 fluidized-bed kilns, 2 Maerz vertical kilns, 2 traveling-grate rotary kilns, and 1 Ellernan kiln.

Hydrators for the production of hydrated lime, including the sugar industry, totaled 110 during 1982: 95 were of the continuous type, and 15 were of the batch type.

In 1982, the number of lime plants in the United States and Puerto Rico decreased by 3 to 148, and the average production per plant, excluding the sugar industry average of 17,100 tons per year, was 125,300 tons per year.

New Plants.—In spite of the bleak economic picture for the lime industry, three companies increased their capacity in 1982. Chemical Lime Co., Inc., of Clifton, Tex., placed its new Maerz-Warwick vertical-shaft, parallel-flow lime kiln in operation in October 1982. Rated at 600 tons per day of quicklime, a programmable computer controlled the kiln's production of soft-burned, high-calcium lime for chemical and road stabilization use. It was the first coal-fired vertical kiln in the United States and had a standby system for natural gas. The kiln's energy consumption was 3.2 million British thermal units (Btu) per ton of quicklime production, less than one-half of the industry average. Chemical Lime was also constructing a second 600-ton-per-day Maerz-Warwick kiln at Marble Falls, Tex., for calcining high-magnesium limestone, estimated to be onstream at yearend 1983. Dolomitic lime was to be produced for use in the production of refractory magnesite. Unique to the Clifton plant was the 1,000-ton-per-hour skid-mounted primary 48-inch Gundlach-Rexnord roll crusher that can accept 4-foot feed with reduction to 5 inches. Together with its two original rotary kilns at Clifton, the estimated lime production capacity of Chemical Lime operations was about 1,800 tons per day, the largest in Texas.

Continental Lime, Inc., a subsidiary of Steel Bros. Canada Ltd., operated two lime plants in Delta, Utah, and Tacoma, Wash., and also placed into operation in late 1982 a new plant in Townsend, Broadwater County, Mont. The Kennedy Van Saun rotary kiln with a Steel Bros. preheater had a capacity of 400 tons per day of quicklime. Original markets included The Anaconda Copper Company at Butte, Mont., which had shut down its lime kiln permanently in November 1981 and purchased commercial lime for their metallurgical operations until early 1983, when the complete plant was shut down. Continental Lime's other markets included the pulp and paper and metallurgical industries of the Pacific Northwest.

Chesapeake Corp. of Virginia awarded a $1.0 million contract to Allis-Chalmers Corp. for the recovery and regeneration of quicklime from the Kraft process slurry at its pulp mill at West Point, Va. A 10-1/2-foot-diameter by 265-foot-long rotary kiln, tube coolers, and ancillary equipment was to be installed for the recycling of 180 tons per day of lime.[2]

Expansions and Changes.—United States Gypsum Co.'s New Braunfels lime plant in Comal County, Tex., initiated operation of its new lime kiln in late 1982. The 600-ton-per-day Kennedy Van Saun 13-1/2-foot-diameter by 175-foot-long rotary kiln with a Polygon preheater consumes about 5 million Btu per ton of quicklime production. A Corson pressure hydrator was also installed for production of hydrated lime for the construction industry. St. Clair Lime Co. of Sallisaw, Okla., increased the capacity from 350 to 500 tons per day of its Marble City plant in Sequoyah County by installation of 6-inch refractory brick replacement of the 9-inch refractory lining of its alloy steel preheaters on its No. 1 and No. 2 kilns, and an improved drive train. With these improvements, St. Clair Lime was able to calcine limestone ranging from 3/8- to 2-1/2-inch size with its coal-fired rotaries, which had a natural gas backup system.[3]

Steetley Resources, Inc., of Woodville, Ohio, purchased the J. E. Baker Co.'s Millersville dolomitic lime and dead-burned dolomite plant in Sandusky County, Ohio, which had been closed in October 1982. In January 1982, Martin Marietta purchased the Woodville Lime & Chemical Co.'s Woodville lime plant in Sandusky County, Ohio. Valley Mineral Products Corp.'s lime plant in Bonne Terre, Mo., was sold to North American Refractories Corp. in January 1982.

Reflecting the depressed industry, several lime plants were closed during 1982. Sierra Chemical Co.'s plant in Caselton, Nev., was inactive, and reported sold in May 1982. Bethlehem Steel's Lackawanna lime kiln in Erie County, N.Y., was permanently closed in November 1981, inactive in 1982, and reported as up for sale in early 1983. United States Steel Corp.'s Lorain lime kiln in Lorain County, Ohio, was shut down in September 1981 and was dormant in 1982. Domtar Industries, Inc., permanently closed its Bellefonte plant in Centre County, Pa. Greer Lime Co. closed its Saltville plant in Smyth County, Va. Other lime plants either closed or idle, all or part of 1982, included Amstar Corp., with plants in Chandler, Ariz., Spreckels, Calif., and Woodland, Calif.; Reynolds Metals Co.'s plant in Hurricane Creek, Ark.; Phelps Dodge Corp.'s Morenci plant in Arizona; CF&I Steel Corp.'s Pueblo plant in Colorado; Basic, Inc.'s Port St. Joe plant in Florida; and S. I. Lime Co.'s Morgan City plant in Louisiana.

As reported by the National Lime Association, direct fuel sources for the commercial lime industry through 1982 were coal, 77.6%; natural gas, 15.2%; petroleum coke, 5.6%; and oil, 1.6%. Compared with 1980 fuel consumption, improvements were made through 1982 with a 38% reduction in the use of natural gas and a 25% increase in the use of coal and coke.

Table 3.—Lime sold or used by producers in the United States, by size of plant[1]

Size of plant	1981			1982		
	Plants	Quantity (thousand short tons)	Percent of total	Plants	Quantity (thousand short tons)	Percent of total
Less than 10,000 tons	12	77	(2)	21	116	1
10,000 to 25,000 tons	26	420	2	30	495	4
25,000 to 50,000 tons	25	837	4	24	867	6
50,000 to 100,000 tons	27	1,925	10	26	1,920	14
100,000 to 200,000 tons	28	4,057	21	31	4,523	32
200,000 to 400,000 tons	26	6,590	35	12	3,156	22
More than 400,000 tons	7	4,983	26	4	3,035	22
Total[3]	151	18,890	100	148	14,112	100

[1]Excludes regenerated lime. Includes Puerto Rico.
[2]Less than 1/2 unit.
[3]Data may not add to totals shown because of independent rounding.

CONSUMPTION AND USES

Lime was consumed in every State. Leading consuming States were Pennsylvania, Ohio, Indiana, Texas, Michigan, and New York, each of which consumed around 1 million tons. These six States accounted for 50% of the total lime consumed. Twenty-seven plants in 13 States produced dolomite quicklime or dead-burned dolomite, and represented about 19% of the lime industry.

Lime consumption in the steel industry decreased 39% in 1982 to 4.8 million tons, and equaled 34% of all lime consumed in the United States. Low housing and building starts during 1982 caused decreases in the sales of mason's and finishing lime, 2% and 13%, respectively. Environmental uses of lime continued to increase. Lime consumption in flue gas desulfurization processes and effluent water cleanup increased 8% during 1982.

Leading quicklime-consuming States in 1982 were Pennsylvania, Ohio, and Indiana, each of which consumed more than 1 million tons. These three States accounted for 32% of the total quicklime consumed.

Leading hydrate-consuming States in 1982 were Texas, Pennsylvania, Illinois, Ohio, and Louisiana, each of which consumed more than 100,000 tons. These five States accounted for 51% of the total hydrate consumed.

Lime sold by producers in 1982 was utilized for chemical and industrial uses, 87%; construction, 10%; refractories, 3%; and agriculture, less than 1%. Captive lime used by producers was 23% of the total, compared with 24% in 1981. Captive lime was used mainly in the production of basic oxygen furnace (BOF) steel, 25%; sugar, 22%; and alkalies, 20%.

Leading individual uses for lime in 1982 were for BOF steel, water purification, paper and pulp, sulfur removal from stack gases, electric steel, and sugar refining, which together accounted for 61% of the total consumption.

Table 4.—Destination of shipments of lime sold or used by producers in the United States, by State[1]

(Thousand short tons)

State	1981			1982		
	Quicklime	Hydrated lime	Total[2]	Quicklime	Hydrated lime	Total[2]
Alabama	587	54	642	369	47	416
Alaska	W	W	1	W	W	23
Arizona	347	18	365	206	17	223
Arkansas	149	27	176	94	30	124
California	647	82	729	448	62	511
Colorado	249	14	264	135	13	148
Connecticut	16	13	29	25	11	36
Delaware	36	6	41	30	5	35
District of Columbia	W	W	9	W	W	10
Florida	427	58	485	287	37	324
Georgia	179	27	206	193	36	229
Hawaii	1	7	8	1	5	5
Idaho	120	4	124	116	2	118
Illinois	740	117	857	483	103	586
Indiana	1,843	48	1,891	1,272	42	1,314
Iowa	100	17	117	70	16	86
Kansas	74	15	89	65	15	79
Kentucky	453	23	476	387	16	403
Louisiana	182	127	309	144	101	245
Maine	31	(3)	32	15	(3)	15
Maryland	365	23	388	316	17	333
Massachusetts	84	17	101	50	13	63
Michigan	1,303	24	1,327	980	28	1,008
Minnesota	237	15	251	219	12	231
Mississippi	111	44	155	111	55	166
Missouri	146	63	209	123	33	156
Montana	238	7	245	67	6	73
Nebraska	94	5	99	56	5	61
Nevada	52	7	59	73	5	79
New Hampshire	W	W	2	W	W	3
New Jersey	103	44	147	82	41	124
New Mexico	114	28	142	68	30	98
New York	748	48	796	597	44	641
North Carolina	141	24	166	163	23	186
North Dakota	87	6	93	100	5	105
Ohio	1,930	150	2,080	1,296	102	1,398
Oklahoma	100	20	119	79	15	94
Oregon	89	10	99	85	8	93
Pennsylvania	2,086	206	2,292	1,315	195	1,509
Rhode Island	4	3	7	4	2	7
South Carolina	120	21	141	79	15	95
South Dakota	7	15	22	11	10	21
Tennessee	159	65	224	147	66	213
Texas	890	577	1,466	614	551	1,165
Utah	175	12	187	172	9	181
Vermont	W	W	3	W	W	1
Virginia	137	72	209	121	82	202
Washington	248	14	262	226	13	240
West Virginia	426	26	453	328	26	355
Wisconsin	118	51	169	109	45	155
Wyoming	53	12	65	62	9	71
Other[4]	14	27	26	35	30	28
Total United States[2]	16,561	2,293	18,855	12,028	2,055	14,083
Exports:						
Canada	12	7	19	7	6	13
Mexico	3	--	3	2	--	2
Other countries	2	10	13	2	12	14
Total exports[2]	18	17	35	11	18	29
Grand total[2]	16,579	2,311	18,890	12,039	2,072	14,112

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Excludes regenerated lime. Includes Puerto Rico.
[2]Data may not add to totals shown because of independent rounding.
[3]Less than 1/2 unit.
[4]Includes Puerto Rico and States indicated by symbol W.

Table 5.—Lime sold or used by producers in the United States, by use[1]

(Thousand short tons and thousand dollars)

Use	1981				1982			
	Sold	Used	Total[2]	Value	Sold	Used	Total[2]	Value
Agriculture	74	--	74	3,595	47	--	47	2,541
Construction:								
Road stabilization	528	--	528	28,500	532	--	532	27,364
Soil stabilization	230	--	230	12,384	220	--	220	13,666
Mason's lime	185	32	217	11,695	179	33	212	13,432
Finishing lime	159	--	159	8,556	138	--	138	10,863
Other	17	27	43	2,343	21	17	38	2,199
Total[2]	1,118	59	1,176	63,478	1,090	49	1,140	67,523
Chemical and industrial:								
Steel, BOF	4,806	1,300	6,107	282,974	2,838	800	3,638	165,870
Water purification	1,422	5	1,427	66,119	1,318	12	1,331	65,435
Paper and pulp	1,079	110	1,189	55,117	990	105	1,096	55,644
Sulfur removal	908	--	908	42.090	996	--	996	48,787
Steel, electric	1,071	147	1,218	56,453	714	61	775	38,814
Sugar refining	54	888	941	43,618	50	719	769	38,267
Alkalies	3	836	839	38,886	14	647	661	33,051
Sewage treatment	849	7	855	39,640	586	6	592	30,983
Magnesia from seawater or brine	W	W	562	26,029	W	W	417	19,610
Copper ore concentration	376	278	654	30,301	240	122	363	18,866
Steel, open-hearth	493	55	547	25,365	338	21	359	16,799
Acid water, mine or plant	233	--	233	10,799	237	--	237	12,567
Calcium carbide	178	70	248	11,491	158	51	209	8,738
Aluminum and bauxite	163	103	266	12,309	97	87	184	10,217
Magnesium metal	11	155	167	7,723	10	147	156	2,833
Glass	167	--	167	7,734	140	--	140	6,375
Precipitated calcium carbonate	64	41	105	4,866	74	30	104	5,233
Petrochemicals	93	--	93	4,334	56	--	56	3,816
Oil and grease	37	--	37	1,707	47	--	47	2,525
Ore concentration, other	63	--	63	2,904	45	--	45	1,910
Oil well drilling	38	--	38	1,744	31	--	31	2,075
Food products, animal or human	37	--	37	1,714	31	--	31	1,709
Metallurgy, other	45	--	45	2,102	26	(3)	26	1,213
Citric acid	--	--	--	--	--	21	21	1,455
Petroleum refining	44	--	44	2,029	21	--	21	1,154
Tanning	18	--	18	854	19	--	19	1,126
Calcium silicate	3	--	3	143	7	--	7	346
Fertilizer	5	--	5	225	6	--	6	434
Gelatin	6	--	6	263	5	--	5	348
Paint	3	--	3	121	2	--	2	109
Brick, sand-lime	4	--	4	185	4	--	4	235
Wire drawing	17	--	17	786	1	(3)	1	84
Other[4]	r466	452	r358	16,594	358	299	240	12,283
Total[2]	12,757	4,447	17,204	797,220	9,460	3,128	12,589	608,911
Refractory dolomite	356	79	435	23,789	296	41	337	19,136
Grand total[2]	14,305	4,585	18,890	888,081	10,893	3,219	14,112	698,112

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Excludes regenerated lime. Includes Puerto Rico.
[2]Data may not add to totals shown because of independent rounding.
[3]Less than 1/2 unit.
[4]Includes asphalt fillers, briquetting, coke and gas, chrome, desiccants, fiberglass, glue, insecticides, ladle desulfurizing, manganese, pharmaceuticals, rubber, silica brick, starfish control, and uses indicated by symbol W.

Of the main chemical and industrial uses in 1982, lime for BOF's was produced principally in Indiana and Illinois combined, 31%; Ohio, 20%; and Pennsylvania, 12%. Lime for water purification was produced mainly in Missouri, 30%; Texas, 9%; and Pennsylvania and Alabama, 8% each. Lime used for paper and pulp, excluding regenerated lime, was produced mainly in Alabama, 27%; Virginia, 16%; Texas, 13%; and Wisconsin, 12%. Lime for sulfur removal from stack gases was principally produced in the Eastern United States. Lime for electric steel was principally produced in Pennsylvania, 23%; Ohio, 16%; Texas, 15%; and Alabama, 8%. Lime for sugar refining was produced mainly in Minnesota, 17%; California, 15%; and Idaho, 13%.

Mason's lime was produced at 28 plants in 15 States, including Puerto Rico. Leading States were Pennsylvania, 23%, with three plants, and Wisconsin, 23%, with four plants. Finishing lime was produced in nine plants in eight States; the leading State was

Ohio with two plants.

The use of lime in agriculture decreased 36% to about 47,000 tons in 1982, continuing its long-term decline. Compared with its high of 252,000 tons per year in 1956, it has become of small significance. Conversely, the less-active, pulverized limestone continued its long-term upward consumption trend with 29 million tons used in 1981.

PRICES

The average value of lime sold or used by producers increased 5% in 1982 to $49.47 per ton, an increase of 184% over the 1973 price. Values ranged from $48.37 for chemical and industrial lime to $59.25 for construction lime, $56.78 for refractory dolomite, and $54.49 for lime used in agriculture.

Values for quicklime sold ranged from $47.54 for chemical lime to $51.32 for construction lime, $34.60 for lime used in agriculture, and $84.00 for dead-burned dolomite, and averaged $47.91, an increase of 3% over the 1981 value.

Values for hydrated lime sold ranged from $61.66 for construction lime to $55.58 for chemical lime and $59.59 for lime used in agriculture, and averaged $58.32, an increase of 9% over the 1981 price.

FOREIGN TRADE

Exports of lime in 1982 decreased 21% to 22,500 tons, 67% below the 1968 record. Of the total exports, Canada received 47%; Mexico, 20%; Panama, 9%; and Guyana, 7%. The remaining 17% went to 37 countries, with order of shipments as follows: the Bahamas, Bermuda, the Philippines, the Windward Islands, Saudi Arabia, Colombia, Denmark, Japan, Peru, the Republic of South Africa, Brazil, Venezuela, Kuwait, the United Kingdom, Bahrain, Australia, Nigeria, Guatemala, the Federal Republic of Germany, the Netherlands Antilles, Norway, the Republic of Korea, the Trust Pacific Islands, Haiti, Belgium, Angola, Pakistan, Ecuador, the Turks and Caicos Islands, India, Belize, Barbados, Libya, Suriname, Argentina, New Zealand, and Honduras.

Imports, principally from Canada, 91%, and Mexico, 9%, were 348,374 tons, a decrease of 31% compared with that of 1981. Net U.S. import reliance, expressed as a percentage of apparent consumption, was 2%.

Table 6.—U.S. exports of lime

	Quantity (short tons)	Value (thousands)
1979	45,421	$3,827
1980	41,843	3,990
1981	28,429	3,996
1982	22,541	3,199

Table 7.—U.S. imports for consumption of lime

	Hydrated lime		Other lime		Total[1]	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1979	85,169	$3,450	554,332	$19,165	639,500	$22,614
1980	62,423	3,129	417,792	16,044	480,215	19,173
1981	65,717	3,471	438,623	18,092	504,340	21,563
1982	60,108	3,305	288,266	13,503	348,374	16,808

[1]Data may not add to totals shown because of independent rounding.

WORLD REVIEW

Canada.—Canadian production of lime in 1982 was 2.4 million tons, a 14% decrease compared with the revised figure of 2.8 million tons for 1981. In 1981, 18 companies operated 25 lime plants in Canada, 1 in New Brunswick, 4 in Quebec, 10 in Ontario, 3 in Manitoba, 5 in Alberta, and 2 in British Columbia. Of these, six were captive plants, of which three were in the sugar industry, two were in the iron and steel industry, one was in the synthetic soda ash industry, and one was used in magnesium, calcium, and strontium production. Seven plants produced hydrated lime for road stabilization and agricultural use. In 1981, principal lime uses were iron and steel, 47%; pulp and paper, 15%; and water and sewage treatment, 5%.[4]

Canada exported 318,000 tons of lime to the United States in 1982 and supplied 91% of all U.S. lime imports. This was a decrease of 46% compared with the record year of 1979.

Indonesia.—In 1980, there were more than 6,000 lime kilns operating in Indonesia, with a combined annual production in excess of 3.3 million tons of quicklime. Many were batch primitive pot kilns, while others were continuously fired with capacities up to 30 tons per day. All had poor fuel efficiency. Fuel was wood, coconut-husks, diesel oil, rubber tires, waste oil, natural gas, coal, or any combination of these. The United Nations Industrial Development Organization completed a successful project to develop a kiln with good fuel efficiency, simple design, built entirely from indigenous materials, and of low cost.[5]

Italy.—Italian lime production, including the captive industry, was 4.3 million tons in 1981, a slight reduction from the 4.4 million tons of 1980. Hydrated lime production was 2.5 million tons, a 2.5% decrease from that of 1980. The low production levels were principally caused by the sluggish iron and steel industry. Estimates for 1982 indicated a further reduction in sales owing to the continuing malaise in the iron and steel industry, construction, and other industrial sectors.[6]

Mexico.—Mexican production of lime in 1982 was estimated at 4.4 million tons, an 11% decrease compared with that of 1981. Over three-fourths of Mexican lime was used in the housing and building construction industry. Many lime plants in Mexico were associated with cement plants because of the use of cement and lime in mortar and plaster formulations used in construction. The balance was used in iron and steel, agriculture, sugar, pulp and paper, and other. Although the Mexican Government planned to increase iron and steel industry production from the 1981 level of 8 million to 20 million tons by 1990, only minor changes were expected in its lime use pattern. The leading Mexican lime producer was Refractarios Basicos, S.A., in Monclova, Coahuila State, followed by Minera del Norte in Monterrey, Nuevo León State, and Cal Apasco, S.A., and Cal Apax, in Apasco, Mexico State.[7]

Saudi Arabia.—Until 1977, Saudi Arabian lime plants supplied lime only to sand-lime brick plants. The Saudi Sand-Lime Brick and Building Materials Co. awarded a contract in 1977 to Krupp Polysius AG of the Federal Republic of Germany for the delivery and erection of a turnkey 200-ton-per-day lime plant on the outskirts of Riyadh, consisting of two 100-ton-per-day annular shaft kilns fed by a skip hoist. The pebble quicklime was pulverized and fed through a continuous hydrator for use in an adjacent sand-lime brick plant with a capacity of 40 million bricks per year.[8]

South Africa, Republic of.—South Africa produced 2.4 million tons of lime in 1982, the same as that in 1981. Production included white hydrated lime, from Union Lime Co.'s (ULCO) plant, pulverized lime, glass, flux, stockfeed calcium supplement, and agricultural lime. Production from ULCO's Ouplaas plant included unslaked lime, hydrated lime, and limestone products including agricultural lime. Expanded lime capacity at ULCO's northern Cape plant contributed to a significant increase in sales in 1981-82. A lower rate of activity in South Africa's mining and steel industries during the year resulted in decreased lime consumption. In 1981, lime consumption by industrial sectors was mining, 37%; metallurgical, 31%; calcium carbide, 13%; soil stabilization, 7%; and other, 12%.[9]

PPC Lime Co., formerly Northern Lime Ltd., placed onstream in early 1983 a 1,650-ton-per-day rotary kiln with an Allis-Chalmers grate preheater. Completely computerized, with no central control panel, this No. 9 kiln, when added to the other eight smaller rotary kilns, made this PPC Lime unit probably the largest lime plant in the world. In 1982, ULCO of Anglo Alpha Cement Co. initiated construction and installation of a Kennedy Van Saun 1,100-ton-per-day rotary kiln with a preheater. Startup was estimated to be in late 1983.[10]

U.S.S.R.—The Volkovysk Cement and Slate Production Association increased the capacity of its lime plant in Brodno Oblast in 1982. After reconstruction, it had a capacity of 110,000 tons per year of building construction lime.[11]

Zaire.—La Générale des Carrières et des Mines (GÉCAMINES) indicated that the refinery at Kakontwe produced 113,600 metric tons of quicklime in 1980 for its own captive use. GÉCAMINES also developed a new coal-firing system for cement and lime kilns for the utilization of domestic coal from Luena.[12]

Table 8.—Quicklime and hydrated lime, including dead-burned dolomite: World production, by country[1]

(Thousand short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Algeria[e]	55	90	100	100	100
Australia[3]	981	963	992	[e]1,000	1,000
Austria	1,120	1,127	1,213	1,139	1,200
Belgium	3,846	3,697	3,554	2,973	3,000
Brazil[e]	5,100	5,200	5,300	5,500	5,500
Bulgaria	1,964	2,059	2,037	1,955	1,900
Canada	2,242	[r]2,050	2,815	2,816	[4]2,415
Chile[e]	680	700	700	660	600
Colombia[e]	1,430	1,430	1,430	1,430	1,430
Costa Rica[e]	8	10	8	12	8
Cyprus	17	[e]20	15	12	12
Czechoslovakia	3,393	3,272	3,327	3,565	3,400
Denmark	179	195	187	215	215
Dominican Republic	[e]28	42	44	[e]44	44
Egypt	110	[e]100	97	101	105
Fiji Islands	1	1	2	2	2
Finland	214	[r]484	432	422	420
France	5,071	4,266	3,979	3,710	3,750
Guatemala	49	45	39	27	28
German Democratic Republic	3,795	3,825	3,749	3,793	3,900
Germany, Federal Republic of	9,910	[r]10,183	9,452	8,708	8,800
Hungary	816	[r]787	769	834	[4]920
India[e]	220	450	440	440	440
Iran[e]	1,000	550	550	550	600
Ireland	101	[r]81	35	51	51
Israel	[e]137	[e]137	[e]137	88	88
Italy	2,360	[r]2,405	2,606	2,543	2,535
Jamaica	173	225	175	146	140
Japan	9,985	10,613	10,307	8,848	8,800
Jordan	3	4	[e]4	22	[4]61
Kenya	[e]55	30	29	[e]30	30
Korea, Republic of	[e]66	[e]66	232	[e]220	220
Kuwait	4	[e]13	13	[e]13	13
Lebanon	111	[r]132	132	67	44
Libya	243	248	254	259	250
Malta	31	33	34	[e]35	35
Martinique	--	--	--	6	6
Mauritius	9	[e]9	8	[e]8	8
Mexico	[e]4,900	[r]5,048	4,795	4,960	4,400
Mongolia	40	51	[e]55	[e]55	62
Mozambique[e]	11	11	11	11	11
New Zealand[e]	175	190	190	190	200
Nicaragua[e]	41	40	44	33	33
Norway	139	[r] [e]145	[e]145	[e]145	145
Paraguay	42	36	61	63	60
Peru	([5])	([5])	([5])	37	39
Philippines	37	59	96	94	95
Poland[6]	10,070	8,435	8,267	8,267	8,270
Portugal	286	288	298	287	275
Romania	4,031	4,221	4,203	4,189	3,900
Saudi Arabia[e]	33	165	165	190	220
South Africa, Republic of (sales)	2,067	1,897	2,407	2,380	2,370
Spain	[r]477	[r]773	1,047	1,158	1,200
Sweden	825	854	[e]880	820	880
Switzerland	75	77	71	63	65
Taiwan	211	195	219	157	160
Tanzania[e]	6	7	7	7	8
Tunisia	471	474	583	514	520
Uganda[e]	28	31	17	17	17
U.S.S.R.[e]	26,000	26,500	27,000	27,600	27,600
Uruguay	94	89	22	[e]55	[4]15
United Arab Emirates	NA	NA	49	[e]45	45
United Kingdom	3,470	3,649	3,285	[e]3,310	3,310
United States, including Puerto Rico (sold or used by producers)	20,484	20,983	19,037	18,890	[4]14,112
Venezuela	NA	NA	NA	2	2
Yugoslavia	2,265	2,647	2,628	3,186	[4]2,984
Zaire	[r]121	[r]127	125	136	136
Zambia	[e]280	[r]276	201	221	200
Total	[r]132,186	[r]132,810	131,105	129,426	123,404

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.
[1]Table includes data available through June 24, 1983.
[2]Lime is produced in many other countries besides those listed. Argentina, China, Iraq, Pakistan, Syria, and Turkey are among the more important countries for which official data are not available.
[3]Data are for years ending June 30 of that stated.
[4]Reported figure.
[5]Less than 1/2 unit.
[6]Excludes output by small producers.

TECHNOLOGY

In Sweden, it had been reported that one-fourth of the water in its national lakes and rivers have critical pH values during some periods of the year. Located on low-weathering bedrock or surrounded by lime-poor soils, deterioration of these waters from acid rain had been observed for many years. The Swedish Government initiated liming measures for restoration in 1976. The largest lake-liming project was Lake Unden, which covered 9,500 hectares in southern Sweden. Results showed up soon in the outflow water, but it was difficult to keep an acceptable pH value at high flow during a snow melt. The National Board of Fisheries, National Environment Protection Board, and the Institute of Freshwater Research, concluded that liming is a possible method of keeping poorly buffered or acidified waters alive; however, the best way to improve the water quality was stated to be to decrease sulfur emissions from refineries and powerplants for the ultimate reduction in the acid load.[13]

The sludge from municipal sewage plants in the Federal Republic of Germany had been only partly utilized in agriculture, and had been disposed of by dumping. Large-scale testing had proven that the sludge can be converted into a hygienically safe, storable product with beneficial fertilizer properties by the addition of pulverized quicklime. Tests on an experimental field showed fertilizer benefits of a lime-sludge granulate. A mixing and spreading machine was developed for the neutralization and application of the stabilized sewage sludge to a field or disposal as landfill.[14]

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Lithium

By John E. Ferrell[1]

In 1982, the United States continued as the world's largest producer and consumer of lithium minerals and chemicals. The United States was self-sufficient in this commodity and was the world's largest exporter. The worldwide recession caused a significant decline in lithium sales to its major industry markets—aluminum, glass and ceramics, and grease. Although sales declined, the two U.S. producers realized a profit in 1982.[2] Imports were insignificant in 1982. U.S. exports declined 12% and estimated apparent consumption fell 37%.

The reduction in domestic lithium demand closely paralleled the downturn in the U.S. aluminum industry, the largest domestic end user, which was operating at only 60% of its production capacity at the end of 1982.[3] The aluminum industry accounts for 33% of lithium used in the United States. In Western Europe and Japan, the glass industry is probably the largest consumer of lithium.[4]

The U.S.S.R. is the world's second largest producer of lithium minerals, although published production data are scant. The United States continued to supply about three-fourths of lithium demand in nonproducing countries; the remainder was supplied by the U.S.S.R. and China in the form of lithium chemicals and by Zimbabwe as mineral concentrate. Brazil, Portugal, and Argentina produce primarily for internal consumption. The Federal Republic of Germany and Japan are large importers of lithium chemicals, primarily lithium carbonate, which they use domestically or convert to downstream chemicals for resale to their export markets.

Domestic Data Coverage.—Domestic production data for lithium are developed by the Bureau of Mines by means of a voluntary production survey. Both of the operations to which a survey request was made responded, representing 100% of the total production data. However, because of the small survey size, production and stock data were withheld from publication in table 1 to avoid disclosing individual company proprietary data.

Table 1.—Salient lithium statistics

(Short tons of contained lithium)

	1978	1979	1980	1981	1982
United States:					
Production[1]	W	W	W	W	W
Yearend producers' stocks[1]	W	W	W	W	W
Imports[1]	10	50	90	150	30
Shipments of Government stockpile surplus[2]	5	--	--	--	14
Supply[1 3]	6,300	6,300	6,200	6,700	5,000
Supply[e 2 4]	5,400	5,600	5,500	5,800	4,300
Exports[e 2]	2,000	2,400	2,500	2,600	2,300
Apparent consumption[e 2]	3,400	3,200	3,000	3,200	2,000
Rest of world: Production[e 1]	2,000	2,250	2,250	2,250	2,000

[e]Estimated. W Withheld to avoid disclosing company proprietary data.
[1]Mineral concentrate.
[2]Chemicals.
[3]Production plus inventory decrease.
[4]A 15% loss was assumed in converting supply from mineral concentrate to the chemical form. Changes in producers' inventories of lithium chemicals were unknown and were assumed to be zero. An estimated 50 short tons of imported chemicals are included.

Legislation and Government Programs.—For 1982, the General Services Administration (GSA) reported two sales of lithium hydroxide monohydrate ($LiOH{\bullet}H_2O$) from excess stocks in the National Defense Stockpile. The sales totaled 14 short tons of material depleted of lithium 6, at a price of $1.53 per pound. GSA reported stocks were 11,500 tons of virgin material and 28,485 tons (4,700 tons of contained lithium) of depleted material that may contain 8 to 9 parts per million of mercury. This material was excess from a nuclear weapons program.

Public Law 96-386, October 1980, could encourage the consumption of lithium in the future. This law provides for an accelerated research and development program on magnetic fusion energy technologies. The program, as presently planned, would require large quantities of lithium to convert the fusion energy to heat energy for electricity generation.

DOMESTIC PRODUCTION

Two companies produced lithium products in the United States in 1982. Foote Mineral Co., 92% owned by Newmont Mining Corp., produced lithium ore from pegmatite dikes in North Carolina and lithium compounds from subsurface brines in Nevada. Lithium Corp. of America (Lithco), owned by Gulf Resources and Chemical Corp., produced lithium from pegmatite dikes in North Carolina.

Foote Mineral reported 1982 production of 9,625 tons of lithium carbonate (Li_2CO_3) equivalent (1,810 tons of contained lithium); 3,950 tons (740 tons of contained lithium) from the North Carolina plant and 5,675 tons (1,070 tons of contained lithium) from the Nevada plant.[5] Reduced production reflected the downturn of lithium markets. Foote Mineral closed its North Carolina plant from August through the remainder of the year, selling from stockpiles and the Nevada plant. Company officials indicated that the plant would reopen in March 1983, when conditions in the primary lithium markets were expected to commence recovering. Foote Mineral reported that lithium sales declined 16% in 1982 owing primarily to the reduced demand of the aluminum industry.[6] Foote Mineral's rated plant capacity remained at 17,000 tons per year of Li_2CO_3 equivalent.

Lithco reported production of 10,730 tons of Li_2CO_3 equivalent (2,015 tons of contained lithium), down 26% from that of 1981.[7] The rated annual mill capacity of Lithco's North Carolina plant was 18,000 tons of Li_2CO_3 equivalent.

CONSUMPTION AND USES

Estimated domestic consumption of lithium fell 37% owing to a severe recession experienced by the principal users—the aluminum, grease, ceramics and glass, and synthetic rubber industries. These markets are closely aligned with the construction and automobile economic sectors.

Most of the mineral concentrate was converted to lithium compounds and metal. The most widely used compound, Li_2CO_3, can be added to aluminum potlines to reduce electricity consumption and fluorine emissions. This compound is also used to produce both ground-coat and cover-coat frits for vitreous enameling of steel. For this use, lithium functions as a flux to lower firing temperatures and reduces thermal expansion to extend the life of the enamel coating.

The second most widely used lithium compound, $LiOH{\bullet}H_2O$, is used to manufacture lithium grease, which withstands temperature extremes better than most other greases. Less widely consumed lithium compounds include lithium bromide, which is used in absorption refrigeration air conditioning systems; lithium chloride (LiCl), which is valued as a dehumidifying agent; and lithium hypochlorite, which serves as a sanitizer for swimming pools. Alkyllithium compounds, principally n-butyllithium, are used in synthetic rubber manufacturing.

Lithium metal for lithium batteries continued as a relatively small, but growing market. New cameras that use disk film design use a lithium battery as an integral part of the camera that may provide twice the service life of typical alkaline cells and, according to some sources, higher energy density and greater resistance to extremes of heat and cold. Disposable lithium batteries, which offer high energy density and long life, find application in calculators, flashlights, pacemakers, and memory circuits. Secondary, or rechargeable, lithium batteries have potential for use in electric vehicles and powerplant systems requiring peak load reserve energy. The U.S. Air

Force awarded a contract for the supply of lithium batteries for the Minuteman Intercontinental Ballistic Missile Program.[8]

Some mineral concentrate, possibly as much as 10% of total production, was used directly by the glass and ceramics industry. In this application, lithium acts as a powerful fluxing agent. In addition, use of lithium instead of soda or potash imparts a greater chemical durability and thermal shock resistance to the finished material.[9] Because of these intrinsic qualities, lithium mineral concentrate is preferred as a glass material in the manufacture of cathode ray tubes and sealed-beam headlights and as a ceramic material in heat-resistant cookware.

PRICES

Domestic producers' midyear prices of lithium materials were unchanged in 1982, as indicated in table 2, despite the decline in total sales.

Table 2.—Domestic midyear producers' prices of lithium and lithium compounds

(Dollars per pound)

	1981	1982
Lithium bromide, 54% brine: 2,268-pound lots, delivered in drums	3.68	3.68
Lithium carbonate, technical: Truckload lots, delivered	1.41	1.41
Lithium chloride, anhydrous, technical: Truckload lots, delivered	2.19	2.19
Lithium fluoride	4.50	4.50
Lithium hydroxide monohydrate: Truckload lots, delivered	1.84	1.84
Lithium metal ingot: 1,000-pound lots, f.o.b	20.65	20.65
Lithium sulfate, anhydrous	2.64	2.64
N-butyllithium in n-hexane (15%): 3,000-pound lots, delivered	12.75	12.75

FOREIGN TRADE

U.S. exports of lithium compounds (shown in table 3) are not completely reported in Bureau of the Census trade statistics. Li_2CO_3 exports were reported as a separate category for the first time in 1982. Overall, a comparative review of 1982 and 1981 indicates that the moderate decline in 1982 exports was far less than that which occurred in apparent domestic consumption. U.S. imports were relatively minor in both reported years.

Table 3.—U.S. exports of lithium chemicals, by compound and country

Compound and country	1981 Gross weight (pounds)	1981 Value	1982 Gross weight (pounds)	1982 Value
Lithium carbonate:[1]				
Argentina	--	--	247,480	$352,402
Brazil	--	--	55,050	73,463
Canada	--	--	602,715	859,831
Germany, Federal Republic of	--	--	6,181,611	7,064,153
Japan	--	--	2,343,220	3,019,904
Mexico	--	--	84,675	121,977
Netherlands	--	--	119,600	165,088
South Africa, Republic of	--	--	39,623	58,435
United Kingdom	--	--	132,208	148,424
Venezuela	--	--	1,083,445	1,608,957
Other	--	--	20,007	33,470
Total	--	--	10,909,634	13,506,104
Lithium hydroxide:				
Argentina	67,000	$113,797	107,247	206,877
Australia	126,700	198,752	89,600	166,660
Belgium	220,000	365,200	15,400	25,564
Brazil	940,814	1,470,091	439,699	834,632
Canada	114,250	200,317	108,423	151,442
Chile	119,565	185,397	16,520	28,051
Colombia	44,700	77,328	39,950	72,096

See footnotes at end of table.

Table 3.—U.S. exports of lithium chemicals, by compound and country —Continued

Compound and country	1981 Gross weight (pounds)	1981 Value	1982 Gross weight (pounds)	1982 Value
Lithium hydroxide —Continued				
France	201,424	$353,081	261,334	$395,224
Germany, Federal Republic of	709,150	1,058,352	854,688	1,344,064
India	154,840	230,098	118,607	203,297
Indonesia	30,000	53,479	100,000	206,456
Israel	75,100	123,394	60,391	100,266
Italy	11,000	19,075	220	3,240
Japan	1,061,318	1,835,684	807,610	1,404,672
Kenya	57,228	92,885	33,000	58,276
Korea, Republic of	29,605	47,879	61,823	104,675
Mexico	128,376	217,087	356,972	631,626
Netherlands	22,000	35,420	316,729	525,030
Peru	--	--	61,600	109,032
Philippines	23,256	40,116	81,200	143,918
Singapore	69,274	108,473	103,241	175,253
South Africa, Republic of	151,200	267,660	234,471	384,813
Spain	123,200	191,096	149,600	230,536
Sweden	31,220	44,166	--	--
United Kingdom	478,032	701,795	644,873	1,090,531
Venezuela	856,549	1,196,092	44,000	68,903
Other	r193,845	r314,833	142,888	266,309
Total	6,039,646	9,541,547	5,250,086	8,931,443
Other:				
Argentina	159,323	214,263	52,950	80,918
Australia	305,909	504,391	511,706	147,069
Belgium	38,245	78,840	12,214	48,229
Brazil	127,658	217,660	266,594	599,360
Canada	4,586,122	5,985,699	1,192,440	1,900,647
China	32,659	20,000	--	--
Colombia	20,000	38,958	12,835	39,188
France	13,593	31,815	54,459	148,996
Germany, Federal Republic of	8,473,063	9,671,592	1,669,517	1,894,869
India	20,476	42,469	204,884	367,627
Israel	35,482	87,939	3,967	40,998
Italy	22,291	193,839	33,805	155,622
Japan	5,475,111	6,954,660	2,769,895	3,924,604
Korea, Republic of	196,430	271,315	--	--
Mexico	437,343	975,566	366,685	806,083
Netherlands	65,233	138,648	44,000	53,240
Pakistan	15,794	43,291	49,116	48,515
Saudi Arabia	--	--	29,372	61,855
South Africa, Republic of	230,857	259,514	15,969	25,818
Spain	89,776	105,260	45,191	57,224
Switzerland	--	--	43,319	99,097
Taiwan	141,876	169,303	66,282	96,134
Turkey	5,839	18,254	40,311	53,173
United Kingdom	414,095	536,661	1,039,563	1,784,818
Venezuela	1,956,541	2,649,502	125,964	197,977
Other	r81,790	r205,390	86,999	158,902
Total	22,945,506	29,414,829	8,738,037	12,790,963

rRevised.
[1]Before 1982, lithium carbonate exports were included with "Other lithium compounds."

Source: U.S. Department of Commerce, Bureau of the Census.

Table 4.—U.S. imports for consumption of lithium-bearing materials, by commodity and country

Commodity and country	1981 Gross weight (pounds)	1981 Value (thousands) Customs	1981 Value (thousands) C.i.f.	1982 Gross weight (pounds)	1982 Value (thousands) Customs	1982 Value (thousands) C.i.f.
Lithium ores:						
Australia	--	--	--	12,181	(1)	$2
Canada	--	--	--	12,423	(1)	(1)
Peru	--	--	--	4,409	$2	2
Total[2]	--	--	--	29,013	3	5

See footnotes at end of table.

Table 4.—U.S. imports for consumption of lithium-bearing materials, by commodity and country —Continued

Commodity and country	1981 Gross weight (pounds)	1981 Value (thousands) Customs	1981 Value (thousands) C.i.f.	1982 Gross weight (pounds)	1982 Value (thousands) Customs	1982 Value (thousands) C.i.f.
Lithium compounds:						
Algeria	--	--	--	350	$1	$1
Austria	--	--	--	3,175	9	9
Canada	7,900	$9	$9	3,015	3	3
China	501,496	524	600	238,043	306	334
Denmark	7	1	1	61	4	4
France	13,989	1,020	1,031	257	12	12
Germany, Federal Republic of	36,297	121	125	19,190	156	165
Japan	162	64	65	161	23	24
Netherlands	--	--	--	73	6	6
Switzerland	595	1	1	551	1	1
United Kingdom	213	13	13	630	8	9
Total	560,659	1,753	1,845	265,506	529	568
Lithium salts:						
Germany, Federal Republic of	--	--	--	67	8	8
United Kingdom	--	--	--	191	2	2
Total	--	--	--	258	10	10
Lithium metal:						
Germany, Federal Republic of	11	1	1	11	2	2
Japan	6	--	--	--	--	--
Total	17	1	1	11	2	2

[1]Less than 1/2 unit.
[2]Data may not add to totals shown because of independent rounding.

Source: U.S. Department of Commerce, Bureau of the Census.

WORLD REVIEW

A worldwide survey of aluminum smelters determined the extent to which Li_2CO_3 was being added to aluminum potlines.[10] Respondents accounting for 11.1 million tons per year of aluminum capacity indicated that 23% of their capacity, or 2.5 million tons per year, used Li_2CO_3 as an additive. Where used, Li_2CO_3 consumption per ton of aluminum product ranged from 4.4 to 12.1 pounds.

Chile.—In 1982, Sociedad Chilena de Litio Ltda. (SCL) began construction of solar evaporation ponds to produce lithium from a brine deposit in northern Chile.[11] Construction of treatment facilities, designed to produce 14 million pounds of Li_2CO_3 annually, began in late 1982. The most recent cost estimate for this facility was $55 million, versus earlier estimates of $61 million, owing to more favorable estimated exchange rates. SCL arranged for $30 million in project financing by a consortium of banks, with the remaining funds to be supplied by SCL. SCL is a limited partnership owned 55% by Foote Mineral and 45% by the Chilean Government's development company, Corporacíon de Fomento de la Produccíon.

Japan.—In contrast to most lithium statistics for 1982, Japanese imports increased by 10% for $LiOH \cdot H_2O$, 6% for LiCl, and 18% for lithium metal, while Li_2CO_3 imports declined only 4%.[12] The United States maintained its strong position in the Japanese import market by supplying 78% of the Li_2CO_3, 54% of the $LiOH \cdot H_2O$, and 91.4% of the metal.

United Kingdom.—Since 1980, Lithium Corp. of Europe, a Lithco subsidiary near Liverpool, produced catalysts for specialty synthetic rubber manufacture and polymers for markets throughout Europe and North Africa. During 1982, new facilities for lithium metal production were brought onstream.[13] In addition, Lithco's European marketing capabilities have been expanded to include specialty as well as primary products.

Table 5.—Lithium Minerals: World production, by country[1]

(Short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Argentina (minerals not specified)	885	117	88	28	22
Brazil:					
Amblygonite	475	206	201	305	220
Lepidolite	55	64	56	2	55
Petalite	2,200	1,655	2,741	2,293	2,760
Spodumene	976	--	108	268	220
China (minerals not specified)[e 3]	11,000	11,000	15,000	15,000	15,400
Portugal, lepidolite	1,300	1,100	1,100	[e]990	880
Rwanda, amblygonite[e]	31	31	33	28	33
U.S.S.R. (minerals not specified)[e 3]	55,000	55,000	61,000	61,000	61,000
United States	W	W	W	W	W
Zimbabwe (minerals not specified)	18,395	14,547	21,982	18,126	16,000

[e]Estimated. [p]Preliminary. W Withheld to avoid disclosing company proprietary data.
[1]Table includes data available through Apr. 20, 1983.
[2]In addition to the countries listed, other nations may produce small quantities of lithium minerals, but output is not reported and no valid basis is available for estimating production levels.
[3]These estimates denote only an approximate order of magnitude; no basis for more exacting estimates is available. Output by China and the U.S.S.R. have never been reported.

TECHNOLOGY

U.S. patents were issued to Foote Mineral for a process to produce and purify LiCl from natural or other LiCl brines.[14] The high-purity end product is suitable for use in the electrolytic production of lithium metal. The new process consists of first concentrating impure LiCl brines by solar evaporation until a 3% LiCl level is achieved. Then treatment with lime and calcium chloride converts the boron, magnesium, and sulfate brine impurities to compounds that precipitate and are separated from the brine in a solar evaporation and concentration step. A brine containing 40% or more LiCl results. This highly concentrated brine is subjected to a temperature of 101° C to produce anhydrous lithium chloride. The temperature is then raised to 200° C or more, followed by extraction of the LiCl with isopropanol. After removal of solvent, a highly pure LiCl product is obtained.

Potential applications of aluminum-lithium alloys have been enhanced by development of rapid-solidification casting technology.[15] This process, in which the cast alloy is cooled within milliseconds at a rate of 1,000,000° C per second, does not allow the metals to segregate and form fracture zones, which previously occurred at slower cooling rates. Researchers at Pratt & Whitney Aircraft, a division of United Technologies Corp., Aluminum Co. of America, and General Electric Co. used rapid solidification to develop a superalloy of lithium and aluminum. The new material has equal strength and 30% less weight than titanium alloys currently used in aircraft frames, and it retains its shape under stress 100 times longer. If a wide-bodied subsonic transport were built with this new alloy, the U.S. Department of Defense estimated that $5 billion would be saved over the plane's lifetime. A defense research manager predicted that the new alloy would replace titanium alloys in aircraft within the next 10 years.

The Tokamak Fusion Test Reactor at Princeton University produced the first blast of plasma, or hot electrified gas, at 100,000° C.[16] The blast lasted only 0.05 second. A blast of 100,000,000° C, lasting for several seconds, was the estimated requirement for the reactor to create as much energy as it consumed. Fusion energy, if successfully developed, might require annual consumption of materials having 70,000 tons of contained lithium.[17]

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[1]Physical scientist, Division of Industrial Minerals.
[2]See 1982 10-K reports for Gulf Resources and Chemical Corp. and Newmont Mining Corp.
[3]Alexander, J. H. Weak Markets Prevail, but Prices Hold the Line. Eng. & Min. J., v. 184, No. 3, March 1983, pp. 128-139.
[4]Roskill Information Services Ltd. (London). The Economics of Lithium. 3d ed., 1979.
[5]Work cited in footnote 2.
[6]Work cited in footnote 2.
[7]Work cited in footnote 2.
[8]Work cited in footnote 3.
[9]Metal Bulletin Ltd. (London). Raw Materials for the Glass Industry. Industry Minerals Glass Survey '77. Lithium. 1977, 132 pp.
[10]Work cited in footnote 4.
[11]Work cited in footnote 2.
[12]Japanese Tariff Association. Japan Exports and Imports, Commodity by Country. V. 81.12, 1981, pp. 123, 125-127; V. 82.12, 1982, pp. 123, 125, 127, 129.
[13]Work cited in footnote 2.
[14]Brown, P. M., S. R. Jacob, and D. A. Boryta (assigned to Foote Mineral Co., Exton, Pa.). Production of Highly Pure Lithium Chloride from Impure Brines. U.S. Pat. 4,271,131, June 2, 1981.
Brown, P. M., and S. R. Jacob (assigned to Foote Mineral Co., Exton, Pa.). Process for Purification of Lithium Chloride. U.S. Pat. 4,274,834, June 23, 1981.
[15]Chemical Week. From Base Metals to Precious Alloys. V. 131, No. 24, Dec. 15, 1982, pp. 27-28.
[16]Washington Post. Fusion Power Advances. Dec. 29, 1982, p. 1.
[17]Buckley, S. Lithium—Recession Delays Market Lift Off. Ind. Miner. (London), No. 185, February 1983, pp. 25-35.

Magnesium

By Benjamin Petkof[1]

For the second consecutive year domestic production of primary magnesium metal declined. Secondary metal recovery also declined. Magnesium consumption decreased markedly, especially for use in aluminum alloys. The United States remained as the world's largest producer followed by the U.S.S.R. World production and consumption also declined in response to the reduced economic activity in the United States and other industrialized countries.

Domestic Data Coverage.—Domestic consumption data for magnesium metal are developed by the Bureau of Mines from a voluntary domestic survey. Out of 175 operations to which a survey request was sent, 70% responded, representing an estimated 76% of the total consumption shown in tables 1 and 3. Consumption by the remaining 52 nonrespondents was estimated using reported prior year consumption levels.

Table 1.—Salient magnesium statistics

(Short tons unless otherwise specified)

	1978	1979	1980	1981	1982
United States:					
Production:					
Primary magnesium[1]	149,463	162,464	169,477	[r]143,230	99,100
Secondary magnesium	36,228	37,222	40,461	46,256	43,232
Exports	41,807	54,280	56,761	34,855	39,613
Imports for consumption	6,668	4,754	3,757	6,897	4,784
Consumption	108,958	108,844	95,788	91,461	74,599
Price per pound	$0.99-$1.01	$1.01-$1.09	$1.07-$1.25	$1.25-$1.34	$1.34
World: Primary production	[r]317,755	[r]338,881	348,454	[p]325,909	[e]272,669

[e]Estimated. [p]Preliminary. [r]Revised.

[1]Derived figure; United States production is not officially reported by the Bureau of Mines in order to avoid disclosing company proprietary data; figures reported represent the differences between total North American production reported by the International Magnesium Association and the Canadian Department of Mines and Natural Resources for 1978-81 inclusive and which is estimated by the Bureau of Mines for 1982.

DOMESTIC PRODUCTION

Domestic primary production, that began to decline in 1981, continued to decline in 1982 following the downward trend of the U.S. economy. Production was slightly greater than one-half of the Nation's installed production capacity. Three companies produced almost 100,000 tons of primary magnesium metal: The Dow Chemical Co., Freeport, Tex.; AMAX Specialty Metals Corp., Rowley, Utah; and Northwest Alloys, Inc., Addy, Wash. The first two companies processed natural brines to magnesium chloride to provide cell feed material for electrolysis to pure magnesium metal. Northwest Alloys produced metal from dolomite using the silicothermic technique. The producers drew down magnesium inventories and made repairs and modifications of plant facilities.

Secondary magnesium continued to provide a significant portion of the domestic magnesium metal supply. However, for the first time since 1974, the quantity of secondary metal that was recovered declined.

Table 2.—Magnesium recovered from scrap processed in the United States, by kind of scrap and form of recovery

(Short tons)

	1978	1979	1980	1981	1982
KIND OF SCRAP					
New scrap:					
Magnesium-base	4,634	5,025	5,929	2,833	2,455
Aluminum-base	17,501	18,315	16,978	19,240	17,346
Total	22,135	23,340	22,907	22,073	19,801
Old scrap:					
Magnesium-base	5,522	4,778	5,275	5,593	5,314
Aluminum-base	8,571	9,104	12,279	18,590	18,117
Total	14,093	13,882	17,554	24,183	23,431
Grand total	36,228	37,222	40,461	46,256	43,232
FORM OF RECOVERY					
Magnesium alloy ingot[1]	4,272	3,739	4,205	4,230	4,228
Magnesium alloy castings (gross weight)	956	790	836	806	746
Magnesium alloy shapes	1,909	2,176	3,144	13	--
Aluminum alloys	27,301	28,857	29,612	38,755	36,587
Zinc and other alloys	19	13	13	9	11
Chemical and other dissipative uses	48	47	9	55	3
Cathodic protection	1,723	1,600	2,642	2,388	1,657
Total	36,228	37,222	40,461	46,256	43,232

[1]Includes secondary magnesium content of both secondary and primary alloy ingot.

CONSUMPTION AND USES

Total annual consumption of primary magnesium metal continued the decline that began in 1979. The structural uses of magnesium metal and its alloys have declined each successive year since 1980, but the principal decline in magnesium consumption since 1979 has been in aluminum alloys.

Table 3.—Consumption of primary magnesium in the United States, by use

(Short tons)

Use	1978	1979	1980	1981	1982
For structural products:					
Castings:					
Die	5,575	5,182	3,190	2,812	1,600
Permanent mold	1,012	1,069	922	917	663
Sand	1,064	1,209	1,735	1,222	1,337
Wrought products:					
Extrusions	6,301	6,420	6,855	5,786	7,059
Sheet and plate	4,375	4,925	4,704	4,547	2,981
Other (includes forgings)	399	217	61	43	88
Total	18,726	19,022	17,467	15,327	13,728
For distributive or sacrificial purposes:					
Alloys:					
Aluminum	58,798	60,549	54,490	50,518	39,878
Copper	12	9	6	5	7
Zinc	21	15	11	9	3
Other	8	8	7	7	3
Cathodic protection (anodes)	6,600	6,769	3,930	6,449	5,964
Chemicals	9,192	9,044	6,278	5,315	4,823
Nodular iron	7,956	4,335	4,176	3,755	2,541
Scavenger and deoxidizer	(1)	(1)	(1)	(1)	(1)

See footnote at end of table.

Table 3.—Consumption of primary magnesium in the United States, by use —Continued

(Short tons)

Use	1978	1979	1980	1981	1982
For distributive or sacrificial purposes —Continued					
Reducing agent for titanium, zirconium, hafnium, uranium, beryllium	6,230	7,435	7,957	9,071	5,901
Other including powder	1,415	1,658	1,466	1,005	1,751
Total	90,232	89,822	78,321	76,134	60,871
Grand total	108,958	108,844	95,788	91,461	74,599

[1]Included with "Other."

STOCKS

Consumer stocks of primary magnesium ingot declined from 11,367 tons at yearend 1981 to 10,268 tons at yearend 1982; magnesium alloy ingot stocks declined from 756 tons at the beginning of the year to 705 tons at yearend.

Table 4.—Stocks and consumption of new and old magnesium scrap in the United States

(Short tons)

	Stocks, Jan. 1	Receipts	Consumption: New scrap	Consumption: Old scrap	Consumption: Total	Stocks, Dec. 31
1981:						
Cast scrap	1,415	6,986	796	6,146	6,942	1,459
Solid wrought scrap[1]	160	833	965	--	965	28
Total	1,575	7,819	1,761	6,146	7,907	1,487
1982:						
Cast scrap	1,459	6,336	376	5,846	6,222	1,573
Solid wrought scrap[1]	28	764	769	--	769	23
Total	1,487	7,100	1,145	5,846	6,991	1,596

[1]Includes borings, turnings, drosses, etc.

PRICES

The quoted price of magnesium metal and magnesium diecasting alloy was constant throughout the year at $1.34 and $1.21 per pound, respectively. Producers reportedly provided small price discounts during the year.

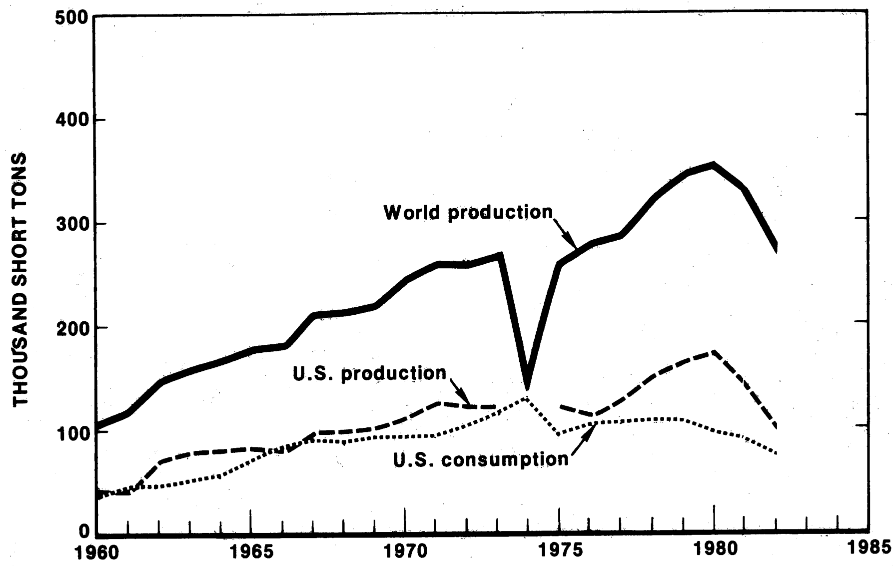

Figure 1.—U.S. and world production and U.S. consumption of primary magnesium.

FOREIGN TRADE

All categories of exports, except waste and scrap magnesium, increased significantly from those of 1981 in quantity and value. Major exports of metal were destined to industrialized nations, especially those with aluminum producing facilities.

Imports of magnesium metal and waste and scrap declined from those of 1981; imports of magnesium alloys and fabricated forms increased, providing a different import pattern from that of 1981.

Table 5.—U.S. exports and imports for consumption of magnesium

Year	EXPORTS					
	Waste and scrap		Metals and alloys in crude form		Semifabricated forms, n.e.c.	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1980	250	$587	49,584	$104,086	6,927	$23,033
1981	261	689	32,910	81,116	1,684	9,048
1982	149	349	37,281	92,554	2,183	11,942

Year	IMPORTS							
	Waste and scrap		Metal		Alloys (magnesium content)		Powder, sheets, tubing, ribbons, wire, other forms (magnesium content)	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1980	2,384	$2,806	940	$2,242	344	$1,770	89	$1,443
1981	3,225	3,338	2,897	6,844	625	2,652	150	4,804
1982	1,873	2,019	1,779	3,713	955	3,889	177	5,982

Table 6.—U.S. exports of magnesium, by country

Country	Waste and scrap		Primary metals, alloys		Semifabricated forms, n.e.c., including powder	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1981						
Argentina	39	$167	390	$908	6	$35
Australia	--	--	1,379	3,113	232	1,239
Austria	--	--	336	857	5	69
Belgium-Luxembourg	--	--	129	328	9	73
Brazil	--	--	2,892	6,540	8	44
Cameroon	--	--	35	83	--	--
Canada	73	162	3,943	9,819	186	883
China	--	--	--	--	--	--
Colombia	--	--	59	187	25	98
France	1	2	143	364	43	566
Germany, Federal Republic of	--	--	1,247	3,225	44	362
Ghana	--	--	--	--	1	3
Hong Kong	--	--	10	25	--	--
India	--	--	154	381	8	17
Israel	--	--	68	380	66	443
Italy	--	--	139	517	53	571
Japan	25	70	7,982	18,310	71	450
Korea, Republic of	--	--	266	669	3	36
Mexico	65	162	2,204	5,338	400	1,775
Netherlands	20	41	9,210	24,146	(1)	1
New Zealand	--	--	74	181	1	20
Norway	--	--	68	448	1	17
Romania	--	--	547	1,389	--	--
Saudi Arabia	37	81	233	481	53	177
Singapore	--	--	11	20	--	--
South Africa, Republic of	--	--	440	1,066	67	261
Spain	--	--	84	238	19	188
Sweden	--	--	1	12	5	55
Taiwan	--	--	159	376	14	102
United Kingdom	--	--	345	884	88	705
Venezuela	--	--	92	160	27	55
Other	1	4	270	671	249	803
Total	261	689	32,910	81,116	1,684	9,048
1982						
Argentina	--	--	215	456	321	731
Australia	--	--	1,686	3,862	276	1,141
Austria	--	--	26	72	9	100
Belgium-Luxembourg	--	--	1	10	8	125
Brazil	--	--	2,976	6,955	39	107
Canada	144	337	2,543	6,034	226	927
Colombia	--	--	29	63	10	40
France	--	--	58	152	23	468
Germany, Federal Republic of	--	--	681	1,617	44	495
India	--	--	177	437	7	21
Israel	--	--	--	--	204	1,191
Italy	--	--	37	378	175	1,206
Japan	--	--	10,787	21,546	97	734
Korea, Republic of	--	--	165	459	31	48
Mexico	--	--	2,423	5,824	186	1,105
Netherlands	--	--	12,996	39,893	23	182
New Zealand	--	--	142	239	2	38
Norway	--	--	47	144	3	43
Saudi Arabia	--	--	883	954	95	345
Singapore	--	--	40	85	45	293
South Africa, Republic of	--	--	394	929	76	294
Spain	--	--	81	231	28	119
Sweden	--	--	--	--	3	29
Taiwan	--	--	101	248	5	78
United Kingdom	--	--	279	775	120	1,200
Venezuela	--	--	44	109	13	50
Other	5	12	470	1,082	114	832
Total	149	349	37,281	92,554	2,183	11,942

[1]Less than 1/2 unit.

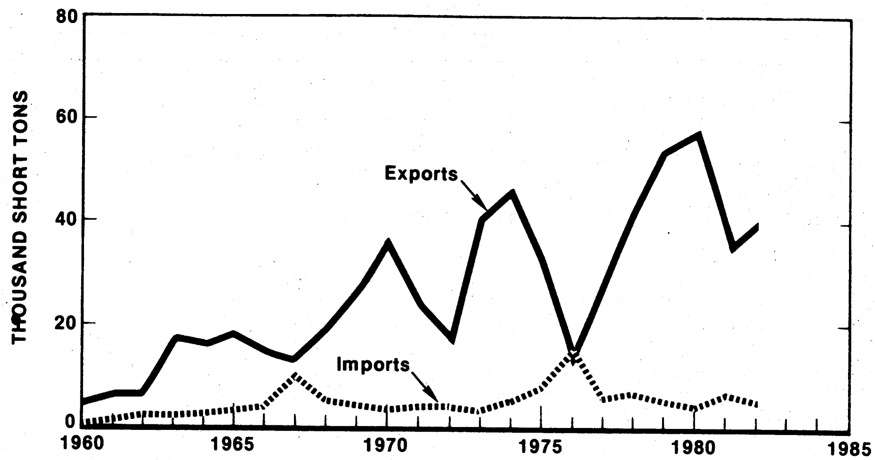

Figure 2.—U.S. imports and exports of magnesium.

WORLD REVIEW

Primary world production declined in 1982 in response to reduced global economic activity. The United States retained its place as the world's largest primary magnesium producer followed by the U.S.S.R. and Norway.

The recovery of secondary magnesium was strong in 1982, but below that of 1981. Available data on the recovery of secondary magnesium appear in table 8. In 1982, the United States and Japan were the major known producers of secondary magnesium.

During 1982, the Norsk Hydro AS magnesium electrolysis facilities at Heroyer, Norway, were being rebuilt and modernized to reduce cost of metal production by improved energy utilization and the reduction of the number of workers required to operate the plant. The completion of this work was expected in 1983. New foundries for pure magnesium and magnesium alloy using new proprietary technology were being built. The pure magnesium foundry was in operation at the end of 1982. A plant for the preparation of magnesium granules to refine and desulfurize iron and steel was expected to be built and in operation by the summer of 1983.

[1]Physical scientist, Division of Nonferrous Metals.

Table 7.—Magnesium: World primary production, by country[1]

(Short tons)

Country	1978	1979	1980	1981[p]	1982[e]
Canada	9,159	9,937	10,199	9,370	8,700
China[e]	6,600	6,600	7,700	7,700	7,700
France	9,370	9,968	10,282	8,006	[2]10,593
India	25	31	14	7	6
Italy	10,668	9,653	8,693	8,623	[2]8,466
Japan	12,304	12,531	10,199	6,247	[2]6,123
Norway	43,166	48,697	48,890	52,472	[2]38,581
U.S.S.R.[e]	77,000	79,000	83,000	86,000	89,000
United States[3]	149,463	162,464	169,477	143,230	99,100
Yugoslavia	--	--	([4])	4,254	4,400
Total	[r]317,755	[r]338,881	348,454	325,909	272,669

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through May 25, 1983.
[2]Reported figure.
[3]Derived figure; U.S. production is not officially reported by the Bureau of Mines in order to avoid disclosing company proprietary data; figures reported represent the difference between total North American production reported by the International Magnesium Association and Canadian production reported by the Canadian Department of Mines and Natural Resources for 1978-81 inclusive and which is estimated by the Bureau of Mines for 1982.
[4]Revised to zero.

Table 8.—Magnesium: World secondary production, by country[1]

(Short tons)

Country	1978	1979	1980	1981[p]	1982[e]
Germany, Federal Republic of[e]	660	660	660	660	660
India	(2)	(2)	(2)	(2)	--
Japan	12,057	18,058	23,800	31,345	24,000
United Kingdom	3,000	3,000	3,000	2,094	[3]1,938
United States	36,228	37,222	40,461	46,256	[3]43,232

[e]Estimated. [p]Preliminary.

[1]Table summarizes available information on world secondary magnesium production, but has not been totaled because of the omission of other producers for which data are not available and for which no reliable basis for estimations are available. Most notable among omitted secondary producers (and probably the only one of significance) is the U.S.S.R. Table includes data available through May 25, 1983.

[2]Data deleted; information indicated that Indian production reported in previous edition as secondary was primary.

[3]Reported figure.

Magnesium Compounds

By Benjamin Petkof[1]

In 1982, the United States continued to be a major producer of magnesium compounds. Magnesium compounds shipped and used in the United States declined from those of 1981. Total exports and imports declined in quantity and value from those of 1981. World production of magnesite was about the same as that of 1981. The U.S.S.R., China, North Korea, Austria, Greece, and Turkey were major world sources of magnesite.

Domestic Data Coverage.—Domestic data for magnesium compounds shipped and used were developed by the Bureau of Mines from a voluntary survey of U.S. operations entitled "Magnesium Compounds." Of the 20 operations to which a survey request was sent, 60% responded, representing an estimated 93% of the total magnesium compounds shipped and used shown in table 3. Data for the remaining eight nonrespondents was estimated using prior year production levels adjusted by trends in employment and other guidelines.

Table 1.—Salient magnesium compound statistics

(Thousand short tons and thousand dollars)

	1978	1979	1980	1981	1982
United States:					
Caustic-calcined and specified magnesias:[1]					
Shipments by producers:					
Quantity	156	164	157	160	148
Value	$43,008	$50,047	$51,282	$58,420	$56,363
Exports: Value[2]	$7,741	$16,433	$17,692	$14,559	$10,925
Imports for consumption: Value[2]	$793	$1,169	$2,122	$2,177	$2,055
Refractory magnesia:					
Sold and used by producers:					
Quantity	796	847	731	616	453
Value	$125,082	$125,289	$162,697	$146,903	$112,101
Exports: Value	$10,617	$8,183	$13,279	$4,727	$2,721
Imports: Value	$14,421	$13,546	$16,672	$22,990	$14,162
Dead-burned dolomite:					
Sold and used by producers:					
Quantity	1,016	793	494	435	NA
Value	$45,881	$41,676	$28,308	$23,789	NA
World: Production (magnesite)	r11,279	r12,111	12,820	p12,356	e12,268

eEstimated. pPreliminary. rRevised. NA Not available.
[1]Excludes caustic-calcined magnesia used in production of refractory magnesia.
[2]Caustic-calcined magnesia only.

DOMESTIC PRODUCTION

Domestic production of caustic-calcined and specified magnesias and refractory magnesia followed the general economic trend and declined significantly in quantity and value from that of 1981. The major source of domestic magnesia refractory compounds continued to be synthetic magnesia that was derived from natural brine solutions found in seawater, lake brines, and well brines. Magnesium compounds were also produced from natural magnesite mined in Nevada. Olivine was produced from deposits in North Carolina and Washington. Olivine was ground to various grades for consumption by the foundry, steel, and refractories industries. Primary U.S. magnesium compound producers are shown in table 2.

Table 2.—Current magnesium compound producers, by raw material source, location, and production capacity

Raw material source and producing company	Location	Capacity (short tons of MgO equivalent)
Magnesite: Basic, Inc	Gabbs, Nev	150,000
Lake brines:		
Great Salt Lake Minerals & Chemicals Corp	Ogden, Utah	100,000
Kaiser Aluminum & Chemical Corp	Wendover, Utah	50,000
Well brines:		
The Dow Chemical Co	Ludington, Mich	300,000
Do	Midland, Mich	75,000
Martin Marietta Chemicals	Manistee, Mich	350,000
Morton Chemical Co	do	5,000
Seawater:		
Barcroft Co	Lewes, Del	5,000
Basic Magnesia, Inc	Port St. Joe, Fla	100,000
The Dow Chemical Co	Freeport, Tex	75,000
Harbison-Walker Refractories Co	Cape May, N.J	100,000
Kaiser Aluminum & Chemical Corp	Moss Landing, Calif	150,000
Merck & Co., Inc	South San Francisco, Calif	15,000
Western Magnesium Corp	Chula Vista, Calif	5,000
Total		1,480,000

CONSUMPTION AND USES

The major portion of U.S. magnesium compound production was converted to refractory products such as refractory brick. The chemical processing and pharmaceutical industries provided a strong market for caustic-calcined and specified magnesias. Caustic-calcined and specified magnesias were also used to prepare animal feeds, fertilizers, construction materials, chemicals, electrical heating rods, fluxes, petroleum additives, and rayon.

Table 3.—Magnesium compounds shipped and used in the United States

	1981		1982	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Caustic-calcined[1] and specified (USP and technical) magnesias	160,067	$58,420	147,525	$56,363
Refractory magnesia	615,661	146,903	453,163	112,101
Magnesium hydroxide (100% $Mg(OH)_2$)[1]	415,009	47,922	357,060	41,597
Magnesium sulfate (anhydrous and hydrous)	33,246	8,120	46,524	11,326
Precipitated magnesium carbonate[1]	4,002	900	4,000	900

[1]Excludes material produced as an intermediate step in the manufacture of other magnesium compounds.

Table 4.—Domestic shipments of caustic-calcined and specified magnesias, by use

(Short tons)

Use	1980	1981	1982
Agriculture, nutrition, pharmaceuticals:			
Animal feed	W	W	W
Fertilizer	W	W	W
Medicinals and pharmaceuticals	598	W	W
Sugar and candy	W	W	W
Winemaking	W	W	W
Total	598	W	W

See footnotes at end of table.

Table 4.—Domestic shipments of caustic-calcined and specified magnesias, by use —Continued

(Short tons)

Use	1980	1981	1982
Construction materials:			
Insulation and wallboard	W	W	W
Oxychloride and oxysulfate cement	W	W	W
Total	W	W	W
Chemical processing, manufacturing, metallurgical:			
Chemical	23,632	19,330	17,591
Electrical heating rods			W
Flux	26,012		W
Petroleum additive		57,581	9,482
Pulp and paper			W
Cosmetics	29,406		W
Rayon			W
Rubber	13,688		13,819
Stack-gas scrubbing		W	W
Uranium processing	4,322		W
Water treatment			W
Total	97,060	76,911	40,892
Unspecified	59,645	83,156	106,633
Grand total	157,303	160,067	147,525

W Withheld to avoid disclosing company proprietary data; included with "Unspecified."

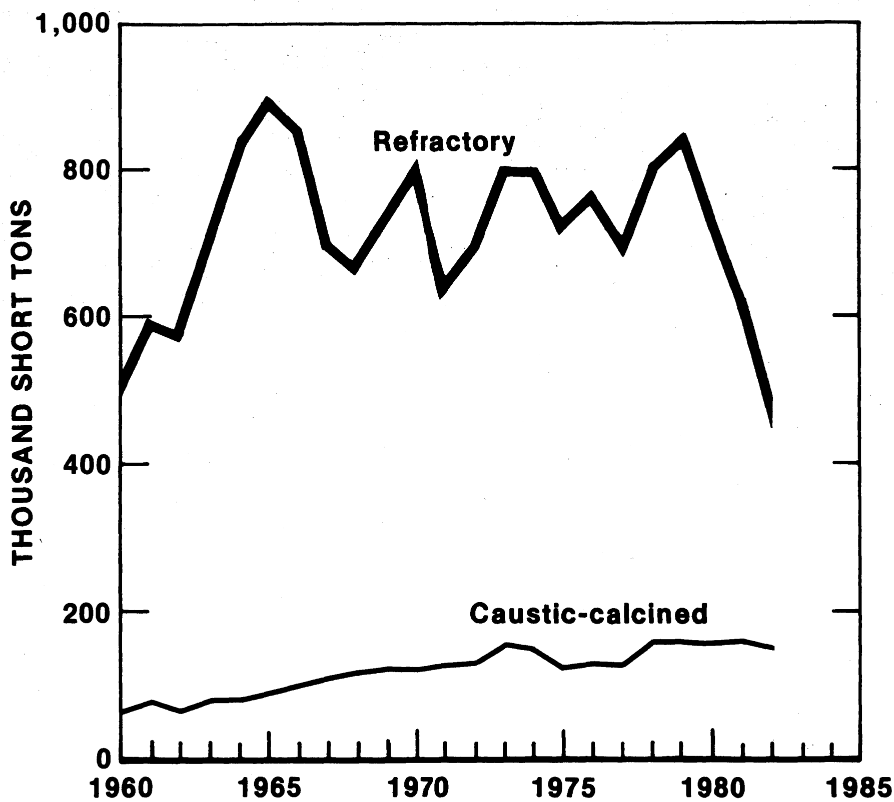

Figure 1.—Consumption and shipments of magnesia in the United States.

PRICES

The Chemical Marketing Reporter published the following prices, at yearend: magnesia, natural, technical, heavy, 85% and 90% (f.o.b. Nevada), $222 and $255 per short ton, respectively; magnesium chloride, hydrous, 99%, flake, $290 per ton; magnesium carbonate, light, technical (freight-equalized), $0.73 to $0.78 per pound; magnesium hydroxide, NF, powder (freight-equalized), $0.78 per pound; and magnesium sulfate, technical, $0.121 per pound.

FOREIGN TRADE

U.S. exports of crude and processed compounds, such as dead-burned magnesia and magnesite and crude, caustic-calcined lump or ground magnesite, declined significantly from those of 1980 and 1981 in both quantity and value.

Total imports of crude and processed magnesite were significantly less than those of 1981 in quantity and value. Additional magnesium compounds valued at almost $8 million were also imported.

Table 5.—U.S. exports of magnesite and magnesia, by country

Country	Magnesite and magnesia, dead-burned				Magnesite, n.e.c., including crude caustic-calcined, lump or ground			
	1981		1982		1981		1982	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Argentina	--	--	--	--	1,354	$527	1,221	$546
Australia	240	$58	58	$8	3,220	1,391	2,690	709
Belgium-Luxembourg	18	4	--	--	679	493	1,066	737
Brazil	--	--	--	--	495	352	172	137
Canada	17,080	3,903	10,054	2,269	24,238	7,423	12,434	4,761
Colombia	1,042	132	1,030	131	141	133	156	165
France	128	41	23	17	202	195	188	184
Germany, Federal Republic of	46	14	--	--	611	366	687	612
Italy	--	--	--	--	317	274	574	525
Japan	31	7	650	51	30	31	2	5
Mexico	518	118	721	163	828	761	515	376
Netherlands	390	88	--	--	110	100	288	274
New Zealand	--	--	--	--	203	222	102	129
Spain	--	--	--	--	151	96	437	279
Sweden	--	--	--	--	191	169	161	192
United Kingdom	239	65	--	--	508	396	130	158
Venezuela	231	52	46	10	2,764	1,062	2,015	874
Other	963	245	287	72	641	568	287	262
Total	20,926	4,727	12,869	2,721	36,683	14,559	23,125	10,925

Table 6.—U.S. imports for consumption of crude and processed magnesite, by country

Country	1981		1982	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Lump or ground caustic-calcined magnesia:[1]				
Australia	--	--	220	$55
Canada	--	--	1,559	323
China	2,467	$133	4,701	214
Greece	8,744	1,917	4,023	927
Japan	375	21	--	--
Netherlands	40	11	2,447	311
Turkey	25	5	669	143
United Kingdom	311	69	312	76
Other	103	21	28	6
Total	12,065	2,177	13,959	2,055

See footnotes at end of table.

Table 6.—U.S. imports for consumption of crude and processed magnesite, by country —Continued

Country	1981 Quantity (short tons)	1981 Value (thousands)	1982 Quantity (short tons)	1982 Value (thousands)
Dead-burned and grain magnesia and periclase:				
Not containing lime or not over 4% lime:				
Brazil	8,587	$1,363	2,746	$474
China	22	11	12,528	1,222
Greece	8,818	2,361	8,277	1,285
Ireland	38,411	12,417	33,868	10,500
Japan	19,568	6,645	391	624
Mexico	537	161	--	--
Other	66	32	142	57
Total	76,009	22,990	57,952	14,162
Containing over 4% lime:				
Austria	3	1	544	229
Canada	535	59	292	22
China	--	--	23	4
Germany, Federal Republic of	233	57	294	90
Greece	--	--	379	74
Guinea	--	--	5	(2)
Ireland	5	(2)	--	--
Japan	25	7	17	5
United Kingdom	--	--	13	2
Total	801	124	1,567	426
Total dead-burned and grain magnesia and periclase	76,810	23,114	59,519	14,588

[1]In addition, crude magnesite was imported as follows: 1981—Canada, 162 short tons ($7); Brazil, 8,819 short tons ($1,500); Ireland, 2,425 short tons ($671); the Federal Republic of Germany, 785 short tons ($55); India, 64 short tons ($1); and Japan, 11 short tons ($2). 1982—Canada, 83 short tons ($5); the United Kingdom, 28 short tons ($6); Greece, 3,133 short tons ($293); India, 60 short tons ($1); and Japan, 1 short ton ($1).

[2]Less than 1/2 unit.

Table 7.—U.S. imports for consumption of magnesium compounds

Year	Oxide or calcined magnesia		Magnesium carbonate[1] (precipitated)		Magnesium chloride (anhydrous)		Magnesium chloride (other)		Magnesium sulfate (epsom salts and kieserite)		Magnesium salts and compounds, n.s.p.f.[2]	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1980	1,468	$1,871	117	$211	61	$20	355	$93	30,031	$1,674	4,092	$2,038
1981	1,537	2,419	212	362	40	20	592	161	30,233	1,852	2,768	1,427
1982	3,217	3,766	173	270	26	11	1,086	197	37,605	2,184	2,690	1,537

[1]In addition, magnesium carbonate, not precipitated, was imported as follows: 1980—41 short tons ($36,357); 1981—119 short tons ($97); and 1982—125 short tons ($69).

[2]Includes magnesium silicofluoride or fluosilicate and calcined magnesium.

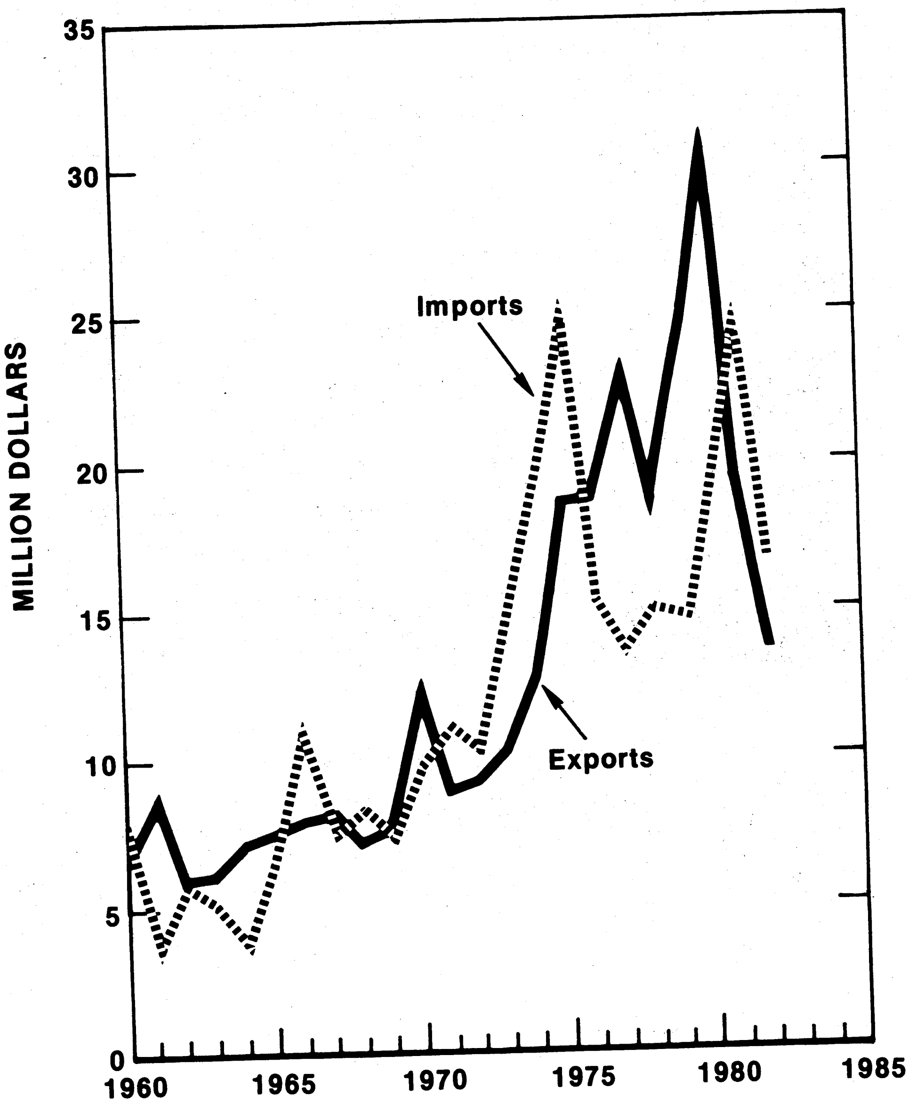

Figure 2.—Value of U.S. exports and imports of magnesia.

WORLD REVIEW

World production of magnesite and synthetic magnesia met world demand for the manufacture of refractory, and caustic-calcined and specified magnesias. Most producing nations derived magnesia from magnesite, but countries such as the United States, Ireland, and Israel used natural brines.

Table 8.—Magnesite: World production, by country[1]

(Short tons)

Country	1978	1979	1980	1981[p]	1982[e]
Australia	23,534	32,299	35,492	29,638	28,900
Austria	1,082,821	1,216,563	1,453,017	1,277,414	1,268,000
Brazil[2]	239,499	292,186	348,166	314,055	330,000
Canada[e 3]	39,000	58,000	69,000	76,000	75,000
China[e]	2,000,000	2,200,000	2,200,000	2,200,000	2,200,000
Colombia	1,543	1,744	1,744	[e]1,800	1,800
Czechoslovakia	725,320	720,911	734,139	732,000	728,000
Greece	1,497,824	1,166,477	1,286,394	909,674	882,000
India	456,539	424,020	408,486	499,798	408,000
Iran[e 4]	5,500	5,500	4,400	4,400	5,500
Kenya	[e]4,400	[e]4,400	1	10	10
Korea, North[e]	1,720,000	2,010,000	2,040,000	2,040,000	2,040,000
Mexico	83,814	89,971	86,987	[r e]94,000	94,000
New Zealand	926	([5])	--	340	330
Pakistan	2,945	3,029	858	780	830
Poland	26,125	22,046	21,605	12,500	13,000
South Africa, Republic of	41,234	[r]72,021	86,871	62,343	[6]35,193
Spain	337,911	420,936	557,253	[e]550,000	500,000
Turkey	[r]460,768	804,071	910,451	864,174	860,000
U.S.S.R.[e]	2,090,000	2,150,000	2,200,000	2,290,000	2,370,000
United States	W	W	W	W	W
Yugoslavia	367,069	[r]323,313	288,630	330,336	[6]361,558
Zimbabwe	72,483	93,140	86,219	66,352	66,000
Total	[r]11,279,255	[r]12,110,627	12,819,713	12,355,614	12,268,121

[e]Estimated. [p]Preliminary. [r]Revised. W Withheld to avoid disclosing company proprietary data.

[1]Figures represent crude salable magnesite. In addition to the countries listed, Bulgaria produced magnesite, but output is not reported quantitatively, and available general information is inadequate for formulation of reliable estimates of output levels. Table includes data available through Apr. 27, 1983.

[2]Series reflects output of marketable concentrates. Production of crude ore was as follows, in short tons: 1978—451,877; 1979—651,583; 1980—803,268; 1981—676,760; and 1982—705,000 (estimated).

[3]Magnesitic dolomite and brucite. Figures reestimated on the basis of reported tonnage dollar value.

[4]Year beginning Mar. 21 of that stated.

[5]Revised to zero.

[6]Reported figure.

TECHNOLOGY

A report reviewed the current state of the art of chemically bonded refractories. Areas that required research and development work to improve ceramic materials were described.[2]

A thorough discussion of magnesia as a refractory material was presented. The author defined some industry terminology and discussed subjects such as uses of magnesia, sources and origins of natural magnesia, grades of natural and synthetic magnesias, and world production capacities.[3]

A discussion of the mineral olivine as a refractory was presented.[4]

The First European Symposium on the Use of Olivine Pellets was held at Helsingör, Denmark, October 5-6, 1982. Conference participants reported the results of blast furnace tests using pelletized olivine as an additive to the melt.[5]

[1]Physical scientist, Division of Nonferrous Metals.

[2]Kalyoncu, R. S. Chemically Bonded Refractories—A Review of the State of the Art. BuMines IC 8878, 1982, 20 pp.

[3]Mikami, H. M. Refractory Magnesia. Proc. Raw Materials for Refractories Conf., U.S. Dept. of the Interior, BuMines, Univ. Alabama, Tuscaloosa, Feb. 8-9, 1982, pp. 179-219.

[4]Wilson, R. C. A Review of Olivine as a Refractory Raw Material. Proc. Raw Materials for Refractories Conf., U.S. Dept. of the Interior, BuMines, Univ. Alabama, Tuscaloosa, Feb. 8-9, 1982, pp. 254-263.

[5]Metal Bulletin Monthly. LKAB's Push for Olivine. No. 147, March 1983, pp. 53-54.

Manganese

By Thomas S. Jones[1]

There was neither production nor shipment of manganese ore containing 35% or more manganese in the United States in 1982. Lower grade manganiferous ores were produced and/or shipped in Minnesota and South Carolina, the quantities being much reduced from those of 1981. Imports of ferromanganese, silicomanganese, manganese metal, and especially of manganese ore all decreased significantly compared with those of 1981. Compared with manganese imported as ore, in 1982 nearly four times as much manganese was imported as manganese ferroalloys and metal combined, mainly as ferromanganese. Levels of domestic production and consumption of manganese ferroalloys were among the lowest since the 1930's, largely because of conditions in the steel industry. Deliveries of ore from Government stockpile excesses by the General Services Administration (GSA) were at a greatly decreased rate.

Domestic Data Coverage.—Domestic production data for manganese are developed by the Bureau of Mines from three separate, voluntary surveys of U.S. operations. Typical of these surveys is the Manganese and Manganiferous Ores survey. Of the four operations to which a survey request was sent, 100% responded, representing 100% of the total production shown in table 2.

Table 1.—Salient manganese statistics in the United States

(Short tons)

	1978	1979	1980	1981	1982
Manganese ore (35% or more Mn):					
Imports, general	547,820	499,782	697,516	639,141	237,759
Consumption	1,281,479	1,372,190	1,070,775	1,076,631	608,741
Manganiferous ore (5% to 35% Mn):					
Production (shipments)	312,124	240,696	173,887	r174,760	31,509
Ferromanganese:					
Production	272,530	317,102	189,472	192,690	119,000
Exports	9,433	25,344	11,686	14,925	10,311
Imports for consumption	680,399	821,213	605,703	671,178	492,708
Consumption	985,623	976,482	789,076	820,921	439,197

rRevised.

Legislation and Government Programs.—No sales of Government manganese stockpile excesses were reported by GSA in 1982. On October 7, GSA announced the offering for sale of approximately 51,045 short tons[2] of chemical-grade manganese ore under Solicitation of Offers for Manganese Ore, Chemical Grade, Types A and B, ORES-258. GSA limited sales under ORES-258 to 25,000 tons through September 30, 1983. This solicitation was open to any party and did not require that ore purchased under it be consumed in the United States. The chemical-grade ore being offered for sale was identified as being about one-half each of Moroccan and Cuban origin plus small quantities of Indian and Fiji Island origin.

Government stockpile physical inventories of manganese items declined at the lowest rate since 1967, when shipments began to exceed acquisitions, if any. The rate of shipment of previously sold excesses slowed progressively in 1982, and shipments stopped altogether in the fourth quarter. Changes in yearend inventories were a decrease of 51,390 tons for stockpile-grade metallurgical ore to 2,690,689 tons and a decrease of 10,368 tons for stockpile-grade natural battery ore to 198,652 tons. Inventories remained unchanged for other items as follows, in tons: nonstockpile-grade natural battery ore, 33,761; synthetic manganese dioxide, 3,011; chemical ore, 221,045; nonstockpile-grade metallurgical ore, 960,942; high-carbon ferromanganese, 599,978; medium-carbon ferromanganese, 28,920; silicomanganese, 23,574; and electrolytic metal, 14,172. Yearend physical inventories included approximately 280,000 tons of metallurgical ore and 13,000 tons of natural battery ore that had been sold but not yet shipped.

It was announced in December that GSA would begin a program of upgrading ore in the National Defense Stockpile into high-carbon ferromanganese and high-carbon ferrochromium. Under this program, 577,000 tons of high-carbon ferromanganese and 519,000 tons of high-carbon ferrochromium were to be produced over a 10-year period. This program was an outgrowth of an investigation of the U.S. ferroalloy industry begun by the U.S. Department of Commerce in 1981 under section 232 of the Trade Expansion Act of 1962. Two objectives of the upgrading program were to improve stockpile readiness and to maintain domestic ferroalloy furnace and processing capacity.

DOMESTIC PRODUCTION

No manganese ore, concentrate, or nodules, containing 35% or more manganese, was produced or shipped in the United States. Ferruginous manganese ores or concentrates containing 10% to 35% manganese were not produced, only shipped on a much curtailed basis from the Cuyuna Range of Minnesota; production in New Mexico had ended in 1981. Manganiferous schist, clay, or other earthy material associated with the manganiferous member of the Battleground schist of the Kings Mountain area was mined in Cherokee County, S.C., by brick manufacturers or contractors for use in coloring brick. This latter material, reported in table 2, ranged in manganese content from 5% to 15% but averaged less than 10%.

Table 2.—Manganiferous ore shipped[1] in the United States, by type and State

(Short tons)

Type and State	1981		1982	
	Gross weight	Manganese content	Gross weight	Manganese content
Ferruginous manganese ore (10% to 35% Mn, natural):				
Minnesota	139,571	20,712	16,307	2,659
New Mexico	12,741	1,453	--	--
Total	152,312	22,165	16,307	2,659
Manganiferous iron ore (5% to 10% Mn, natural):				
South Carolina[2]	r22,448	2,160	15,202	1,325
Grand total	r174,760	24,325	31,509	3,984
Value	$2,889,669	XX	$293,214	XX

r Revised. XX Not applicable.

[1]Shipments are used as the measure of manganiferous ore production for compiling U.S. mineral production value. They are taken at the point at which the material is considered to be in marketable form for the consumer. Besides direct-shipping ore, they include, without duplication, concentrate and nodules made from domestic ores.

[2]Miscellaneous ore.

CONSUMPTION, USES, AND STOCKS

Consumption of manganese as ferroalloys, metal, and direct-charged ore, as reported to the Bureau of Mines by consumers, totaled 10.8 pounds per ton of raw steel produced. This calculation was based on a preliminary figure of 73,900,000 tons for production of raw steel as ingots, continuous- or pressure-cast blooms, billet, slabs, etc., and steel castings. In terms of contained manganese, makeup of the 10.8-pound total was ferromanganese, 8.9; silicomanganese, 1.7; spiegeleisen, none; metal, 0.2; and manganese ore containing 35% or more manganese, negligible. The comparable 1981 total, on the same basis, was 12.0 pounds with ferromanganese at 10.3; silicomanganese at 1.5; spiegeleisen, negligible; metal at 0.2; and ore, negligible. In 1982, consumption of manganese as manganese ore in making pig iron or equivalent hot metal was approximately 1.0 pound per ton of raw steel produced. This ratio was the same as in 1981 and 1980.

Within a domestic ferroalloy industry whose operating rate sank at one period during the year below 20% of normal capacity, domestic producers of manganese ferroalloys cut back on production and shut down plants temporarily or for an indefinite period. For ferromanganese, production was the lowest since 1932; for silicomanganese, production was the lowest since the Bureau of Mines began publishing this statistic a quarter century ago. Helping cause the severe production declines were both a two-fifths decrease in steel output and inventory reduction programs by producers.

Table 3.—Consumption and industry stocks of manganese ore[1] in the United States, by use

(Short tons)

Use	Consumption 1981	Consumption 1982	Stocks, Dec. 31, 1982
Manganese alloys and metal	744,832	412,280	367,119
Pig iron and steel	147,812	83,906	104,610
Dry cells, chemicals, miscellaneous	183,987	112,555	279,707
Total	1,076,631	608,741	751,436

[1]Containing 35% or more manganese (natural); foreign ore plus small quantities from U.S. Government excess stockpile disposals.

Table 4.—Consumption by end use, and industry stocks of manganese ferroalloys and metal in the United States in 1982

(Short tons, gross weight)

End use	Ferromanganese: High carbon	Ferromanganese: Medium and low carbon	Silicomanganese	Spiegeleisen	Manganese metal[1]
Steel:					
Carbon	270,633	58,784	66,601	--	5,085
Stainless and heat-resisting	7,472	645	3,178	--	1,803
Full alloy	36,926	8,318	18,343	--	687
High-strength low-alloy	29,534	7,032	6,823	--	704
Electric	16	87	317	--	80
Tool	179	26	36	--	52
Unspecified	302	90	551	--	--
Total steel	345,062	74,982	95,849	--	8,411
Cast irons	12,543	434	7,736	--	10
Superalloys	224	W	W	--	126
Alloys (excluding alloy steels and superalloys)	1,289	580	1,785	82	8,206
Miscellaneous and unspecified	3,549	534	275	--	388
Total consumption	362,667	76,530	105,645	82	17,141
Stocks, Dec. 31:					
Consumer	161,925	10,928	7,863	W	W
Producer	34,676	35,404	28,167	W	W
Total stocks	196,601	46,332	36,030	7	7,415

W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous and unspecified" where applicable.
[1]Virtually all electrolytic.

Table 5.—Ferromanganese and silicomanganese produced in the United States and manganese ore consumed in their manufacture

Year	Production				Manganese ore[1] consumed[2] (gross weight, short tons)	
	Ferromanganese			Silicomanganese (gross weight, short tons)		
	Gross weight (short tons)	Manganese content			Total quantity	Per ton of ferromanganese and silicomanganese made[3]
		Percent	Short tons			
1978	272,530	80.6	219,707	142,000	831,566	1.9
1979	317,102	80.2	254,389	165,000	910,794	1.8
1980	189,472	79.7	150,982	188,000	726,127	1.9
1981	192,690	80.0	154,156	173,000	742,579	2.0
1982[4]	119,000	82.0	97,500	69,000	412,000	2.2

[1]Containing 35% or more manganese (natural); foreign ore plus small quantities from U.S. Government excess stockpile disposals.
[2]Includes ore used in producing silicomanganese and metal.
[3]Ratio of ore consumed to ferromanganese produced if silicomanganese is considered a special grade of ferromanganese. Includes ore used in producing silicomanganese.
[4]Rounded.

Electrolytic Manganese Metal.—All manganese metal produced domestically was electrolytic metal. The same is believed to be true for that imported and that consumed. Some low- or medium-carbon ferromanganese, such as the domestically produced Massive Manganese or the imported Gimel Metal, and some manganese-aluminum additives may have been erroneously reported by consumers as manganese metal. The metal that was used to make manganese-aluminum additives is included in table 4 under the "Alloys (excluding alloy steels and superalloys)" category.

At 18,589 tons, production of electrolytic manganese metal was the lowest in over a decade. Production was by three companies at three plants: Elkem Metals Co., Marietta, Ohio; Foote Mineral Co., New Johnsonville, Tenn.; and Kerr-McGee Chemical Corp., Hamilton (Aberdeen), Miss.

Ferromanganese.—Domestic production was by four companies at four locations; no blast furnaces were used. Electric furnaces were used to produce ferromanganese for shipment by three companies at three plants: Elkem Metals, Marietta, Ohio; Roane Alloys Div., Rockwood, Tenn.; and SKW Alloys Inc., Calvert City, Ky. Fused-salt electrolysis was used by Chemetals Corp. at Kingwood, W. Va., to make low- and medium-carbon ferromanganese sold under the trade name of Massive Manganese. Shipments of ferromanganese from U.S. furnaces decreased by nearly one-half to 98,000 tons compared with 188,000 tons in 1981. Shipments in 1980 and 1979 were 194,000 tons and 330,000 tons, respectively.

The ferromanganese production reported in the various tables is net production; that is, the quantity of ferromanganese produced for shipment outside the producing ferroalloy facility. It does not include the remelt material; that is, the fines, offgrade, or other ferromanganese output of the furnace that was fed back to the furnace or lost in the plant, and which is included in gross production data reported by the furnace operator.

Silicomanganese.—Domestic production for shipment was in electric furnaces by five companies at five plants: Autlán Manganese Corp., Theodore (Mobile), Ala.; Elkem Metals, Marietta, Ohio; Globe Metallurgical Div., Interlake Inc., Beverly, Ohio; Roane Alloys, Rockwood, Tenn.; and SKW Alloys, Calvert City, Ky. Production quantities in table 5 are net and do not include silicomanganese produced for use in the same plant as an intermediate for the production of medium- or low-carbon ferromanganese. Shipments of silicomanganese from U.S. furnaces dropped by three-fifths to 83,000 tons compared with 173,000 tons in 1981. Shipments in 1980 and 1979 were 162,000 tons and 167,000 tons, respectively. End-use consumption of silicomanganese—that is, consumption outside the ferroalloy plants—rose to 24.1% of ferromanganese consumption in 1982, compared with 19.0% in 1981 and 19.7% in 1980.

Spiegeleisen.—There was no domestic

production of spiegeleisen, and reported consumption was negligible.

Pig Iron.—A total of 274,000 tons of manganese-bearing ores containing 5% or more manganese (natural) was consumed in production of pig iron or its equivalent hot metal. Domestic sources supplied 188,000 tons, all of which was manganiferous iron ore containing 5% to 10% manganese. Foreign sources supplied 86,000 tons, of which all but 2,000 tons was manganese ore containing more than 35% manganese.

Battery and Miscellaneous Industries.—The ore reported in table 3 includes that consumed in making synthetic manganese dioxide by both electrolytic and chemical means but does not include consumption of synthetic dioxide. Although some synthetic dioxide is used for chemical purposes, most of it is used in manufacturing dry-cell batteries, particularly the alkaline-manganese dioxide type. Synthetic dioxide is also used as a blend with natural ore in carbon-zinc dry cells, mainly in the heavy-duty type.

Domestic capacity for synthetic manganese dioxide appeared on the verge of significant increase. Toward yearend, Chemetals began production of chemical manganese dioxide at its Baltimore, Md., plant, using new facilities with an annual capacity for dioxide of 6,600 tons. Foote Mineral completed and put into operation at its New Johnsonville, Tenn., location a pilot plant for electrolytic manganese dioxide. Kerr-McGee contracted with Rust Engineering Co. for a cost study of a plant capable of producing 10,000 to 12,000 tons of manganese dioxide annually. The proposed plant would be at Hamilton, Miss., adjacent to Kerr-McGee's existing facilities for manganese metal and various chemicals. Kerr-McGee stated the proposed plant would approximately double the company's production capacity for manganese dioxide, presently 12,000 tons per year at a plant in Henderson, Nev.

Major manufacturers of dry-cell batteries reported their sales held up well in spite of generally unfavorable economic conditions. The Battery Products Div. of Union Carbide completed a research and development center at Westlake, Ohio. The Duracell Inc. subsidiary of Dart & Kraft Inc., expanded internationally by acquiring the continental European battery business of British Ever Ready Ltd. In transactions beginning in the latter part of the year, Inco Ltd. of Canada sold RAYOVAC Corp. of Madison, Wis., then a part of Inco ElectroEnergy Corp., to a group of private investors. RAYOVAC'S battery operations include production of electrolytic manganese dioxide by ESB Materials Co. at Covington, Tenn.

American Minerals Inc., which specializes in grinding manganese ore, closed its plant at Philadelphia, Pa., and moved its facilities there to a larger plant near Wilmington, Del. The Wilmington plant had been purchased from C-E Minerals, a subsidiary of Combustion Engineering Inc., which had been grinding manganese ore and other materials at the plant.

PRICES

Manganese Ore.—All manganese ore prices are negotiated. Prices depend primarily on manganese content but also on other chemical constituents, and on physical character, quantity, delivery terms, ocean freight rates, insurance, inclusion or exclusion of duties if applicable, buyer's needs, and availability of ores having the specifications desired. Trade journal quotations reflect the editor's evaluation of the market. Information on contract prices for 1982 delivery of metallurgical ore to the United States was sparse, partly because ore buying for Elkem Metals was being conducted through the parent firm of Elkem AS in Norway. A representative average 1982 price for metallurgical ore containing 48% manganese of about $1.58 per long ton unit, c.i.f. U.S. ports, was judged to have been established as of midyear. This price represented a reduction from the 1981 average price of $1.72, in line with a worldwide trend of decreasing price that began with contracts negotiated by Japanese buyers in March and then by European consumers shortly afterwards.

Manganese Alloys.—Published price quotations indicated that domestic producers attempted to keep prices steady in spite of falling demand from the steel industry. However, competition from imported material priced progressively lower reportedly led to discounting by domestic producers. The two list prices of $530 and $490 per long ton of alloy, f.o.b. shipping point, for standard high-carbon ferromanganese with a minimum manganese content of 78% were reduced to only one in late January when Elkem Metals withdrew its list price of $530. The nominal $490 price that remained throughout the year was in contrast to an overall decline of roughly 10% in the price of imported high-carbon ferromanganese of the same manganese content. For imported material, the price range went from $400 to $430 in January to $365 to $380 in November and thereafter, per long ton of alloy, f.o.b. Pittsburgh or Chicago warehouse. The price of domestic silicomanganese began the year at 26.5 cents per pound of alloy, f.o.b. producer, but declined to 24.5 cents in late January when Elkem Metals lowered its price and other producers followed suit. No further price change was announced. The price of imported silicomanganese fell more sharply than that for imported standard ferromanganese, dropping from a range in January of 22.5 to 23.5 cents per pound of alloy, f.o.b. warehouse, to a range in November and thereafter of 16.5 to 18 cents, an overall decrease of about 25%.

Manganese Metal.—Two of the three domestic producers attempted to raise the price of standard and comparable grades of electrolytic manganese metal to 80 cents from 70 cents per pound for bulk shipments, f.o.b. producer plant, effective January 1. However, the increase was retracted in June as the other producer never raised its price, and discounting was reportedly being practiced by all in order to meet foreign competition.

FOREIGN TRADE

Ferromanganese exports were 10,311 tons valued at $7,517,481 in 1982, compared with 14,925 tons valued at $12,477,137 in 1981. Principal 1982 recipients were Canada, 7,441 tons; Trinidad and Tobago, 1,762 tons; and Mexico, 772 tons. Silicomanganese exports in 1982 totaled 2,952 tons with a value of $1,531,654, compared with 3,941 tons valued at $2,171,783 in 1981. Trinidad and Tobago, with 2,318 tons, was the principal recipient in 1982. Exports classified as "manganese and manganese alloys, wrought or unwrought, and waste and scrap" were, at 2,948 tons with a value of $3,860,730, higher than in 1981, in which year the corresponding totals were 2,523 tons and $3,979,619. Material in this classification was reported as exported to 26 countries in 1982, of which the leading recipients were Sweden, 578 tons; the Netherlands, 574 tons; Canada, 487 tons; the Federal Republic of Germany, 185 tons; and Brazil, 162 tons. This classification included electrolytic manganese metal and certain nonferrous manganese-rich products such as manganese-aluminum briquets.

Exports of ore and concentrate containing 5% or more manganese were 28,560 tons with a value of $2,510,226, compared with 65,064 tons valued at $5,132,190 in 1981. Practically all of the 1982 exports consisted of shipments to Canada, 17,203 tons; Mexico, 8,804 tons; Colombia, 1,653 tons; and Ecuador, 606 tons. Much of the tonnage to Canada and Mexico is believed to have been metallurgical ore obtained from excess Government stocks, whereas most of that exported elsewhere appears to have been imported manganese dioxide ore that may or may not have been ground, blended, or otherwise classified in the United States.

Imports of manganese ore fell by nearly two-thirds overall, as receipts from all 1981 source countries were down significantly. Distribution of 1982 supply was reported as the Republic of South Africa, 55%; Gabon, 19%; Australia, 16%; Morocco, 4%; Brazil, 3%; Canada, 2%; and Mexico, 1%. The average grade of imported manganese ore continued on the low side of 47%, reflecting the high proportion of ore from the Republic of South Africa plus a transshipment from Canada of ore averaging 41% manganese. Imports of manganiferous ore (more than 10% but less than 35% manganese) decreased to 1,479 tons, all of which was from Mexico with an average manganese content of 28%.

Imports of manganese ferroalloys and metal declined but not so precipitously as those of ore. The Republic of South Africa remained as the leading supplier of ferromanganese and virtually the only source of manganese metal imports, and was the third largest supplier of silicomanganese. For both ferromanganese and silicomanganese, about 80% of imports were received from the Republic of South Africa plus the three other leading source countries: France, Mexico, and Brazil for ferromanganese; and Brazil, Yugoslavia, and Australia for silicomanganese. The average manganese content of all ferromanganese imports was 78%, the same as in 1981.

Silicomanganese imports for consumption totaled 62,095 tons containing 41,121 tons of manganese in 1982 and 129,005 tons containing 84,900 tons in 1981. Sources and gross weight tonnages in 1982 were as follows: Brazil, 12,897; Yugoslavia, 12,511; the Republic of South Africa, 12,347; Australia, 11,883; Mexico, 5,209; Norway, 3,441; Canada, 1,980; France, 1,605; and Taiwan, 221.

Imports for consumption classified as unwrought manganese metal were 5,194 tons, reported as follows: the Republic of South Africa, 5,063; Canada, 71; and Australia, 60. Receipts from Australia were suspect and of low unit value. An additional 32 tons of manganese metal waste and scrap of low unit value were imported, all from Canada.

Imports for consumption of spiegeleisen were reported as 43 tons, of which about equal quantities were received from Canada and the Federal Republic of Germany.

Among imports for consumption of inorganic manganese compounds, those of manganese dioxide advanced to 19,746 tons compared with 16,310 tons in 1981. Almost all of the 1982 total was apparently battery-grade synthetic dioxide: 15,913 tons from Japan; 2,060 tons from Greece; 1,473 tons from Belgium; 219 tons from Ireland; 53 tons from Brazil; and 3 tons from the Federal Republic of Germany. Manganese sulfate imports of variable unit value totaled 74 tons, of which 64 tons were from Belgium, 10 tons from the Federal Republic of Germany, and negligible amounts from Sweden and Canada. Imports of potassium permanganate increased to 873 tons in 1982 versus 703 tons in 1981; principal sources in both years were Spain (515 tons in 1982) and China (294 tons in 1982).

Tariffs.—The respective rates of duty for manganese and manganiferous ore, metal, and the principal manganese ferroalloys are given in table 7. Tariff rates for ferroalloys were changed to a wholly ad valorem basis beginning in 1982, in accordance with the staged tariff reductions of the Tokyo Round of Multilateral Trade Negotiations.

Table 6.—U.S. imports[1] of manganese ore (35% or more Mn), by country

Country	1981			1982		
	Gross weight (short tons)	Mn content (short tons)	Value (thousands)	Gross weight (short tons)	Mn content (short tons)	Value (thousands)
Australia[2]	65,762	34,259	$5,028	36,884	18,842	$2,667
Brazil	76,252	38,909	6,291	6,167	2,962	344
Canada[3]	--	--	--	4,242	1,734	153
Gabon	179,528	90,629	13,582	46,059	23,156	3,514
Mexico	64,982	25,813	4,504	3,278	[4]1,492	345
Morocco[2]	25,407	[4]13,594	2,717	9,345	[4]4,996	968
South Africa, Republic of	227,211	97,536	10,522	131,782	57,873	8,169
Total[5]	639,141	300,740	42,643	237,759	111,054	16,160

[1]Quantities for general imports and imports for consumption were identical.
[2]After adjustment of data for shipment originally declared as from Australia but subsequently identified as having been from Morocco.
[3]Country of transshipment rather than original source.
[4]Includes Bureau of Mines conversion of part of reported data (from apparent MnO_2 content to Mn content).
[5]Data may not add to totals shown because of independent rounding.

Table 7.—U.S. import duties

Item	TSUS no.	Most favored nation (MFN)		Non-MFN
		Jan. 1, 1982	Jan. 1, 1987	Jan. 1, 1982
Ore and concentrate	601.27	Free	Free	1 cent per pound Mn.
Ferromanganese:				
Low-carbon	606.26	2.6% ad valorem[1]	2.3% ad valorem	22% ad valorem.
Medium-carbon	606.28	1.4% ad valorem[1]	1.4% ad valorem	6.5% ad valorem.
High-carbon	606.30	1.6% ad valorem[1]	1.5% ad valorem	10.5% ad valorem.
Silicomanganese	606.44	5.2% ad valorem[1]	3.9% ad valorem	23% ad valorem.
Metal	632.30	14% ad valorem	14% ad valorem	20% ad valorem.

[1]Free from certain countries under Generalized System of Preferences.

Table 8.—U.S. imports for consumption of ferromanganese, by country

Country	1981			1982		
	Gross weight (short tons)	Mn content (short tons)	Value (thousands)	Gross weight (short tons)	Mn content (short tons)	Value (thousands)
Australia	6,471	5,099	$2,168	6,063	4,759	$1,980
Brazil	12,401	9,425	3,676	30,864	23,607	8,853
Canada	62,422	48,793	21,169	18,360	14,241	5,669
China	5	4	3	--	--	--
France	189,498	148,139	65,729	102,854	80,729	35,710
Germany, Federal Republic of	39	33	33	1,252	1,031	691
India	--	--	--	9,645	7,204	2,646
Japan	4,949	4,002	2,948	5,627	4,564	3,334
Korea, Republic of	21	16	6	--	--	--
Mexico	45,654	35,786	18,325	34,422	27,400	13,866
Norway	5,109	4,069	2,420	1,056	907	965
Portugal	32,858	25,630	10,109	19,538	14,966	5,201
South Africa, Republic of	274,482	212,047	87,118	242,414	188,711	70,269
Spain	9,508	7,662	5,005	--	--	--
United Kingdom	14,257	10,659	3,565	16,756	12,585	4,245
Yugoslavia	13,503	10,465	4,343	3,858	2,998	1,063
Total[1]	671,178	521,827	226,618	492,708	383,702	154,490

[1]Data may not add to totals shown because of independent rounding.

WORLD REVIEW

Australia.—Manganese ore production declined again, by about one-fifth to 1,248,000 tons. Virtually all production was by Groote Eylandt Mining Co. Pty. Ltd. (Gemco). Gemco's export shipments were, in tons, to Japan, 535,000; Europe, 238,000; the Republic of Korea, 77,000; the United States, 66,000; Norway, 37,000; Pakistan, 28,000; and Taiwan, 18,000; for a total of 999,000, a minimal increase.[3] Shipments of 323,000 tons for domestic consumption were nearly 40% lower. Gemco was conducting test production of trial quantities of natural battery ore from a portion of its Groote Eylandt deposit.

Belgium.—A new and independent company, Belgische Venootschap voor Mangaanproduktion (BVM), was formed early in 1982 to conduct the manganese ferroalloy operations that had been a part of the Sadaci Div. of Sadacem NV. Ownership of BVM was divided equally between the Government steel-holding company, Société Nationale de Financement et de Participations de la Sidérurgie, which contributed capital, and Sadacem, which contributed manufacturing facilities at the existing plant near Ghent. BVM was equipped to produce ferromanganese of all grades and silicomanganese, production of which ferroalloys had been curtailed for some time.

Brazil.—Exports of manganese ore products from the Serra do Navio, Amapá Territory, operations of Indústria e Comércio de Minérios S.A. (ICOMI) via Porto de Santana on the Amazon River were 796,000 tons, a decrease of about one-seventh from those in 1981. In 1982, the largest part of exports again went to Europe, 563,000 tons. Destinations of the remainder were Asia, 116,000 tons; North America, 75,000 tons; and South American countries, 42,000 tons. ICOMI also shipped just over 200,000 tons to Brazilian customers, for total shipments of 996,000 tons.[4] Production of manganese ferroalloys increased by about one-sixth overall, advancing to another new record of just under 190,000 tons for silicomanganese and building again for ferromanganese, to 133,000 tons.

As part of the Grande Carajás Development Project, the Government in September chose state-controlled Cia. Vale do Rio Doce (CVRD) to develop the large manganese resources of the Carajás region, Pará state. CVRD's selection was in preference to several private parties that had made other proposals. CVRD had made a considerable investment in development of manganese mining in the region, and was producing battery ore on a small scale for domestic consumption. Full-scale mining was to commence with the Igarapé Azul (Blue Stream) deposits, which have been rated at over 40 million tons of ore containing more than 40% manganese. Initial production was targeted at about 500,000 tons of concentrates per year, to be followed by a doubling of production rate within a few years. Also projected for the Carajás region was installation of both a ferromanganese plant with an initial capacity of about 150,000 tons per year and hydroelectric facilities. Progress of the manganese projects rested upon that of a much larger development of iron ore mining already underway in the Carajás region, also by CVRD.

Manganese was one of several minerals identified as of interest in a new mineral province found north of the Amazon River, southwest of Serra do Navio. The new province, termed Novo Carajás and also in Pará state, was outlined by aeromagnetic surveying.

France.—Société du Ferromanganese de Paris-Outreau (SFPO) was reorganized in April, with ownership divided principally between Gabonese and French interests, as follows: Cie. Minière de l'Ogooué S.A. (COMILOG), the Gabonese manganese ore mining company, 35%; Société Nationale d'Investissement du Gabon, an agency of the Gabonese Government, 20%; Bureau de Recherches Géologiques et Minières, owned by the French Government, 35%; Aciéries de Paris et d'Outreau, the predecessor company to SFPO and in receivership since December 1978, 5.7%; and Cie. Financière de Paris et des Pays-Bas, a French investment bank, 4.3%. SFPO has been Western Europe's leading producer of ferromanganese. Its blast furnace plant at Boulogne has been both a major supplier of ferromanganese to the United States and a major consumer of Gabonese ore.

Blast furnace production of high-carbon ferromanganese plus a small amount of spiegeleisen was 370,000 tons in 1982, according to preliminary data.

Gabon.—Manganese ore production by COMILOG increased marginally to 1,667,000 tons at an average manganese content of 51%, of which about 1,550,000 tons was metallurgical and chemical ore, and 116,000 tons was battery ore (82% MnO_2). COMILOG's exports through Pointe Noire in the Congo declined 8% to 1,564,000 tons, of which about 1,468,000 tons was metallurgical and chemical ore, and 95,000 tons was battery ore. As in 1981, the majority of the exports of metallurgical ore were to Western Europe while the majority of the exports of battery ore were to the Far East. In 1981, the contribution of manganese ore to Gabon's total export earnings had fallen to 4% as compared with 6% in 1980. United States Steel Corp. continued to have the largest interest in COMILOG, although its shareholding decreased from 41% to 39% in 1982. A restructuring of France's SFPO in April gave Gabonese interests a majority of the ownership of that large blast furnace producer of ferromanganese. COMILOG's share of SFPO became 35% and that of the Gabonese Government 20%.

Ghana.—Exports of manganese ore by Ghana National Manganese Corp. dropped by one-third to 146,000 tons in 1982. Ore produced at the Nsuta Mine was exported through the port of Takoradi to the five Western European countries of Belgium, Ireland, Norway, Spain, and the United Kingdom and to Japan.[5] A plant to convert carbonate ore into oxide nodules and thereby extend the life of operations at Nsuta was being set up by Fuller Co. of the United States. At full capacity, this nodulizing plant would be able to process considerably more ore than has been produced annually in Ghana in recent years. The nodulizing process being installed was similar to that of Cía. Minera Autlán S.A. de C.V., in Mexico.

India.—Manganese Ore India Ltd. (MOIL) continued with development of plans for improving mine operations and for establishing plants for producing ferromanganese, synthetic manganese dioxide, and electrolytic manganese metal. These plans included beneficiation and sintering plants near the Balaghat Mine, Madhya Pradesh State, for increasing manganese recovery and utilizing fines. Projected annual capacities were 440,000 tons of run-of-mine feed for the beneficiation plant and 66,000 tons of fluxed product containing 40% manganese from the sinter plant. MOIL has been producing about one-third of total Indian ore output and a majority of the higher grade ore.

Italy.—Further seabed exploration in Italian territorial waters of the Tyrrhenian Sea between Italy and Sicily outlined deposits of pea-sized "micronodules" with a manganese content of about 40%. This finding was made under direction of the state-owned Societa per Azioni Minero-Metallurgiche in relatively shallow waters less than 300 feet deep. The economic potential of seafloor deposits in this area was yet to be determined.

Japan.—The average grade in 1982 of a somewhat diminished production of manganese concentrates was 26% manganese. Production of ferromanganese, silicomanganese, and manganese metal all decreased, by 5% to 593,000 tons for ferromanganese, by 5% to 297,000 tons for silicomanganese, and by 8% to 4,300 tons for metal. Exports of ferromanganese fell by nearly one-fourth to 29,400 tons, while those of silicomanganese remained insignificant. By contrast, imports of ferromanganese nearly doubled to 13,200 tons and those of silicomanganese increased by about one-sixth to over 83,000 tons. Production and exports of synthetic manganese dioxide both rose by 4% to 50,700 tons for production and by 14% to 34,500 tons for exports.

Mexico.—Minera Autlán S.A. de C.V., with mining operations in the Molango district of Hidalgo state, developed long-range plans for possible doubling of both mine and oxide nodule output. Under consideration were expansion of underground production from the existing Tetzintla Mine and development of a new open pit mine at Naopa. In 1981, Autlán mined over 800,000 tons of carbonate ore, as the company's underground production rose to equal its open pit production, and also mined 40,000 tons of battery ore at Nonoalco. Autlán's production of oxide nodules from carbonate ore was approximately 520,000 tons in 1981. Autlán's ferroalloy capacity was increased by installation of two new furnaces at the Tamos plant in Vera Cruz state. These furnaces, each rated at 15 megawatt-amperes, were built with the flexibility to produce high-carbon ferromanganese and silicomanganese as well as standard grades of ferrosilicon and silicon metal.

South Africa, Republic of.—South African Manganese Amcor Ltd. (SAMANCOR) acquired Middelplaats Manganese Ltd. from Anglo American Corp. of South Africa Ltd., effective March 31. SAMANCOR thus became owner also of an underground mine near SAMANCOR's large open pit Mamatwan Mine in the southern portion of the Kalahari manganese field. The acquisition was accomplished by transfer of shares in SAMANCOR to Anglo American, which further increased Anglo American's part ownership of SAMANCOR. The announcement of the acquisition indicated that Middelplaats Manganese would continue to operate independently and that rationalization of production and cost savings were to be expected. Ore mining and processing at the Middelplaats Mine, which opened in 1979, were described.[6]

Preliminary data indicated manganese ore production totaled about 5,750,000 tons, an increase of 3% over that of 1981. Production of metallurgical ore containing over 45% manganese rose significantly, whereas production of metallurgical ore containing less than 40% manganese fell somewhat because of a declining production rate in the latter half of the year. In tons, the approximate 1982 production of metallurgical ore was 5,380,000 of which 2,540,000 contained 30% to 40% manganese, 790,000 contained 40% to 45% manganese, 1,570,000 contained 45% to 48% manganese, and 490,000 contained over 48% manganese. The approximate 1982 production of chemical ore was 369,000 tons, of which 325,000 contained less than 35% manganese dioxide, 43,000 contained 35% to 65% manganese dioxide, and 115 contained 65% to 75% manganese dioxide.

Ferromanganese production was curtailed by both of the leading producers, Metalloys Ltd., a subsidiary of SAMANCOR with a plant at Meyerton in Transvaal Province, and Feralloys Ltd., a subsidiary of The Associated Manganese Mines of South Africa Ltd., with a plant at Cato Ridge in Natal Province. Metalloys terminated an unexpired, longstanding arrangement under which Iscor Ltd. had been using a blast furnace at Newcastle in Natal Province to convert manganese ore into ferromanganese for Metalloys.

U.S.S.R.—Ore production is believed to have increased slightly for 1982. During the year, a new open pit with an annual output of over 100,000 tons was put into operation in the Chiatura Basin in Georgia. Official statistics for 1981 indicated the average grade of ore and concentrates was 30% manganese. Production and exports of ore and concentrates both declined in 1981 compared with those in 1980, more so for production than for exports. Exports of ore and concentrates in 1981 totaled 1,316,000 tons; principal destinations, which accounted for over 90% of the export total, were, in tons: Poland, 543,000; Czechoslovakia, 410,000; German Democratic Republic, 143,000; and Bulgaria, 129,000.

Zaire.—Société Minière de Kisenge (SMK) was included on a Government listing of unprofitable state-owned enterprises to be converted to private management. SMK continued to hold a large stockpile of previously mined ore, as prolongation of difficulties with rail transport impeded shipments out of the country.

Table 9.—Manganese ore: World production, by country[1]

(Thousand short tons, gross weight)

Country[2]	Percent Mn[e]	1978	1979	1980	1981[p]	1982[e]
Australia	37-53	[r]1,386	[r]1,900	2,226	1,597	[3]1,248
Bolivia[4] [5]	28-54	1	12	1	1	([6])
Brazil[7]	38-50	2,113	2,490	2,515	2,251	1,433
Bulgaria	30-	44	46	54	50	55
Chile	32-36	26	28	31	28	26
China[e] [8]	20+	1,400	1,650	1,750	1,760	1,760
Egypt	28+	([6])	--	--	--	--
Gabon	50-53	1,885	2,535	2,366	1,640	[3]1,667
Ghana	30-50	348	300	278	248	146
Greece	48-50	8	6	6	6	6
Hungary[9]	30-33	126	91	91	78	102
India[10]	10-54	1,785	1,935	1,814	1,682	[3]1,596
Indonesia	47-56	6	7	5	3	4
Iran[11]	33+	33	[e]22	--	--	--
Italy[12]	30	11	11	10	10	10
Japan	24-28	115	97	88	96	[3]90
Korea, Republic of	23-40	1	([6])	([6])	--	--
Mexico[4]	27+	577	543	493	637	[3]561
Morocco	50-53	139	150	145	121	[3]104
Pakistan	35-	([6])	([6])	([6])	([6])	([6])
Philippines	35-45	4	4	3	3	3
South Africa, Republic of	30-48+	4,759	5,713	6,278	5,555	[3]5,750
Sudan	48	([6])	([6])	([6])	([6])	([6])
Thailand	46-50	80	39	60	12	9
Turkey	27-46	75	[r]46	46	16	6
U.S.S.R.[13]	30-33	9,984	11,292	10,750	10,090	10,140
Vanuatu (formerly New Hebrides)	40-44	23	12	--	--	--
Yugoslavia	30+	30	33	33	34	34
Zaire	30-57	--	--	18	34	4
Total	XX	[r]24,959	[r]28,962	29,061	25,952	24,754

[e]Estimated. [p]Preliminary. [r]Revised. XX Not applicable.

[1]Table includes data available through July 6, 1983.

[2]In addition to the countries listed, Colombia, Cuba, and the Territory of South-West Africa (Namibia) may have produced manganese ore and/or manganiferous ore, but available information is inadequate to make reliable estimates of output levels. Low-grade ore not included in this table has been reported as follows in thousand short tons: Argentina (16% to 22% Mn), 1978—20, 1979—11, 1980—7, 1981—3, 1982—2; Czechoslovakia (about 17% Mn), an estimated 1 in each year; Malaysia (grade unspecified but apparently a manganiferous ferruginous ore), 1978—47, 1979—35, 1980—4, 1981—zero, 1982—zero; Romania (about 22% Mn), an estimated 90 in each year; the Republic of South Africa (15% to 30% Mn, in addition to material listed in table), 1978—105, 1979-82—zero.

[3]Reported figure.

[4]Estimated on the basis of reported contained manganese.

[5]Exports.

[6]Less than 1/2 unit.

[7]Figures are the sum of (1) sales of direct-shipping manganese ore and (2) production of beneficiated ore, both as reported in Annuario Mineral Brasileiro.

[8]Includes manganiferous ore.

[9]Concentrate. Crude ore tonnages (18% to 26% Mn) were reported prior to 1978.

[10]Much of India's production grades below 35% Mn; recent details on output by grade are not available.

[11]Reported as if data are for calendar years, but may actually represent output for Iranian calendar years beginning Mar. 21 of the year stated.

[12]From wastes.

[13]Reported in Soviet sources. Grade represents the annual averages obtained from reported metal contents of the gross weights shown.

TECHNOLOGY

The Bureau of Mines extended the information available on the thermodynamic properties of two manganese oxides, Mn_3O_4 and Mn_2O_3. Experiments were conducted in which equilibrium oxygen pressures for the systems MnO-Mn_3O_4-O_2 and Mn_3O_4-Mn_2O_3-O_2 were measured. A high-temperature solid-state electrochemical cell employing a zirconia electrolyte was used.[7]

The Bureau also developed information relating to waste management aspects of extracting manganese and other metals from ocean nodules. Mineralogical and chemical compositions of manganese nodules from the Pacific Ocean were reviewed, as were physical and chemical characteristics of wastes likely to be generated by first-generation nodule-processing plants.[8]

A Minerals Availability System study by the Bureau of Mines indicated that profitable utilization of representative domestic deposits would require an ore price ranging from about 5 times up to nearly 20 times the then prevailing price.[9] In making a mineral assessment of Chugach National Forest, Alaska, the Bureau found a manganese-bearing outcrop, a sample of which contained 17% manganese; selected specimens contained up to 37% manganese.[10]

Solid-phase equilibria in the iron-rich portion of the iron-manganese system were investigated by means of laboratory experiments involving use of diffusion couples and equilibration procedures. Limiting compositions for fully ferritic and fully austenitic phases were established for temperatures of about 600° C up to the alpha-to-gamma transformation temperature of 911° C for pure iron.[11]

The significance of factors to be considered in manufacturing and using austenitic manganese steel castings was reviewed. Most such castings have the same basic composition as that proposed in the 19th century by Hadfield, about 1.2% carbon and 13% manganese. Thickness of many manganese steel castings dictates that their carbon content should not be increased above that of the basic composition; otherwise mechanical properties deteriorate. The very high toughness of manganese steel is an important reason for selecting it for such uses as large crushing equipment.[12]

Steel containing relatively high contents of manganese and aluminum have been under investigation as cheaper alternatives to nickel-chromium stainless steel, with manganese substituting for nickel and aluminum for chromium. A steel with 30% manganese and 10% aluminum has been proposed to replace brass for seagoing ship propellers, and a test propeller of this steel has been placed in service on a Chinese fishing vessel.[13] Manganese-aluminum steels of similar and other compositions have shown promise as alternatives to Type 304 stainless steel for resisting oxidation at about 600° C.[14] The potential of manganese-aluminum steels as substitutes for austenitic stainless steels in cryogenic applications was also being explored. Mechanical properties of a 24% manganese, 5% aluminum steel both at room temperature and 78° K were favorable enough that evaluation of other properties was recommended.[15] A low-carbon steel with about 20% manganese, 1% aluminum, 3% chromium, and 1% nickel was suggested for making castings for cryogenic service.[16]

The American Society for Testing and Materials issued a revised specification for ferromanganese, A99-82, which was essentially unchanged from the previous specification, A99-76, except for addition of information on friability.[17]

Laboratory tests indicated manganese oxide powder of chemical formula Mn_3O_4 was a possible new inorganic coloring and/or corrosion-inhibiting pigment usable in a variety of coatings. Epoxy-ester, epoxy-polyamide, and some inorganic coating formulations pigmented with manganese oxide performed favorably compared with similar coatings containing such established pigments as zinc chromate, zinc dust, titanium dioxide, and red iron oxide.[18]

Pilot plant trials of a slurry electrode process for electrolytic manganese dioxide (EMD) were made by Broken Hill Pty. Ltd. of Australia. The test process was based on reversibility of the dioxide deposition reaction of the standard sulfate process. Partly because barium impurity in the ore feed interfered, commercially satisfactory results were not achieved in the pilot plant. By also operating the pilot plant using standard sulfate technology, it was found that commercially acceptable EMD could be produced from Groote Eylandt ore.[19]

Test work in India outlined the possibility of coextracting zinc metal, battery-grade manganese dioxide, and elemental sulfur from a combined feed of zinc sulfide concentrate and high-grade pyrolusite-type manganese ore. The first step of the process was to leach feed material having a stoichiometric ZnS:MnO_2 ratio at about 100° C in the presence of a proprietary additive. The resultant zinc- and manganese-bearing solution was then electrolyzed under optimized conditions to achieve simultaneous deposition of zinc at the cathode and manganese dioxide at the anode.[20]

[1]Physical scientist, Division of Ferrous Metals.

[2]Unless otherwise stated, the unit of weight used in this chapter is the short ton of 2,000 pounds.

[3]Skillings' Mining Review. V. 72, No. 18, Apr. 30, 1983, p. 17.

[4]———. V. 72, No. 25, June 18, 1983, p. 15.

[5]———. V. 72, No. 9, Feb. 26, 1983, p. 20.

[6]Engineering & Mining Journal. SAMANCOR's Middleplaats. V. 183, November 1982, pp. 136-137.

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[8]Haynes, B. W., S. L. Law, and D. C. Barron. Mineralogical and Elemental Description of Pacific Manganese Nodules. BuMines IC 8906, 1982, 60 pp.

Haynes, B. W., and S. L. Law. Predicted Characteristics of Waste Materials From the Processing of Manganese Nodules. BuMines IC 8904, 1982, 10 pp.

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[14]Garcia, J. C., N. Rosas, and R. J. Rioja. Development of Oxidation Resistant Fe-Mn-Al Alloys. Metal Prog., v. 122, August 1982, pp. 47-50.

[15]Charles, J., A. Lutts, and A. Berghezan. High-Alloy Manganese-Aluminum Steels for Cryogenic Applications. Adv. in Cryogenic Eng., No. 28, 1982, pp. 105-114.

[16]Li, L.-S., D.-Z. Yang, G.-S. Wei, and C. M. Wayman. Structure and Properties of Low-Carbon High-Manganese Cast Steels for Cryogenic Use. Metallography, v. 15, December 1982, pp. 355-365.

[17]American Society for Testing and Materials. Standard Specification for Ferromanganese A99-82. In 1983 Annual Book of ASTM Standards, Section 1—Iron and Steel Products, v. 01.02—Ferrous Castings; Ferroalloys; Shipbuilding. Philadelphia, PA, 1983, pp. 71-74.

[18]Metil, I. Developments in Inorganic Pigments. Modern Paint and Coatings, v. 72, June 1982, pp. 49-55.

[19]Dim, A., and D. B. Fraser. Pilot Plant Production of Electrolytic Manganese Dioxide. BHP Tech. Bull., v. 26, No. 1, 1982, pp. 60-64.

[20]Pande, A. M., K. N. Gupta, and V. A. Altekar. Single Cell Extraction of Zinc and Manganese Dioxide From Zinc Sulphide Concentrate and Manganese Ores. Hydrometallurgy, v. 9, No. 1, 1982, pp. 57-68.

Mercury

By Linda C. Carrico[1]

Domestic mercury mine production and imports for consumption declined in 1982. Mine production decreased for the second consecutive year and was reported by three mines, all located in Nevada. Secondary production declined in 1982 primarily because of the General Services Administration's (GSA) temporary suspension of auctions in October 1981. Consumption and prices also declined.

World mine production of mercury declined owing partly to the closure of the Monte Amiata mercury mine in Italy at midyear.

Domestic Data Coverage.—Domestic data for mercury are developed by the Bureau of Mines from three separate, voluntary surveys of U.S. operations. Typical of these surveys is Mercury, a survey of mercury consumption. Of the 410 operations to which this survey was sent, 85% responded, representing an estimated 99% of the total U.S. consumption shown in tables 1, 5, and 6. Consumption for the remaining 61 nonrespondents was estimated using prior years' consumption levels.

Table 1.—Salient mercury statistics

	1978	1979	1980	1981	1982
United States:					
Producing mines	2	3	4	3	3
Production flasks	24,163	29,519	30,657	27,904	25,760
Value thousands	$3,705	$8,299	$11,939	$11,549	W
Imports:					
For consumption flasks	41,693	26,448	9,416	12,408	8,916
General do	42,874	28,818	11,564	13,024	15,217
Stocks, Dec. 31 do	38,749	27,582	33,069	27,339	29,327
Consumption do	59,393	62,205	58,983	59,244	48,943
Price: New York, average per flask	$153.32	$281.10	$389.45	$413.89	$370.93
World:					
Production flasks	[r]181,372	[r]174,436	205,210	[p]213,970	[e]204,009
Price: London, average per flask	$131.57	$291.73	$398.07	$417.52	$376.96

[e]Estimated. [p]Preliminary. [r]Revised. W Withheld to avoid disclosing company proprietary data.

Legislation and Government Programs.—During 1982, under Public Law 97-35, dated August 13, 1981, GSA sold primary mercury and mercuric oxide held in the National Defense Stockpile.

On the third Tuesday of each month, GSA continued to auction primary mercury from the National Defense Stockpile and sold 6,403 flasks[2] of primary mercury in 1982, leaving 42,924 flasks available for disposal. Total inventory at yearend was 184,315 flasks. In June, Congress removed the domestic consumption restriction, allowing the primary mercury sold from the National Defense Stockpile to be exported.

On August 4, GSA held the first in a series of monthly auctions of surplus mercuric oxide held in the National Defense Stockpile, selling 1,000 pounds. GSA rejected bids received in September and October and later canceled its auctions of mercuric oxide for November and December because the containers holding the mercuric oxide did not conform to U.S. Department of Transportation regulations. When the container problem is resolved, GSA will resume offering a maximum of 35,000 pounds of mercuric oxide on the first Wednesday of each month with a minimum acceptable bid of 1,000 pounds. At yearend, the stockpile contained 712,202 pounds of mercuric oxide, all of which was available for disposal. The mercuric oxide held in the stockpile is equivalent to 659,592 pounds or 8,679 flasks of mercury metal. Under Public Law 97-35, the mercuric oxide sold from the National Defense Stockpile was restricted for domestic consumption.

The Environmental Protection Agency (EPA), under the Clean Water Act, issued final regulations on December 3, 1982, on the discharge of waste water from ore mining and milling facilities.[3] EPA set effluent limitations for mercury at 0.002 milligram per liter as a maximum for any 1 day and 0.001 milligram per liter on an average daily value for 30 consecutive days.

DOMESTIC PRODUCTION

Three mines were in operation during 1982: the Carlin gold mine, the Pinson gold mine, and the McDermitt mercury mine, all located in Nevada. The Carlin and Pinson Mines continued to recover mercury as a byproduct of their gold mining operations, while the McDermitt Mine remained the principal mercury producer in the United States. The numerous mercury mines that once produced in the United States remained closed because of low prices and high costs associated with mining and environmental pollution control requirements.

Placer Amex Inc. continued exploration work at its McDermitt Mine in Nevada and other mercury prospects in the Western United States. The McDermitt Mine had about 6 years of proven reserves based on an annual production rate of about 25,000 flasks.

Secondary mercury production decreased, due primarily to the temporary suspension of auctions of surplus secondary mercury conducted by GSA. Other major sources of secondary mercury were batteries, dental amalgams, sludges, and obsolete industrial and control instruments.

Table 2.—Mercury produced in the United States

Year and State	Producing mines	Flasks	Value[1] (thousands)
1981:			
California and Nevada	3	27,904	$11,549
1982:			
Nevada	3	25,760	W

W Withheld to avoid disclosing company proprietary data.
[1]Value calculated at average New York price.

Table 3.—Mercury ore treated and mercury produced in the United States[1]

Year	Ore treated (short tons)	Mercury produced	
		Flasks	Pounds per ton of ore
1978	256,197	24,144	7.2
1979	242,564	29,499	9.2
1980	356,043	30,623	6.5
1981	262,380	27,888	8.1
1982	300,978	25,704	6.5

[1]Excludes mercury produced from old surface ores, dumps, and placers, and as a byproduct.

Table 4.—Production of secondary mercury in the United States

(Flasks)

Year	Industrial production	GSA releases	Total
1978	3,560	5,702	9,262
1979	4,287	11,300	15,587
1980	6,793	10,013	16,806
1981	4,244	7,000	11,244
1982	4,473	--	4,473

CONSUMPTION AND USES

The battery industry continued to be the dominant consumer of mercury followed by paints, chlorine and caustic soda, measuring and control devices, wiring devices and switches, and other uses.

Pennwalt Corp. closed its Calvert City, Ky., chlorine and caustic soda plant, a major user of mercury, in early 1982. Shipments of mercury from the closed plant were about 4,000 flasks. Mercury consumed in the production of chlorine and caustic soda decreased 15%, due primarily to the closure of the Calvert City facility.

Table 5.—Mercury consumed in the United States, by use

(Flasks)

Use	1978	1979	1980	1981	1982
Agriculture[1]	W	W	W	79	36
Catalysts	W	548	265	815	499
Dental preparations	512	793	1,041	1,866	1,213
Electrical apparatus	(2)	(2)	(2)	(2)	(2)
Electrolytic preparation of chlorine and caustic soda	11,166	12,180	9,470	7,323	6,224
General laboratory use	420	410	363	328	272
Industrial and control instruments	(2)	(2)	(2)	(2)	(2)
Paint, mildew proofing	8,956	9,979	8,621	7,049	6,794
Pharmaceuticals	W	W	--	--	--
Other[3]	(2)	(2)	(2)	(2)	(2)
Total known uses	59,393	62,205	58,983	59,244	48,943

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes fungicides and bactericides for industrial purposes.
[2]See table 6 of this chapter and those of previous years for SIC end-use data.
[3]Includes mercury used for installation and expansion of chlorine and caustic soda plants.

Table 6.—Mercury consumed in the United States in 1982, by use

(Flasks)

Use	Primary	Redistilled	Secondary	Total
Chemicals and allied products:				
Chlorine and caustic soda preparation	6,224	--	W	6,224
Pigments	W	--	--	W
Catalysts	W	W	--	499
Laboratory uses	152	120	W	272
Plastic materials and synthetic (processing and resins)	W	--	--	W
Paint	6,794	--	--	6,794
Agricultural chemicals	36	--	--	36
Chemicals and allied products, n.e.c	W	W	--	W
Electrical and electronic instruments:				
Electrical lighting	W	W	--	826
Wiring devices and switches	1,553	451	W	2,004
Batteries	17,323	W	W	24,880
Other electrical and electronic equipment	W	W	--	W
Instruments and related products:				
Measuring and control devices	1,291	1,773	W	3,064
Dental equipment and supplies	W	1,019	W	1,019
Other instruments and related products	W	W	W	194
Other identified end uses:				
Refining lubricating oils	--	--	W	W
Other	W	W	W	982
Other	2,753	8,207	1,247	2,149
Total known uses	36,126	11,570	1,247	48,943

W Withheld to avoid disclosing company proprietary data; included with "Other."

Table 7.—Stocks of mercury, December 31

(Flasks)

Year	Producer (mine)	Consumer and dealer	Total
1978	16,600	22,149	38,749
1979	9,181	18,401	27,582
1980	11,095	21,974	33,069
1981	11,783	15,556	27,339
1982	14,098	15,229	29,327

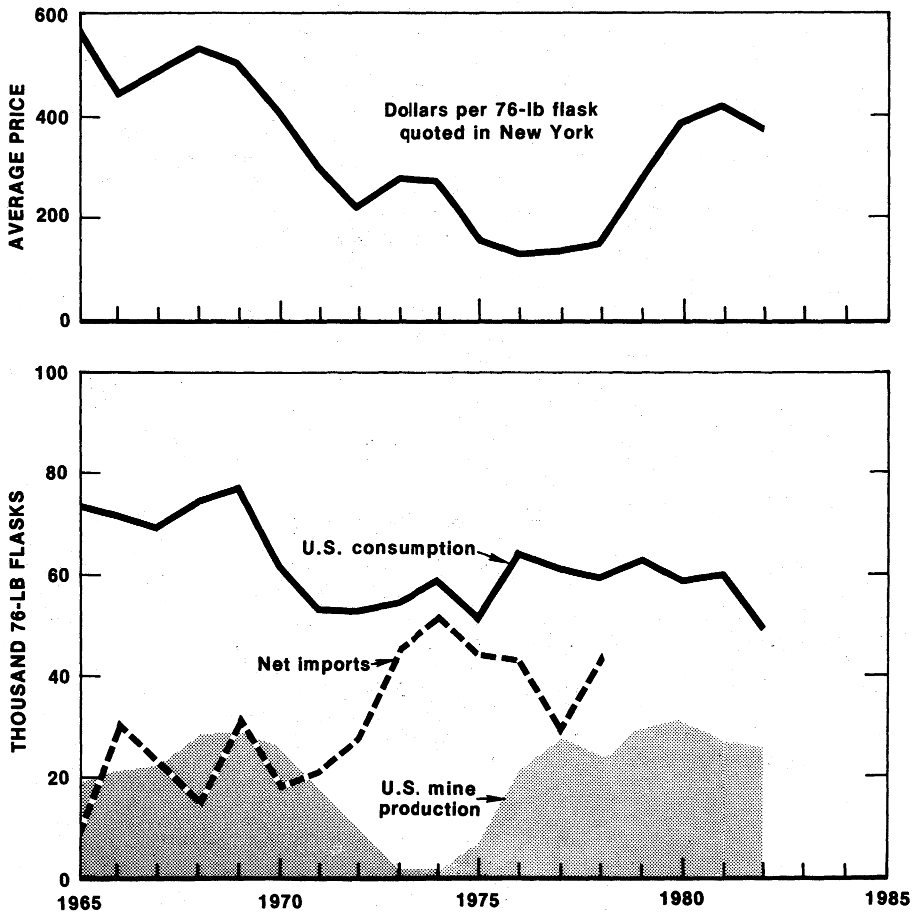

Figure 1.—Trends in production, consumption, net imports, and price of mercury, in the United States.

PRICES

Domestic mercury prices generally declined during 1982, averaging $370.93 per flask on the New York market compared with $413.89 per flask in 1981. The New York dealer price began the year at $418 to $425 per flask and declined to $380 to $390 per flask by yearend. London prices showed a similar pattern during 1982; the annual average London price was $376.96 per flask compared with $417.52 per flask in 1981. The London price began the year in a range of $416 to $422 per flask and ended the year at $350 to $360 per flask.

Table 8.—Average monthly prices of mercury at New York and London

(Per flask)

	1981		1982	
	New York[1]	London[2]	New York[1]	London[2]
January	$364.52	$368.06	$396.75	$410.06
February	381.39	389.00	375.00	394.69
March	409.77	413.61	386.74	391.94
April	417.96	421.88	372.38	382.56
May	413.75	426.67	359.00	375.63
June	419.32	430.00	362.00	373.56
July	433.17	429.33	355.57	369.56
August	441.67	430.56	331.59	364.89
September	430.52	430.06	363.57	366.81
October	426.14	427.78	376.25	369.83
November	418.22	422.38	391.05	365.06
December	410.18	420.95	381.30	358.89
Average	413.89	417.52	370.93	376.96

[1]Metals Week, New York.
[2]Metal Bulletin, London; reported in terms of U.S. dollars.

FOREIGN TRADE

There were no mercury exports reported in 1982.

Imports for consumption of mercury in 1982, which includes mercury imported for immediate consumption plus material withdrawn from bonded warehouses, decreased substantially and reached the lowest level since 1941. The average unit value of imports during 1982 was $336.81 per flask, compared with $403.37 per flask in 1981.

The U.S. rate of duty on mercury metal imports from countries with most-favored-nation status in 1982 was 10.6 cents per pound ($8.06 per flask). The statutory rate of 25 cents per pound ($19 per flask) applied to other countries.

Table 9.—U.S. imports for consumption[1] of mercury, by country

Country	1980		1981		1982	
	Flasks	Value (thousands)	Flasks	Value (thousands)	Flasks	Value (thousands)
Canada	843	$197	112	$78	5	$14
China	204	61	801	308	100	42
Denmark	--	--	500	201	390	161
Dominican Republic	200	73	129	54	--	--
France	--	--	(2)	(2)	--	--
Germany, Federal Republic of	15	24	--	--	2	1
Japan	3,813	1,260	2,372	925	4,345	1,444
Mexico	989	206	104	29	182	59
Netherlands	--	--	--	--	200	62
Philippines	--	--	--	--	881	293
Spain	3,352	1,020	4,989	2,021	1,404	484
Turkey	--	--	500	197	900	286
United Kingdom	--	--	--	--	507	157
Yugoslavia	--	--	2,901	1,192	--	--
Total	9,416	2,841	12,408	5,005	8,916	3,003

[1]General imports: 1980—11,564 ($3,618,781), China 200 ($60,635), Japan 5,464 ($1,840,377), and Spain 3,853 ($1,218,025); 1981—13,024 ($5,259,480), Japan 2,317 ($898,675), and Spain 6,160 ($2,503,566); 1982—15,217 ($5,200,795), Japan 5,156 ($1,718,367), Spain 4,863 ($1,750,498), and the United Kingdom 2,538 ($814,529).
[2]Less than 1/2 unit.

WORLD REVIEW

World mine production of mercury in 1982 decreased, primarily in response to declining world demand and prices. The International Association of Mercury Producers, Assimer, met periodically in 1982 to review the mercury market.

Italy.—Italy's nonferrous metals agency, Societa per Azioni Minero-Metallurgiche, reported the suspension of mercury production at the Monte Amiata mercury mine on July 2 because of poor demand, low prices, and rising stocks. The mine had been in operation for about 15 months prior to its temporary closure.

Yugoslavia.—The Government plans to reopen the Idria mercury mine in 1983. Planned production is expected to be about 8,700 flasks annually. The reopening was prompted by the discovery of a new mineral vein, close to the surface, which could be mined using open pit methods.

[1]Mineral specialist, Division of Nonferrous Metals.
[2]Flask, as used throughout this chapter, refers to the 76-pound flask.
[3]Environmental Protection Agency. Ore Mining and Dressing Point Source Category Effluent Limitations Guidelines and New Source Performance Standards. Federal Register, v. 47, No. 233, Dec. 3, 1982, pp. 54598-54621.

Table 10.—Mercury: World production, by country[1]

(Flasks)

Country	1978	1979	1980	1981[p]	1982[e]
Algeria	[r]30,592	[r]14,719	24,403	[e]25,000	20,000
China[e]	20,000	20,000	20,000	20,000	20,000
Czechoslovakia	5,686	4,960	6,236	8,383	8,500
Dominican Republic	[r]449	[r]281	159	77	[2]49
Finland	1,145	[r]1,348	2,170	1,949	2,000
Germany, Federal Republic of	2,437	2,639	1,624	2,205	2,200
Italy	87	--	96	7,310	4,000
Mexico	2,205	1,973	4,206	6,962	6,500
Spain	29,588	33,275	49,198	45,253	45,000
Turkey	5,020	[r]4,722	4,461	5,927	6,000
U.S.S.R.[e]	60,000	61,000	62,000	63,000	64,000
United States	24,163	29,519	30,657	27,904	[2]25,760
Total	[r]181,372	[r]174,436	205,210	213,970	204,009

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through Apr. 13, 1983.
[2]Reported figure.

Mica

By Fred Block[1] and Wilton Johnson[2]

In 1982, a total of 106,000 short tons of scrap and flake mica was reported produced in the United States, a 20% decrease from 1981 production. Output of ground mica decreased similarly to 96,000 tons.

Consumption of mica block decreased sharply by 43% to 95,000 pounds. Consumption of mica splittings also declined significantly, 40%, to 2.6 million pounds.

Exports of unmanufactured mica remained at 11,000 tons. The total value of imports of all forms of mica decreased 10% to $6.5 million.

Domestic Data Coverage.—Domestic production and consumption data for mica are developed by the Bureau of Mines by means of three separate, voluntary domestic surveys and one mandatory domestic survey. Of the 58 canvassed operations to which 1 or more of the 4 survey forms were submitted, 54 operations, or 93%, responded, representing 96% of the total mica production and consumption data shown in table 1. Production and consumption for the nonrespondents were estimated by adjusting reported prior year production and consumption levels using the percentage decrease for respondent data for 1982 compared with that for 1981.

Table 1.—Salient mica statistics

	1978	1979	1980	1981	1982
United States:					
Production (sold or used by producers):					
Sheet mica ---- thousand pounds	(1)	1	NA	NA	NA
Value ---- thousands	(1)	(1)	NA	NA	NA
Scrap and flake mica ---- thousand short tons	139	134	116	133	106
Value ---- thousands	$7,916	$7,708	$6,262	$8,212	$6,302
Ground mica ---- thousand short tons	124	122	111	117	96
Value ---- thousands	r$13,775	r$15,169	r$14,870	r$17,440	$16,106
Consumption:					
Block ---- thousand pounds	239	277	156	166	95
Value ---- thousands	$1,328	$1,841	$1,886	$1,533	$1,366
Film ---- thousand pounds	8	5	4	3	3
Value ---- thousands	$34	$25	$18	$13	$15
Splittings ---- thousand pounds	5,537	4,877	4,383	4,386	2,639
Value ---- thousands	$3,031	$3,248	$3,101	$3,064	$2,032
Exports ---- thousand short tons	9	12	14	11	11
Imports ---- do	7	10	12	13	10
World: Production ---- thousand pounds	r775,319	r734,226	697,492	p737,895	e624,602

eEstimated. pPreliminary. rRevised. NA Not available.
[1]Less than 1/2 unit.

Legislation and Government Programs.—The total Government inventory of stockpile-grade natural sheet mica was reduced by 5% to 26.1 million pounds by December 31, 1982. Sales of sheet mica by the General Services Administration (GSA) during 1982 were 603,000 pounds of muscovite splittings and 23,000 pounds of phlogopite splittings. GSA sold no block or film mica during 1982.

Table 2.—Stockpile goals and Government inventories for mica, December 31, 1982

(Thousand pounds)

Material	Goal	Inventory: Stockpile grade	Inventory: Non-stockpile grade	Available for disposal	Sales 1981-82
Block:					
Muscovite, Stained and better	6,200	5,006	207	--	--
Phlogopite	210	17	114	--	--
Film: Muscovite, 1st and 2d qualities	90	1,274	1	--	--
Splittings:					
Muscovite	12,630	18,165	--	5,120	603
Phlogopite	930	1,681	--	749	23

DOMESTIC PRODUCTION

Scrap and Flake Mica.—U.S. production of scrap (flake) mica[3] in 1982 was 106,000 tons valued at $6.3 million. North Carolina was again the major producing State with 63% of the total. The remaining 37% was produced in Connecticut, Georgia, New Mexico, Pennsylvania, South Carolina, and South Dakota. Most of the scrap (flake) mica was recovered from mica schist, high-quality sericite schist, and as a byproduct of kaolin, feldspar, and lithium beneficiation. The five leading producers in 1982 were, in order of output, Mineral Industrial Commodities of America, Inc. (M.I.C.A.), Santa Fe, N. Mex.; Kings Mountain Mica Co., Kings Mountain, N.C.; Lithium Corp. of America, Inc., Gastonia, N.C.; Feldspar Corp., Spruce Pine, N.C.; and Mineral Mining Corp., Kershaw, S.C.

Ground Mica.—Production (sold or used) of ground mica, from scrap and flake mica, decreased by 18% to 96,000 tons from that of 1981. Dry-ground mica, 89% of the total, decreased by 21%, whereas wet-ground mica remained unchanged. The total value of ground mica production was $16.1 million.

During 1982, 15 companies operated 16 grinding plants; of these, 12 produced dry-ground, 2 produced wet-ground, and 1 produced both wet- and dry-ground material. Leading ground mica producers were, in order of output, Harris Mining Co., Spruce Pine, N.C.; M.I.C.A., Santa Fe, N. Mex.; Kings Mountain Mica, Kings Mountain, N.C.; Western Mica Co., a division of United States Gypsum Co., Chicago, Ill.; and Deneen Mica Co., Micaville, N.C.

In 1982, production of low-quality sericite, primarily for use in brick manufacturing, was 29,100 tons valued at $93,100. Approximately 29,600 tons of ground sericite valued at $177,400 was produced in 1982 from this crude sericite. Low-quality sericite is excluded from tabulated data contained in this report.

Table 3.—Scrap and flake mica sold or used by producers in the United States[1]

(Thousand short tons and thousand dollars)

Year and State	Quantity	Value
1978	139	7,916
1979	134	7,708
1980	116	6,262
1981	133	8,212
1982:		
North Carolina	67	4,793
Other States[2]	38	1,509
1982 total	[3]106	6,302

[1]Includes finely divided mica recovered from mica schist and high-quality sericite schist, and mica that is a byproduct of feldspar, kaolin, and lithium beneficiation.

[2]Includes Connecticut, Georgia, New Mexico, Pennsylvania, South Carolina, and South Dakota.

[3]Data do not add to total shown because of independent rounding.

Table 4.—Ground mica sold or used by producers in the United States, by method of grinding[1]

(Thousand short tons and thousand dollars)

Year	Dry-ground		Wet-ground		Total[2]	
	Quantity	Value	Quantity	Value	Quantity	Value
1978	110	r9,835	14	3,940	124	r13,775
1979	108	r10,840	14	4,329	122	r15,169
1980	100	r11,381	10	r3,490	111	r14,870
1981	107	r13,439	11	r4,001	117	r17,440
1982	85	11,604	11	4,502	96	16,106

rRevised.
[1]Domestic and some imported scrap. Low-quality sericite is not included.
[2]Data may not add to totals shown because of independent rounding.

CONSUMPTION AND USES

Sheet Mica.—Consumption of muscovite block (ruby and nonruby) totaled 85,500 pounds, a decrease of 45% from that of 1981. Of the total muscovite block fabricated, 82% went into electronic uses, more than one-half for vacuum tubes. The remaining 18% went into nonelectronic uses, including gauge glass and diaphragms, 4%, and other uses, 14%. Most of the decrease in consumption was in Stained quality, although it remained in greatest demand, accounting for 77% of consumption. Consumption of grade No. 6 decreased by 88%.

Eight companies operating eight plants in seven States consumed muscovite block and film, two in North Carolina and one each in Massachusetts, New Jersey, New York, Ohio, Pennsylvania, and Virginia. The New York, Pennsylvania, and Virginia companies consumed 72% of the total block and film used for fabrication in 1982.

Phlogopite block fabrication totaled 9,400 pounds, a decrease of 13% from that of 1981. Five companies in five States consumed phlogopite block in 1982.

In 1982, 2.6 million pounds of mica splittings was consumed, a 40% drop from that of 1981. India supplied 98% of these splittings, and the remainder was phlogopite splittings obtained from Madagascar, the sole producer. The splittings were fabricated into various built-up mica products by 11 companies operating 11 plants in 9 States.

Built-up Mica.—The primary use of this mica-base product, made by mechanical or hand setting of overlapping splittings and alternate layers of binders and splittings, was as electrical insulation material. In 1982, total production, sold or used, of built-up mica decreased 26% from that of 1981. Molding plate and segment plate continued to be the major end products, accounting for 35% and 33% of the total, respectively.

Reconstituted Mica (Mica Paper).—In 1982, five companies consumed 5.0 million pounds of scrap mica to produce 3.6 million pounds of mica paper. The principal source of the scrap mica was India. Primary end uses for mica paper were the same as those for built-up mica. Manufacturing companies were, in order of output, Proctor-Silex Div., SCM Corp., Mount Airy, N.C.; General Electric Co., Schenectady, N.Y.; U.S. Samica Corp., Rutland, Vt.; Kirkwood-Acim Corp., Hempstead, N.Y.; and Corona Film, Inc., West Townsend, Mass.

Ground Mica.—In 1982, a total of 96,000 tons of ground mica was sold or used by U.S. producers, a decrease of 18% from that of 1981. The major end uses continued to be joint cement, 51%, and paint, 16%. Other end uses, including oil well drilling mud, roofing, and rubber, accounted for 33% of the total.

Table 5.—Fabrication of muscovite ruby and nonruby block and film mica and phlogopite block mica in the United States in 1982, by quality and end-product use

(Pounds)

Variety, form, and quality	Electronic uses: Capacitors	Electronic uses: Tubes	Electronic uses: Other	Electronic uses: Total	Nonelectronic uses: Gauge glass and diaphragms	Nonelectronic uses: Other	Nonelectronic uses: Total[1]	Grand total[1]
Muscovite:								
Block:								
Good Stained or better	200	200	400	800	2,900	100	3,000	3,800
Stained	--	49,800	13,100	62,900	400	2,100	2,600	65,500
Lower than Stained[2]	--	3,300	2,900	6,200	100	9,900	10,000	16,200
Total[1]	200	53,200	16,500	69,900	3,500	12,100	15,600	85,500
Film:								
1st quality	1,300	--	--	1,300	--	--	--	1,300
2d quality	1,400	--	--	1,400	--	--	--	1,400
Total	2,700	--	--	2,700	--	--	--	2,700
Block and film:								
Good Stained or better[3]	2,900	200	400	3,500	2,900	100	3,000	6,600
Stained[4]	--	49,800	13,100	62,900	400	2,100	2,600	65,500
Lower than Stained	--	3,300	2,900	6,200	100	9,900	10,000	16,200
Total[1]	2,900	53,200	16,500	72,600	3,500	12,100	15,600	88,200
Phlogopite: Block (all qualities)	--	--	200	200	--	9,200	9,200	9,400

[1]Data may not add to totals shown because of independent rounding.
[2]Includes punch mica.
[3]Includes 1st- and 2d-quality film.
[4]Includes other-quality film.

Table 6.—Fabrication of muscovite ruby and nonruby block and film mica in the United States in 1982, by quality and grade

(Pounds)

Form, variety, and quality	No. 4 and larger	No. 5	No. 5 1/2	No. 6	Other[1]	Total[2]
Block:						
Ruby:						
Good Stained or better	2,200	600	100	300	--	3,100
Stained	7,000	23,700	24,500	3,500	3,000	61,600
Lower than Stained	3,400	--	1,100	1,000	7,100	12,500
Total[2]	12,600	24,300	25,700	4,700	10,100	77,300
Nonruby:						
Good Stained or better	500	200	--	--	--	700
Stained	2,900	200	400	400	--	3,800
Lower than Stained	1,400	--	--	400	1,900	3,700
Total	4,800	400	400	800	1,900	8,200
Total block (ruby and nonruby)[2]	17,300	24,700	26,100	5,400	12,000	85,500
Film:						
Ruby:						
1st quality	--	300	300	200	--	800
2d quality	--	400	500	300	--	1,200
Total	--	700	800	500	--	2,000
Nonruby:						
1st quality	--	--	300	300	--	500
2d quality	--	--	200	--	--	200
Total	--	--	500	300	--	700
Total film (ruby and nonruby)	--	700	1,300	800	--	2,700

[1]Figures for block mica include all smaller than No. 6 grade and punch mica.
[2]Data may not add to totals shown because of independent rounding.

Table 7.—Consumption and stocks of mica splittings in the United States, by source

(Thousand pounds and thousand dollars)

	India		Madagascar		Total[1]	
	Quantity	Value	Quantity	Value	Quantity	Value
Consumption:						
1978	5,371	2,837	166	194	5,537	3,031
1979	4,714	2,745	163	503	4,877	3,248
1980	4,216	2,543	167	557	4,383	3,101
1981	4,268	2,601	117	463	4,386	3,064
1982	2,576	1,775	63	257	2,639	2,032
Stocks on Dec. 31:						
1978	2,695	NA	76	NA	2,771	NA
1979	2,331	NA	110	NA	2,441	NA
1980	2,917	NA	69	NA	2,986	NA
1981	2,621	NA	101	NA	2,722	NA
1982	1,922	NA	42	NA	1,964	NA

NA Not available.
[1]Data may not add to totals shown because of independent rounding.

Table 8.—Built-up mica[1] sold or used in the United States, by product

(Thousand pounds and thousand dollars)

Product	1981		1982	
	Quantity	Value	Quantity	Value
Molding plate	1,318	3,696	1,018	3,119
Segment plate	1,329	4,208	947	3,115
Heater plate	110	r352	72	201
Flexible (cold)	289	r1,295	222	1,033
Tape	512	r2,940	387	2,211
Other	325	1,600	241	1,239
Total[2]	3,882	r14,090	2,886	10,919

rRevised.
[1]Consists of alternate layers of binder and irregularly arranged and partly overlapped splittings.
[2]Data may not add to totals shown because of independent rounding.

Table 9.—Ground mica sold or used by producers in the United States, by end use

(Thousand short tons and thousand dollars)

End use	1981		1982	
	Quantity	Value	Quantity	Value
Roofing	W	W	W	W
Rubber	W	W	W	W
Paint	18	r3,130	15	2,852
Joint cement	52	r6,851	49	6,947
Other[1]	47	r7,459	32	6,306
Total	117	r17,440	96	[2]16,106

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes mica used for agricultural products, molded electrical insulation, plastics, welding rods, well-drilling mud, textile and decorative coatings, and uses indicated by symbol W.
[2]Data do not add to total shown because of independent rounding.

STOCKS

Reported yearend consumer stocks of sheet mica in 1982 were 2.3 million pounds; of this, mica splittings represented 84% and mica block represented 16%.

PRICES

Average reported values of muscovite sheet mica in 1982, based on consumption data, were block, $15.50 per pound; film, $5.36 per pound; and splittings, $0.69 per pound. The average values of phlogopite sheet mica for 1982 were $4.34 per pound for block and $4.06 per pound for splittings. Compared with 1981 average unit values, muscovite block increased 66%, muscovite film increased 18%, and muscovite splittings increased 13%. The average value of phlogopite block decreased 44% compared with that of 1981, while the value of phlogopite splittings increased only slightly.

The average value of scrap (flake) mica, including high-quality sericite, was $59.73 per ton. The average value per ton for North Carolina scrap (flake) mica, predominantly a flotation product, was $71.03.

The averages of reported prices for ground mica are shown in table 10.

Table 10.—Averages of reported prices for dry- and wet-ground mica sold or used by U.S. producers in 1982

(Dollars per short ton)

Wet-ground	419
Dry-ground	136
End uses:	
Roofing	W
Rubber	W
Paint	193
Joint cement	142
Other[1]	197

W Withheld to avoid disclosing company proprietary data; included with "Other."

[1]Includes mica used for agricultural products, molded electrical insulation, plastics, welding rods, well-drilling mud, textile and decorative coatings, miscellaneous, and uses indicated by symbol W.

FOREIGN TRADE

Unmanufactured mica exports decreased 30% to 2,774 tons valued at $1.04 million in 1982. Of this, the United Kingdom, the leading country of destination, received 32% and Japan received 26%.

Exports of ground mica increased 20% to 8,373 tons valued at $2.1 million. Canada was again the leading country of destination, receiving 27% of the total.

The total value of stamped or built-up mica exports decreased 21% to $5.5 million, with Canada continuing to be the leading country of destination, accounting for 41% of the total value shipped.

Imports of all classes of mica in 1982 decreased in value by 10% to $6.5 million. Total imports of the "uncut sheet and punch" category in table 13 decreased by 35% in value.

Table 11.—U.S. exports of mica and manufactures of mica in 1982, by country

Country	Mica, unmanufactured, including block, film, splittings, and waste[1]		Mica, ground or pulverized		Mica, cut or stamped, built-up mica
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Value (thousands)
Australia	19	$5	42	$11	$216
Brazil	--	--	13	3	209
Canada	101	26	2,238	468	2,233
Egypt	--	--	285	137	3
France	33	9	791	172	69
Germany, Federal Republic of	128	45	289	73	47
India	--	--	--	--	171
Italy	82	23	192	63	374
Japan	735	387	427	145	156
Mexico	96	28	777	176	300
Netherlands	--	--	273	107	20
Peru	--	--	47	34	3
Singapore	40	21	222	56	5
South Africa, Republic of	3	1	12	3	70
Spain	7	2	906	183	190
United Arab Emirates	--	--	19	10	--
United Kingdom	890	289	122	26	896
Venezuela	188	43	1,032	216	22
Other[2]	452	160	686	260	515
Total	2,774	1,039	8,373	2,143	5,499

[1]Some shipments of ground mica are included in this category.
[2]Includes Angola, Argentina, Austria, the Bahamas, Barbados, Belgium, Belize, Bermuda, Bolivia, Cameroon, Cayman Islands, Chile, China, Colombia, Costa Rica, the Dominican Republic, Ecuador, El Salvador, Finland, French Pacific Islands, Gabon, Ghana, Guatemala, Haiti, Honduras, Hong Kong, Ireland, Israel, the Ivory Coast, Jamaica, Jordan, the Republic of Korea, Kuwait, Leeward and Windward Islands, Malaysia, Morocco, Netherlands Antilles, New Zealand, Nigeria, Pakistan, Panama, the Philippines, Portugal, Qatar, Romania, Saudi Arabia, Sudan, Sweden, Switzerland, Taiwan, Thailand, Trinidad and Tobago, Tunisia, Turks and Caicos Islands, and Uruguay.

Table 12.—U.S. imports for consumption of mica, by country

Country	UNMANUFACTURED									
	Waste and scrap						Other			
	Phlogopite		Other		Block mica		Muscovite		Other, n.e.c.	
	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)
1980	72,570	$7	--	--	70,591	$477	--	--	7,568,423	$1,128
1981	352	23	--	--	31,796	172	--	--	8,100,267	1,374
1982:										
Belgium	--	--	--	--	1,103	4	--	--	--	--
Brazil	--	--	992,070	$47	8,830	37	--	--	--	--
Canada	--	--	--	--	--	--	45,300	$2	--	--
France	--	--	--	--	6,172	29	224,916	69	--	--
India	--	--	--	--	3,883	28	2,409,345	449	--	--
United Kingdom	--	--	--	--	1,914	22	--	--	--	--
Other	--	--	--	--	3,602	13	6,614	1	--	--
Total	--	--	992,070	47	25,504	133	2,686,175	521	--	--

Country	MANUFACTURED							
	Splittings		Not cut or stamped, not over 0.006 inch in thickness[1]		Cut or stamped			
					Not over 0.006 inch in thickness		Over 0.006 inch in thickness	
	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)
1980	4,223,989	$1,660	13,825	$40	102,785	$1,277	103,331	$700
1981	2,417,672	1,115	1,008,288	86	75,124	980	152,848	728
1982:								
Belgium	--	--	--	--	500	1	2,204	8
Brazil	1,987	8	--	--	--	--	1,688	8
Canada	--	--	--	--	--	--	809	6

See footnotes at end of table.

Table 12.—U.S. imports for consumption of mica, by country —Continued

	MANUFACTURED							
					Cut or stamped			
	Splittings		Not cut or stamped, not over 0.006 inch in thickness[1]		Not over 0.006 inch in thickness		Over 0.006 inch in thickness	
	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)
1982 —Continued								
France	221	$4	--	--	--	--	--	--
India	1,833,523	828	2,590,835	$230	63,414	$664	85,548	$465
Japan	--	--	--	--	--	--	64,092	254
Madagascar	46,296	65	--	--	--	--	--	--
United Kingdom	--	--	--	--	2,819	26	--	--
Other	201	1	--	--	355	39	2,243	57
Total	1,882,228	906	2,590,835	230	67,088	730	156,584	798

	Mica plates and built-up mica		Ground or pulverized		Articles not especially provided for of mica	
	Quantity (pounds)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (pounds)	Value (thousands)
1980	615,443	$1,413	5,673	$1,065	9,145	$95
1981	395,069	917	6,684	1,389	41,423	434
1982:						
Belgium	263,310	434	--	--	2,639	8
Canada	491	2	5,295	1,485	2,650	14
France	25,641	45	42	44	614	5
India	119,440	339	34	6	10,069	213
Japan	27,006	89	22	166	12,040	40
Taiwan	--	--	--	--	933	15
United Kingdom	27,429	116	19	15	535	8
Other	4,746	17	1	8	2,868	63
Total	468,063	1,042	5,413	1,724	32,348	366

[1]Includes film.

Table 13.—Summation of U.S. mica trade data

	EXPORTS					
	Unmanufactured[1]		Ground or pulverized		Manufactured, cut or stamped, built-up	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1978	3,414	$2,051	5,848	$1,204	NA	$4,697
1979	5,827	1,673	5,846	1,374	NA	5,224
1980	6,275	1,953	8,187	2,247	NA	7,665
1981	3,943	1,352	6,977	2,085	NA	7,000
1982	2,774	1,039	8,373	2,143	NA	5,499

	IMPORTS							
	Uncut sheet[2] and punch		Scrap		Ground or pulverized		Manufactured, cut or stamped, built-up	
	Quantity (thousand pounds)	Value (thousands)	Quantity (thousand pounds)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (thousand pounds)	Value (thousands)
1978	8,855	$2,629	1,221	$59	1,728	$263	969	$3,096
1979	10,587	3,147	176	9	4,533	743	776	2,929
1980	11,877	3,305	73	7	5,673	1,065	831	3,487
1981	11,558	2,747	r(3)	23	6,684	1,389	664	3,059
1982	7,185	1,790	992	47	5,413	1,724	724	2,936

rRevised. NA Not available.
[1]Includes block, film, splittings, and waste. Sometimes shipments of ground mica are placed in this category.
[2]Includes block, film, splittings, and other. The "Other" classification included in this category often contains scrap mica shipments.
[3]Less than 1/2 unit.

WORLD REVIEW

World production of all forms of mica declined by 15% to 625 million pounds. India led the world in production of sheet mica. The United States remained the leader in production of scrap (flake) mica.

India.—The emphasis in the Indian mica industry was on various value-added products, including mica powder, mica paper, mica capacitors, silvered mica, and micanite products.[4] The Government's Mica Trading Corp. (MITCO) planned to promote development of several new plants for ground and fabricated mica products. Also, an agreement for collaboration with a Japanese company for the manufacture of mica paper by mechanical and calcining processes was signed in 1982.[5]

As part of its 1981-85 trade agreement with the U.S.S.R., India signed an agreement for export of Indian mica to the U.S.S.R. in 1982. India traditionally has supplied all of the sheet mica import requirements of the U.S.S.R., which represents over 40% of India's total mica exports. The volume of mica exports to the U.S.S.R. was expected to increase over the next few years. MITCO also announced that it had signed a contract in 1982 to supply mica to the German Democratic Republic.[6]

U.S.S.R.—Estimated mica output in 1982 remained at about 50,000 short tons, still inadequate to meet domestic demand, and strategic-grade mica continued to be imported from India. To meet its demand for mica for insulating purposes, the U.S.S.R. was producing built-up mica from mica raw material that was being scrapped. This has helped to alleviate the mica shortage and has enabled the U.S.S.R. to reduce mica requirements, but has not eliminated the need for imports of high-grade mica.

Yugoslavia.—Preparations began for development of a new mine in Yugoslavia to produce mica along with quartz sand, feldspar, and kaolin.[7]

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[1]Physical scientist, Division of Industrial Minerals.
[2]Mineral specialist, Division of Industrial Minerals.
[3]Production of high-quality sericite is included in the totals; however, figures for low-quality sericite, used principally for brick manufacturing, are not included.
[4]U.S. Embassy, New Delhi, India. Indian Non-Fuel Minerals Resources and Mineral Based Industries: Industrial Outlook-1982. State Department Airgram A-43, Aug. 19, 1982.
[5]Industrial Minerals (London). No. 173, February 1982, p. 68.
[6]———. No. 173, February 1982, p. 11.
[7]Work cited in footnote 5.

Table 14.—Mica: World production, by country[1]

(Thousand pounds)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Argentina:					
Sheet	785	[r]794	481	97	90
Waste, scrap, etc	5,018	2,513	1,358	1,012	880
Brazil[3]	10,033	[r]8,982	10,620	9,921	9,920
Egypt	[e]190	--	--	--	--
France[e]	16,100	15,400	15,400	15,000	14,300
India:					
Exports:					
Block	[r]2,930	[r]2,476	[e]2,600	[r][e]2,200	2,400
Film and disk	[r]168	[r]582	[e]190	[r][e]220	440
Splittings	[r]8,748	[r]9,160	[e]7,960	[r][e]7,900	8,800
Scrap	[r]20,578	[r]17,177	[e]30,670	[r][e]31,000	17,600
Powder	[r]18,779	[r]9,685	[e]17,600	[r][e]15,400	11,000
Manufactured	[r]873	[r]860	[e]660	[r][e]660	660
Domestic consumption, all forms[e]	[r]6,600	[r]6,600	[r]6,600	[r]6,600	6,600
Total	[r]58,676	[r]46,540	[e]66,280	[r][e]63,980	47,500
Korea, Republic of (all grades)	37,309	22,057	22,773	[e]22,000	22,000
Madagascar (phlogopite):					
Block	NA	134	185	736	660
Sheet and splittings	3,452	2,438	3,631	--	--
Scrap	NA	NA	NA	108	110
Mexico	884	536	730	882	880
Mozambique (including scrap)	[r][e]2,000	553	440	440	440
Norway (including scrap)[4]	[r]NA	[r]NA	NA	NA	NA
Peru	220	[e]110	[e]180	1,265	1,200
South Africa, Republic of:					
Sheet	(5)	(5)	(5)	--	--
Scrap	5,604	[r]3,792	5,573	5,280	[e]3,871
Spain	7,374	11,395	10,650	7,769	7,300

See footnotes at end of table.

Table 14.—Mica: World production, by country[1] —Continued

(Thousand pounds)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Sri Lanka (scrap)	309	814	320	401	440
Sudan	2,200	4,409	[e]3,300	4,409	4,400
Tanzania (sheet)	13	13	22	11	11
U.S.S.R. (all grades)[e]	99,000	101,000	101,000	104,000	106,000
United States:					
Sheet[6]	([5])	1	NA	NA	NA
Scrap and flake[7]	278,000	268,000	232,000	266,000	212,000
Ground mica	248,000	244,000	222,000	234,000	192,000
Yugoslavia	152	745	549	584	600
Grand total	[r]775,319	[r]734,226	697,492	737,895	624,602

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.
[1]Table includes data available through May 12, 1983.
[2]In addition to the countries listed, China, Namibia, Pakistan, Romania, Sweden, the United Kingdom, and Zimbabwe are known to produce mica, but available information is inadequate to make reliable estimates of output levels.
[3]Exports.
[4]Official Norwegian sources indicate that actual mica output is "not available for publication," and information is inadequate to form an estimate.
[5]Less than 1/2 unit.
[6]Reported figure.
[7]Excludes U.S. production of low-quality sericite.

Molybdenum

By John W. Blossom[1]

Domestic and foreign molybdenum markets were imbalanced in 1982. Worldwide mine production exceeded demand, while consumer stocks were kept at a minimum. U.S. mine output of molybdenum decreased to about one-half of that produced in 1981 and represented 41% of world production. Reported end-use consumption of molybdenum in raw materials and apparent domestic demand declined in 1982 compared with that of 1981. World demand for molybdenum fell, resulting in smaller quantities of molybdenum exported from the United States, and domestic producer stocks of molybdenum concentrate and products increased by 10%. Confronted with large stock inventories, domestic producers reduced prices during the year. World market prices were considerably below those of most U.S. producer price listings for most of the year. Despite a lack of global demand stability, several countries increased their output of molybdenum.

Domestic Data Coverage.—Domestic production data for molybdenum are developed by the Bureau of Mines by means of three separate, voluntary surveys. These surveys are the Molybdenum Ore and Concentrate, Molybdenum Concentrate and Molybdenum Products, and Molybdenum Concentrates. Out of the 54 operations to which surveys were sent, 100% responded, and the data are reported in table 1.

Table 1.—Salient molybdenum statistics

(Thousand pounds of contained molybdenum and thousand dollars)

	1978	1979	1980	1981	1982
United States:					
Concentrate:					
Production	131,843	143,967	150,686	139,900	83,050
Shipments	130,694	143,504	149,311	118,916	77,789
Value	$607,950	[1]$871,068	$1,344,181	[r]$945,540	$514,834
Consumption	96,375	103,152	108,206	80,725	49,444
Imports for consumption	2,705	2,329	1,825	1,988	3,115
Stocks, Dec. 31: Mine and plant	8,980	9,520	18,101	[r]35,043	35,527
Primary products:					
Production	96,052	101,753	106,284	[r]105,824	65,381
Shipments	105,920	109,419	95,391	64,368	47,884
Consumption	61,091	60,388	53,265	50,189	27,665
Stocks, Dec. 31: Producers	7,996	8,502	27,007	44,961	49,401
World: Production	[r]220,604	[r]229,350	241,664	[p]241,097	[e]200,339

[e]Estimated. [p]Preliminary. [r]Revised.
[1]For 1979, value is based on the average domestic price of molybdenum in technical-grade molybdic oxide ($6.07 per pound) sold by the major domestic producer.

DOMESTIC PRODUCTION

In 1982, domestic mine production of molybdenum decreased for the second consecutive year to a total of 83.0 million pounds of contained molybdenum. The country's three largest producers in 1982 were AMAX Inc., The Anaconda Minerals Company, and Duval Corp., which together produced about 85% of the year's total production from their mines. Tungsten and tin were reclaimed as byproducts at the

Climax molybdenum mine in Colorado. In addition, small quantities of rhenium were reclaimed in the roasting of molybdenite concentrate from certain domestic copper ores.

AMAX's Climax and Henderson Mines, located in Colorado, remained two of the world's largest primary molybdenum mines. The production from these mines in 1982 represented approximately 50% of U.S. output and 21% of total world production.

Molybdenum produced in association with domestic copper mining accounted for over 38% of total U.S. output compared with 34% in 1981. Anaconda Minerals and Duval are the leading producers of molybdenum from copper-mining operations. Other domestic mining companies that recovered molybdenum from copper ore were Anamax Mining Co., ASARCO Incorporated, Cities Service Co., Cyprus Mines Corp., Kennecott Minerals Co., Inspiration Consolidated Copper Co., Magma Copper Co., and Phelps Dodge Corp.

During 1982, domestic producers attempted to correct oversupply conditions by reducing production, closing mines, and canceling or extending new project development.

AMAX shut down its two mines in Colorado during July; they were reopened in August and ran at a reduced output through September. They were closed again in October, to be opened upon recovery of the molybdenum market. Anaconda Minerals also closed its mine at Tonopah, Nev., until the market improves. Cities Service closed its Pinto Valley Mine at the end of June. Duval opened its Sierrita Mine in March, but its other two mines remained closed throughout the year. Inspiration shut down its molybdenum concentrator at the end of February for the remainder of the year.

Despite the worldwide surplus of molybdenum stocks in 1982, Anaconda Minerals completed its leaching circuit at its concentrating plant for the Tonopah operation, and U.S. Borax & Chemical Corp. continued the development of its Quartz Hill molybdenum project east of Ketchikan, Alaska. U.S. Borax also obtained a site for a conversion plant at Grays Harbor, Wash., for processing the molybdenum concentrate from the Quartz Hill Mine.

Table 2.—Production, shipments, and stocks of molybdenum products in the United States

(Thousand pounds of contained molybdenum)

	1981	1982	1981	1982	1981	1982
	Molybdic oxides[1]		Metal powder		Ammonium molybdate	
Received from other producers	5,767	4,912	45	324	1,144	852
Gross production during year	86,507	52,176	4,062	3,842	3,273	2,195
Used to make other products listed here	26,864	16,822	548	539	1,558	1,282
Net production	59,645	35,354	3,513	3,304	1,715	913
Shipments	49,044	37,143	3,603	3,693	2,689	1,696
Producer stocks, Dec. 31	38,999	41,854	507	443	1,075	1,072
	Sodium molybdate		Other[2]		Total	
Received from other producers	23	14	262	76	7,241	6,178
Gross production during year	96	121	11,886	7,047	105,824	65,381
Used to make other products listed here	(3)	(3)	14	15	28,984	18,658
Net production	96	121	11,871	7,035	76,840	46,727
Shipments	131	115	8,901	5,237	64,368	47,884
Producer stocks, Dec. 31	27	48	4,353	5,984	44,961	49,401

[1]Includes technical and purified molybdic oxide and briquets.
[2]Includes ferromolybdenum, calcium molybdate, phosphomolybdic acid, molybdenum disulfide, molybdic acid, molybdenum metal, pellets, molybdenum pentachloride, and molybdenum hexacarbonyl.
[3]Less than 1/2 unit.

CONSUMPTION AND USES

The quantity of molybdenum in concentrate roasted domestically to produce technical-grade molybdic oxide decreased to 49.4 million pounds, about 39% below that of 1981. The remainder of the mine production of concentrate, containing about 26.6 million pounds of molybdenum, was either exported for conversion, added to producer inventories, or purified to lubrication-grade molybdenum disulfide. The oxide, or roasted concentrate, is the chief form of molybdenum utilized by industry, particularly steel, cast iron, and superalloy producers. However, some of the material is also converted to other molybdenum products such as ferromolybdenum, high-purity oxide, ammonium and sodium molybdate, and metal powder.

Apparent domestic demand (calculated from mine production, imports minus exports, and change in industry stocks) decreased by about 2% from that of 1981 to 57.8 million pounds of molybdenum. The decline in apparent demand was the third since 1979 and reflected the depressed economic conditions existing in 1982. Likewise, total reported end-use consumption of molybdenum in raw materials decreased about 45% from that of 1981. Molybdenum consumed in oxide form (technical-grade, purified, and briquets) accounted for about 64% of total reported consumption; in ferromolybdenum and calcium molybdate, 14%; and in other forms, 22%.

Molybdenum reported as consumed in the production of steel accounted for over 61% of total consumption in 1982. Approximately 24% of consumption was attributed to other metallurgical uses, such as cast irons, superalloys, and as a refractory metal. Catalyst, lubricant, pigment, and other nonmetallurgical applications composed the final 15% of total consumption. Nearly all end-use areas exhibited a decline in molybdenum consumption when compared with those of 1981.

Table 3.—U.S. consumption of molybdenum, by end use

(Thousand pounds of contained molybdenum)

End use	Molybdic oxides	Ferromolybdenum[1]	Ammonium and sodium molybdate	Other molybdenum materials[2]	Total
1981					
Steel:					
Carbon	1,145	128	--	12	1,285
Stainless and heat resisting	5,595	796	--	134	6,525
Full alloy	20,843	2,192	--	44	23,079
High-strength, low-alloy	1,521	624	--	66	2,211
Tool	2,099	400	--	49	2,548
Cast irons	457	2,257	--	177	2,891
Superalloys	923	236	--	1,191	2,350
Alloys (excludes steels and superalloys):					
Welding and alloy hard-facing rods and materials	--	331	--	12	343
Other alloys[3]	228	218	--	140	586
Mill products made from metal powder	--	--	--	3,035	3,035
Chemical and ceramic uses:					
Pigments	W	--	332	--	332
Catalysts	2,648	--	W	72	2,720
Other	8	--	--	829	837
Miscellaneous and unspecified	673	101	505	168	1,447
Total	36,140	7,283	837	5,929	50,189
1982					
Steel:					
Carbon	766	125	--	12	903
Stainless and heat resisting	2,729	456	--	133	3,318
Full alloy	9,571	1,105	--	33	10,709
High-strength, low-alloy	678	344	--	2	1,024
Tool	736	209	--	5	950
Cast irons	368	1,032	--	6	1,406
Superalloys	595	152	--	857	1,604
Alloys (excludes steels and superalloys):					
Welding and alloy hard-facing rods and materials	--	185	--	12	197
Other alloys[3]	243	93	--	95	431
Mill products made from metal powder	--	--	--	2,980	2,980
Chemical and ceramic uses:					
Pigments	W	--	327	--	327
Catalysts	1,735	--	W	98	1,833
Other	3	--	--	892	895
Miscellaneous and unspecified	366	48	571	103	1,088
Total	17,790	3,749	898	5,228	27,665

W Withheld to avoid disclosing company proprietary data.

[1]Includes calcium molybdate.

[2]Includes purified molybdenum disulfide, molybdenite concentrate added directly to steel, molybdenum metal powder, molybdenum metal, pellets, and other molybdenum materials.

[3]Includes magnetic and nonferrous alloys.

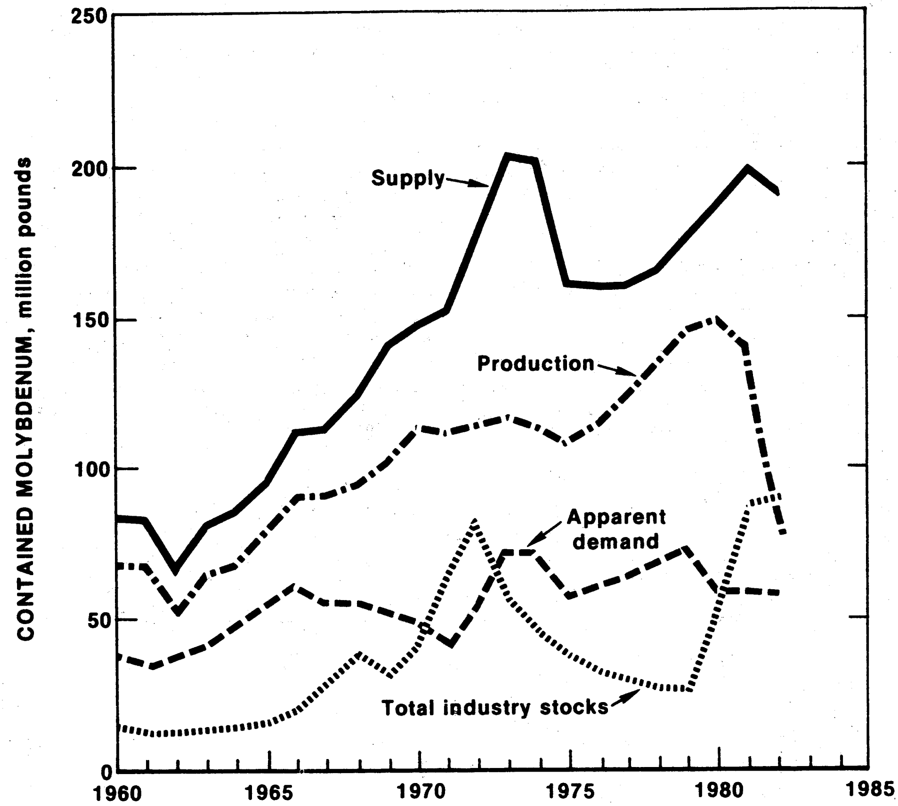

Figure 1.—Apparent demand, supply, production, and total industry stocks of molybdenum in the United States.

STOCKS

With the continued decline in consumption and lower exports, inventories of domestic molybdenum producers rose during 1982. Inventories of industrial stocks were at their highest levels since 1972. Total industry stocks, which include producers and consumers, increased by almost 4% to 89.1 million pounds of contained molybdenum during 1982. Inventories of molybdenum in concentrate at mine locations registered an advance from 35.0 to 35.5 million pounds. Producers' stocks of molybdenum in consumer products, such as oxide, ferromolybdenum, molybdate, metal powders, and other types, increased from 45 million pounds at the beginning of the year to 50 million pounds by yearend. Compared with monthly molybdenum shipments, yearend producers' stocks of these materials totaled almost a 12-month supply. Domestic consumers held inventories of about 4 to 5 million pounds throughout most of 1982, representing approximately a 2-month supply when compared with average monthly reported consumption.

Table 4.—Industry stocks of molybdenum materials, December 31

(Thousand pounds of contained molybdenum)

Material	1978	1979	1980	1981	1982
Concentrate: Mine and plant	8,980	9,520	18,101	[r]35,043	35,527
Producers:					
Molybdic oxides[1]	5,275	6,172	22,825	38,999	41,854
Metal powder	300	270	560	507	443
Ammonium molybdate	495	381	944	1,075	1,072
Sodium molybdate	47	58	48	27	48
Other[2]	1,879	1,621	2,630	4,353	5,984
Total	7,996	8,502	27,007	44,961	49,401
Consumers:					
Molybdic oxides[1]	5,893	5,102	3,816	3,217	2,103
Ferromolybdenum[3]	1,864	1,872	1,507	914	616
Ammonium and sodium molybdate	444	325	280	167	76
Other[4]	1,824	1,761	1,813	1,467	1,386
Total	10,025	9,060	7,416	5,765	4,181
Grand total	27,001	27,082	52,524	[r]85,769	89,109

[r]Revised.
[1]Includes technical and purified molybdic oxide and briquets.
[2]Includes ferromolybdenum, calcium molybdate, phosphomolybdic acid, molybdenum disulfide, molybdic acid, molybdenum metal, pellets, molybdenum pentachloride, and molybdenum hexacarbonyl.
[3]Includes calcium molybdate.
[4]Includes purified molybdenum disulfide, molybdenite concentrate added directly to steel, molybdenum metal powder, molybdenum metal, pellets, and other molybdenum materials.

PRICES

The economic downturn that started in 1981 continued through 1982, which greatly affected the molybdenum markets. Producers and dealers, under pressure from weak demand accompanied by excess stocks, were unable to improve their price position.

Quoted prices by dealers for molybdenum oxide were $4.70 to $5.10 per pound of contained molybdenum in early January, rose to $4.80 to $5.15 per pound by early February, then declined to $4.30 to $4.85 per pound. Early in March, prices had increased to $4.99 to $5.20 per pound. The trend continued into April, when prices reached $5.35 to $5.65 per pound, but deteriorated during the month to $4.85 to $5.20 per pound of contained molybdenum by monthend.

During May, prices continued to deteriorate. They bottomed out at $4.15 to $4.50 per pound in June. The downward trend in market economy prices reversed during June. Dealer oxide quotes rose to $4.60 to $4.75 per pound at the end of July. August was a quiet period with the prices declining to $4.30 to $4.60 per pound. September was the point at which the producers started to reduce their prices. Climax Molybdenum Co. led the way by indicating that, as of October, the domestic price for oxide would be $5.85 per pound at the roasting plant; the European price would be $6.00 per pound, f.o.b. Rotterdam; and the Japanese price would be $6.00 per pound, c.i.f. Payment terms were reduced to 30 days. Duval and Placer Development Ltd. reduced their Japanese price for oxide to $5.90 per pound, with payment in 30 days. Kennecott Corp. reduced its oxide price to $5.18 per pound, c.i.f. Japan.

September ended with dealers quoting oxide at $4.10 to $4.40 per pound of contained molybdenum. In October, dealer-quoted prices continued to decline to $2.90 to $3.30 per pound. November showed an improvement in dealer prices around the midpoint by $0.10 per pound, but returned to their original level of $2.90 to $3.30 per pound at monthend. During December, Climax suspended posting prices.

Duval reduced its prices of oxide to $4.20 per pound for drums and $4.30 per pound of contained molybdenum for cans. The dealer-quoted prices for oxide were $2.35 to $2.65 by monthend.

Table 5.—Domestic price listings for molybdenum

	1981	1982
Producer quotes:		
Concentrate	$3.35-$7.90	[1]$7.90
Oxide	6.85- 8.50	[1]8.50
Oxide-export	5.51- 8.75	[1]8.75
Ferromolybdenum	7.75- 9.40	[1]9.40
Ferromolybdenum-export	8.10- 9.90	[1]9.90
Dealer quotes:		
Oxide	3.45- 5.15	2.35- 5.55

[1]Standard Climax listing suspended Dec. 16, 1982.

FOREIGN TRADE

Exports.—Exports of molybdenum in concentrate and oxide dropped to 49.8 million pounds, 3% under that of 1981. Molybdenum exports were about 60% of domestic mine production. Approximately 83% of reported concentrate and oxides were shipped to Chile, the Federal Republic of Germany, Japan, the Netherlands, and the United Kingdom. Exports of other molybdenum materials were almost negligible and varied slightly from that of 1981. The calculated molybdenum content of all exports decreased from 52.4 million pounds in 1981 to 51.3 million pounds in 1982. Because of both the lower quantity of exports and lower unit price, the total value of exports fell sharply from $477 million in 1981 to $294 million in 1982.

Imports.—Approximately 9.6 million pounds of molybdenum in various forms was imported into the United States during 1982, an increase of 30% compared with that of 1981. This quantity represented 5% of supply and 17% of apparent demand for 1982. Total value of all forms of molybdenum imported decreased 4% from $52 million in 1981 to $50 million in 1982. In terms of both value and quantity, the major forms imported were as concentrate, miscellaneous materials in chief value molybdenum, and ammonium molybdate. The principal originating countries for these imports were Canada, Chile, China, and Peru. China was a notable supplier of ammonium molybdate in 1982.

Table 6.—Molybdenum reported by producers as shipments for export from the United States

(Thousand pounds of contained molybdenum)

	1981	1982
Molybdenite concentrate	[r]32,735	21,870
Molybdic oxide	19,072	22,938
All other primary products	932	437

[r]Revised.

Table 7.—U.S. exports of molybdenum ore and concentrates (including roasted concentrates), by country

(Thousand pounds of contained molybdenum and thousand dollars)

Country	1980 Quantity	1980 Value	1981 Quantity	1981 Value	1982 Quantity	1982 Value
Austria	2,034	20,407	2,723	21,793	1,523	8,485
Belgium-Luxembourg	11,412	129,004	2,518	24,069	2,458	14,312
Brazil	445	4,762	115	1,052	30	167
Canada	314	2,593	369	2,204	1,482	4,236
Chile	312	2,055	2,315	7,691	3,197	6,062
France	901	8,430	408	3,381	304	413
Germany, Federal Republic of	9,077	94,824	5,080	30,374	7,502	22,712
Japan	12,654	134,099	7,958	73,567	5,411	37,394
Mexico	624	5,471	863	5,969	68	330
Netherlands	24,642	252,911	22,027	189,116	20,688	115,358
Sweden	2,601	27,536	1,840	13,556	1,928	5,099
Switzerland	83	1,215	81	395	40	135
U.S.S.R	277	2,802	1,080	9,547	--	--
United Kingdom	2,003	20,974	3,501	20,047	4,740	15,191
Other	838	8,348	472	4,055	412	2,320
Total	68,217	715,431	51,350	406,816	49,783	232,214

Table 8.—U.S. exports of molybdenum products

(Thousand pounds, gross weight, and thousand dollars)

Product and country	1981		1982	
	Quantity	Value	Quantity	Value
Ferromolybdenum:[1]				
Australia	208	1,223	67	376
Canada	99	561	8	36
Japan	14	93	129	400
Malaysia	3	20	--	--
Mexico	--	--	34	133
Philippines	39	442	2	11
South Africa, Republic of	14	104	--	--
Other	78	540	15	79
Total	455	2,983	255	1,035
Metal and alloys in crude form and scrap:				
Belgium	8	53	254	109
Canada	24	269	23	168
France	7	61	--	--
Germany, Federal Republic of	1,604	4,248	198	434
India	5	56	4	34
Japan	138	1,317	116	740
Mexico	83	370	53	595
Netherlands	12	82	5	40
Spain	5	43	27	79
Sweden	342	1,935	2	26
United Kingdom	50	223	([2])	9
Other	363	1,106	15	83
Total	2,641	9,763	697	2,317
Wire:				
Argentina	4	97	([2])	12
Australia	4	76	([2])	14
Austria	([2])	11	([2])	9
Bahamas	125	137	128	186
Belgium-Luxembourg	([2])	1	1	28
Brazil	14	373	17	444
Canada	27	485	28	468
France	4	136	12	232
Germany, Federal Republic of	98	1,700	130	2,188
India	5	81	3	92
Italy	83	1,954	54	1,033
Japan	76	1,514	131	1,720
Mexico	19	488	12	289
Netherlands	9	501	27	930
Singapore	([2])	62	([2])	2
South Africa, Republic of	1	21	4	71
Spain	16	337	22	347
Sweden	12	284	10	206
United Kingdom	15	216	5	55
Other	31	556	48	746
Total	543	9,030	632	9,072
Powder:				
Australia	([2])	9	1	4
Belgium-Luxembourg	--	--	224	295
Canada	18	138	8	72
France	13	167	9	148
Germany, Federal Republic of	4	33	49	225
Italy	3	48	1	30
Japan	48	275	8	64
Mexico	29	181	29	190
Netherlands	3	20	3	18
Sweden	8	81	--	--
Taiwan	83	1,382	83	1,225
United Kingdom	48	345	5	26
Other	13	141	6	59
Total	270	2,820	426	2,356
Semifabricated forms, n.e.c.:				
Australia	4	81	([2])	19
Belgium-Luxembourg	([2])	1	([2])	17
Brazil	20	625	22	698
Canada	24	517	33	800
France	8	283	6	237
Germany, Federal Republic of	36	767	31	647
Japan	16	236	24	613
Mexico	6	178	5	120

See footnotes at end of table.

Table 8.—U.S. exports of molybdenum products —Continued

(Thousand pounds, gross weight, and thousand dollars)

Product and country	1981 Quantity	1981 Value	1982 Quantity	1982 Value
Semifabricated forms, n.e.c. —Continued				
Netherlands	3	192	4	47
Philippines	2	41	(2)	6
Singapore	(2)	5	(2)	6
South Africa, Republic of	9	643	18	439
United Kingdom	21	559	40	914
Other	16	640	7	199
Total	165	4,768	190	4,762
Molybdenum compounds:				
Argentina	4	11	2	18
Australia	9	14	87	378
Belgium-Luxembourg	382	1,110	244	447
Brazil	22	118	85	255
Canada	499	3,328	1,088	5,338
Germany, Federal Republic of	112	777	635	1,311
Japan	4,765	28,768	5,333	20,469
Mexico	81	414	281	447
Netherlands	577	1,879	2,178	5,303
Sweden	(2)	2	160	260
Switzerland	4	61	--	--
Taiwan	7	39	22	121
United Kingdom	233	985	2,025	6,134
Other	633	3,180	301	1,325
Total	7,328	40,686	12,441	41,806

[1]Ferromolybdenum contains about 60% to 65% molybdenum.
[2]Less than 1/2 unit.

Table 9.—U.S. imports for consumption of molybdenum products

(Thousand pounds and thousand dollars)

TSUS No.	Material	1981 Gross weight	1981 Contained molybdenum	1981 Value	1982 Gross weight	1982 Contained molybdenum	1982 Value
601.33	Ore and concentrate	4,959	1,988	9,911	6,332	3,115	13,429
603.40	Material in chief value molybdenum	5,085	1,651	9,574	4,577	2,749	12,143
606.31	Ferromolybdenum	1,175	918	6,353	1,665	1,218	6,308
628.70	Waste and scrap	NA	296	2,674	NA	258	1,474
628.72	Unwrought	NA	153	2,893	NA	67	1,370
628.74	Wrought	93	NA	2,557	79	NA	1,959
417.28	Ammonium molybdate	3,866	2,217	15,387	3,193	1,782	8,298
419.60	Molybdenum compounds	206	152	1,056	507	293	1,833
421.10	Sodium molybdate	31	13	114	38	15	96
423.88	Mixtures of inorganic compounds, chief value molybdenum	3	1	15	164	121	1,643
473.18	Molybdenum orange	1,058	NA	1,480	870	NA	1,160
	Total	16,476	7,389	52,014	17,425	9,618	49,713

NA Not available.

Table 10.—U.S. import duties on molybdenum materials

TSUS No.	Material	Most favored nation (MFN) Jan. 1, 1983	Most favored nation (MFN) Jan. 1, 1987	Non-MFN Jan. 1, 1983
601.33	Ore and concentrate	10.5 cents per pound	9 cents per pound	35 cents per pound.
603.40	Material in chief value molybdenum.	8 cents per pound plus 2.5% ad valorem.	6 cents per pound plus 1.9% ad valorem.	50 cents per pound plus 15% ad valorem.
606.31	Ferromolybdenum	5.9% ad valorem	4.5% ad valorem	31.5% ad valorem.
	Molybdenum:			
628.70	Waste and scrap	8.3% ad valorem	6% ad valorem	50% ad valorem.
628.72	Unwrought	8.1 cents per pound plus 2.5% ad valorem.	6.3 cents per pound plus 1.9% ad valorem.	50 cents per pound plus 15% ad valorem.
628.74	Wrought	9.6% ad valorem	6.6% ad valorem	60% ad valorem.
	Molybdenum chemicals:			
417.28	Ammonium molybdate	5.3% ad valorem	4.3% ad valorem	29% ad valorem.
418.26	Calcium molybdate	4.8% ad valorem	4.7% ad valorem	24.5% ad valorem.
419.60	Molybdenum compounds.	3.7% ad valorem	3.2% ad valorem	20.5% ad valorem.
420.22	Potassium molybdate	3.4% ad valorem	3% ad valorem	23% ad valorem.
421.10	Sodium molybdate	4.4% ad valorem	3.7% ad valorem	25.5% ad valorem.
423.88	Mixtures of inorganic compounds, chief value molybdenum.	3.2% ad valorem	2.8% ad valorem	18% ad valorem.
473.18	Molybdenum orange	4.4% ad valorem	5% ad valorem	25% ad valorem.

WORLD REVIEW

World mine production of molybdenum was 200.3 million pounds, a decrease of 17% from that produced in 1981. Over 93% of world production was supplied by Canada, Chile, the U.S.S.R. (production estimated), and the United States. Although comprehensive statistics on world consumption were not available, market evidence clearly indicated that for the third year in succession supply exceeded demand. World molybdenum consumption continued to decline in 1982, and production was reduced, but the net result was a 7% increase in stocks.

Canada.—Molybdenum production (shipments) in Canada increased by about 16% in 1982 over that of 1981. Molybdenum output from Lornex Mining Corp. Ltd. increased by 55% as a result of a capacity expansion in 1981. Utah International increased its Island Copper Mine output in 1982 over that of 1981. Teck Corp. operated its Highmont Mine at nominal capacity during the entire year. Cominco Ltd. did not recover molybdenum from its copper production. Noranda Mines Ltd. curtailed production at its molybdenum mines in British Columbia and Quebec. In July, Noranda reduced the rate of production to 50% of capacity at the Boss Mountain Mine. The company's Gaspé operation in Quebec was closed for 1 month in midyear. Operations were then resumed at one-third capacity until October, when full production was resumed. In December, Noranda closed the operation until market conditions improved. Brenda Mines Ltd., a subsidiary of Noranda, suspended operations from July to August. The mine had been operating at about 70% of capacity. Placer Development closed its Endako Mine on June 5 and later announced it would remain closed indefinitely. However, the Endako roaster operation was continued. Mining at Gibralter Mine Ltd. was halted during the year, but milling was continued with low-grade ore from stockpiles. AMAX of Canada, Ltd., closed the Kitsault Mine during August, and announced on November 7 that it would remain closed until market conditions improve.

Chile.—Molybdenum production in Chile increased 30% in 1982 compared with that of 1981. Corporación Nacional del Cobre de Chile (CODELCO) was the sole producer of molybdenum from its four divisions: Chuquicamata, El Teniente, El Salvador, and Andina. The increased production of molybdenum was due to the expansion of concentrating capacity from 70,000 to 96,000 metric tons per day at these properties. Also, molybdenum content of the ore was exceptionally high, about 0.1%. During the year, CODELCO inaugurated its first molybdenite roaster at Chuquicamata. This $16 million facility can convert about 5,400 metric tons per year of molybdenum sulfide into molybdic oxide.

[1]Physical scientist, Division of Ferrous Metals.

Table 11.—Molybdenum: World mine production, by country[1]

(Thousand pounds of contained molybdenum)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Bulgaria[e]	330	330	330	330	330
Canada (shipments)	30,739	24,634	26,211	31,160	36,290
Chile	29,092	29,895	30,133	33,863	44,092
China[e]	4,400	4,400	4,400	4,400	4,400
Japan	[r]163	[r]154	124	164	216
Korea, Republic of	485	417	661	1,025	882
Mexico	24	105	163	994	992
Peru	1,607	[r]2,637	5,926	5,485	5,655
Philippines	121	311	130	176	132
U.S.S.R.[e]	21,800	22,500	22,900	[r]23,600	24,300
United States	131,843	143,967	150,686	139,900	83,050
Total	[r]220,604	[r]229,350	241,664	241,097	200,339

[e]Estimated. [p]Preliminary. [r]Revised.

[1]Table includes data available through Apr. 20, 1983.

[2]In addition to the countries listed, Mongolia, Niger, North Korea, Romania, Turkey, and Yugoslavia are believed to produce molybdenum, but output is not reported quantitatively, and available general information is inadequate to make reliable estimates of output levels.

Nickel

By Scott F. Sibley[1]

For the third consecutive year, generally poor conditions prevailed in the nickel market as domestic consumption declined about 28% compared with that of 1981. Stainless steel and corrosion-resistant alloy producers and electroplaters continued to operate well below capacity. Reduction in demand occurred in nearly all end-use areas in-line with the economic recession. A similar situation existed in Europe and Japan. Continued high interest rates throughout the year deterred spending in the durable and capital goods sectors on which nickel demand depends. Producers pared inventories in the United States and operated worldwide at about 50% of capacity on the average. Sales by the U.S.S.R. in Europe contributed to a price deterioration. Because of these conditions, and high electrical power costs, the single U.S. nickel mine, in Oregon, closed in April.

Major consumption occurred in stainless and alloy steel, 46%; nonferrous alloys, 31%; and electroplating, 15%. Cathode nickel prices listed by several major producers were unchanged throughout the year. However, spot prices for nickel declined to $1.50 per pound late in the year.

Domestic Data Coverage.—Domestic production data for nickel are developed by the Bureau of Mines from two separate, voluntary surveys of U.S. operations. One of these, the Nickel Ore survey, is sent to only one company, which responded, representing most of the mine production shown in table 1. Byproduct nickel from copper smelting is obtained from another annual survey, and 100% coverage was obtained from this survey.

Table 1.—Salient nickel statistics

(Short tons unless otherwise specified)

	1978	1979	1980	1981	1982
United States:					
Mine production[1]	13,509	15,065	14,653	12,099	3,203
Plant production:					
Domestic ores	11,298	11,691	11,225	10,305	3,456
Imported materials	26,000	32,500	33,000	38,500	41,500
Secondary[2]	12,304	13,201	11,338	11,696	NA
Exports (gross weight)	36,293	50,810	56,675	[r]46,836	57,029
Imports for consumption	234,352	177,205	189,188	[r]209,008	129,787
Consumption (primary)	180,723	196,293	156,299	[r]144,851	103,981
Stocks, Dec. 31: Consumer	20,443	19,518	15,231	22,508	18,853
Price, cents per pound	210-193	193-320	320-345	345-320	320
World: Mine production	[r]725,398	[r]750,138	836,312	[p]784,505	[e]669,800

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.
[1]Mine shipments.
[2]Nonferrous scrap only; does not include nickel from stainless or alloy steel scrap.

Legislation and Government Programs.—Discussions were continued on international cooperation and jurisdiction over seabed nickel-bearing manganese nodules at the 10th Session of the 3d United Nations Conference on the Law of the Sea, held during 1982. The United States planned to continue in the effort to construct a framework of international cooperation in the oceans, but voted against the international treaty as proposed in 1982 because of certain provisions considered unacceptable. These included (1) lack of "grandfather" protection for companies already engaged in seabed mining, (2) insecure access to seabed deposits for new entrants, (3) production quotas designed to protect both the international seabed mining authority (the Enterprise) and land-based mineral producers, (4) lack of a guaranteed seat on the ruling body for the United States, (5) major changes could be made in the treaty by a two-thirds vote of the signatories without ratification by the U.S. Senate, and (6) mandatory transfer of seabed mining technology. Many countries signed the final treaty in a ceremony held in Caracas, Venezuela, in December. Independently, the United States, France, the Federal Republic of Germany, and the United Kingdom signed an "Interim Agreement on Polymetallic Nodules" on September 2 as a first step toward resolving differences in future deep seabed mining operations.

The Minnesota Department of Natural Resources held a sale in November of copper-nickel mining leases in Beltrami, Itasca, Koochiching, Lake of the Woods, Marshall, Roseau, and St. Louis Counties. About 550 sealed bids for leases to prospect for, mine, and remove copper, nickel, and associated metals were accepted by the Commissioner of Natural Resources. Leases were awarded in December. Thirteen firms and individuals submitted bids.

DOMESTIC PRODUCTION

The nickel mine of Hanna Mining Co. at Riddle, Oreg., shipped 3,203 short tons of nickel in laterite ore in 1982. Nickel recovered as ferronickel, and byproduct nickel salts and metal produced at copper and other metal refineries, totaled 3,456 tons. The Port Nickel refinery of AMAX Nickel Inc. at Braithwaite, La., was operated at 100% of capacity, processing nickel-copper matte from Botswana and Australia. Production of nickel at the facility totaled about 41,500 tons, as reported in its 10-K report. AMAX Nickel reduced its nickel matte purchases from Botswana by 25% in 1982. Because of poor market conditions, the company obtained an amendment to the contract with its supplier, Bamangwato Concessions, Ltd. (BCL), reducing its annual purchase commitment from 40,000 tons of BCL's annual production to 30,000 tons. About 10,000 tons of matte was to be diverted to the Falconbridge, Ltd., refinery in Kristiansand, Norway, and Rio Tinto Zinc, Ltd.'s nickel facility at Bindura in Zimbabwe. The new agreement was to extend over a 27-month period. Workers at the refinery ratified a 3-year pact in late August that froze basic wage rates for the life of the contract.

Hanna announced March 19 that it would shut down one of the two operating lines at its ferronickel smelter in Riddle, Oreg., beginning April 4. According to officials, the action was taken to reduce inventories that had accumulated owing to the weak market for nickel. Shortly thereafter, Hanna announced a complete shutdown of its mine and smelter effective April 19 because of a continuing slump in the worldwide nickel market. About 375 employees were affected by the closure. For several months prior to the shutdown, production costs had exceeded market prices. Hanna officials, union representatives, and employees had held discussions on ways to reduce labor costs at the operation, but the talks were unsuccessful. In addition, the operation had been impacted by a jump in power costs and a diminishing crude ore grade. Productivity had been improved during 1981, but the measures taken were insufficient. Hanna started production in 1954 and was the Nation's only integrated nickel mine and smelter for many years.

AMAX Exploration Inc. decided to withdraw from its Minnamax copper-nickel project in northeastern Minnesota, near Babbit. A lease agreement with Bear Creek Mining Co., a Kennecott Minerals Corp. subsidiary, was canceled, and a State permit formerly held by AMAX Exploration was transferred to Kennecott, which then assumed responsibility for monitoring the site. AMAX Exploration had conducted extensive environmental studies and had sunk a 1,700-foot shaft to explore for copper and nickel, in addition to drilling thousands of feet of core in the area. AMAX Exploration's investment since 1974 was put at more than $20 million. The company halted its work after concluding that both the ore grade and world metal prices were too low to justify continued exploration. Bear Creek Mining held the mineral rights on about 6,000 acres of land near Babbitt over a small part of what is known as the Duluth Gabbro. Kennecott had no immediate plans to develop the site.

Three companies were active during 1982 in recycling of spent hydrotreating catalysts. These were Gulf Chemical and Metallurgical, Inc., Freeport, Tex.; Inmetco, Inc., Pittsburgh, Pa.; and the Pesses Co., Solon, Ohio. In March, the Hall Chemical Co. of Wickliffe, Ohio, announced plans for the construction of a catalyst reclamation facility, to be located in the vicinity of Mobile, Ala. The $40 million plant was to have the capacity to produce about 1.5 million pounds of nickel per year and about the same amount of cobalt. However, construction had not yet begun by yearend. In 1978, two other companies, in a joint venture, attempted recovery of metals from a similar feedstock, but were unsuccessful.

Table 2.—Nickel recovered from nonferrous scrap processed in the United States, by kind of scrap and form of recovery

(Short tons)

	1981	1982
KIND OF SCRAP		
New scrap:		
Nickel-base	1,315	NA
Copper-base	2,684	NA
Aluminum-base	1,778	NA
Total	5,777	NA
Old scrap:		
Nickel-base	4,889	NA
Copper-base	524	NA
Aluminum-base	506	NA
Total	5,919	NA
Grand total	11,696	NA
FORM OF RECOVERY		
As metal	545	NA
In nickel-base alloys	2,676	NA
In copper-base alloys	4,303	NA
In aluminum-base alloys	2,374	NA
In ferrous and high-temperature alloys[1]	1,171	NA
In chemical compounds	627	NA
Total	11,696	NA

NA Not available.
[1]Includes only nonferrous scrap added to ferrous high-temperature alloys.

CONSUMPTION

Total demand, including secondary nickel, was estimated to be 178,000 tons, down 17,000 tons from the 1981 level. Demand for primary nickel remained depressed throughout the year. Reported consumption (primary nickel) was the lowest since 1958. All end uses showed significant declines. The largest declines occurred in stainless steel, alloy steel, nickel-copper and copper-nickel alloys, and superalloys.

The share of the primary nickel market held by pure unwrought nickel increased significantly, from 70% in 1981 to 76% in 1982; ferronickel decreased from 18% in

1981 to 15% in 1982; and nickel oxide sinter dropped from 6% to 4% of the market. The pure nickel forms (Class I) were utilized principally in the production of nickel wrought products, high-nickel heat- and corrosion-resistant alloys, copper-base alloys, and electroplating; ferronickel and oxide sinter were used largely in the production of stainless and alloy steels. The latter is referred to as charge or Class II nickel.

Although primary nickel consumption declined for the third year in a row, the pattern of consumption by type of product remained similar, as follows: stainless and heat-resistant steels, 31%; electroplating, 20%; heat and corrosion-resistant alloys, 17%; superalloys, 11%; alloy steels, 10%; and other, 11%. The approximate average percentages of total nickel used in 1982 that were consumed in wrought products were stainless steel (96), alloy steel (90), superalloys (65), and nickel-copper and copper-nickel alloys (90).

Table 3.—Nickel (exclusive of scrap) consumed in the United States, by form

(Short tons of contained nickel)

Form	1978	1979	1980	1981	1982
Metal	122,972	135,987	111,609	101,847	79,032
Ferronickel	33,272	39,977	29,919	26,290	15,426
Oxide powder and oxide sinter	19,817	14,189	8,492	r9,412	4,196
Salts[1]	2,026	3,944	3,330	r4,197	3,874
Other	2,636	2,196	2,949	r3,105	1,453
Total	180,723	196,293	156,299	r144,851	103,981

rRevised.
[1]Metallic nickel salts consumed by plating industry are estimated.

Table 4.—U.S. consumption of nickel (exclusive of scrap) in 1982, by use and form

(Short tons of contained nickel)

Use	Commercially pure unwrought nickel	Ferronickel	Nickel oxide	Nickel sulfate and other nickel salts	Other forms	Total
Steel:						
Stainless and heat-resisting	19,386	11,519	1,271	--	25	32,201
Alloys (excludes stainless)	5,353	2,917	1,676	2	65	10,013
Superalloys	10,272	436	5	185	54	10,952
Nickel-copper and copper-nickel alloys	3,670	--	211	47	338	4,266
Permanent magnet alloys	380	26	--	--	--	406
Other nickel and nickel alloys	16,818	425	506	9	116	17,874
Cast irons	996	102	213	6	628	1,945
Electroplating (sales to platers)[1]	17,350	--	--	3,447	92	20,889
Chemicals and chemical uses	1,634	--	188	108	96	2,026
Other[2]	3,173	1	126	70	39	3,409
Total reported by companies canvassed and estimated	79,032	15,426	4,196	3,874	1,453	103,981

[1]Based on monthly estimated sales to platers.
[2]Includes batteries, ceramics, and other alloys containing nickel.

Table 5.—Nickel (exclusive of scrap) in consumer stocks in the United States, by form

(Short tons of contained nickel)

Form	1980	1981	1982
Metal	10,825	18,355	16,743
Ferronickel	2,046	2,257	1,122
Oxide powder and oxide sinter	1,503	1,039	488
Salts	547	508	226
Other	310	349	274
Total	15,231	22,508	18,853

Table 6.—U.S. consumption, stocks, receipts, shipments, and/or sales of secondary nickel in 1982, by use

(Short tons of contained nickel)

Use	Receipts	Consumption	Shipments or sales	Stocks, end of year
Steel (stainless and heat-resisting and alloy)[1]	29,381	26,931	3,342	9,617
Nonferrous alloys (super, nickel-copper and copper-nickel, permanent magnet, other nickel)	4,178	4,354	14	374
Foundry (cast irons)	411	403	--	12
Chemicals (catalysts, ceramics, plating salts, other chemical uses)	1	3	--	1
Total reported by companies canvassed and estimated	33,971	31,691	3,356	10,004

[1]Purchased scrap only.

STOCKS

Both the inventory and goal for nickel in the National Defense Stockpile remained unchanged at 32,309 tons and 200,000 tons, respectively. Consumer stocks at yearend decreased by 16% compared with those at the end of 1981. Stocks held by producers or their agents in the United States declined by 33%. Estimated stocks of nickel at yearend in the foundry industry were as follows, in tons: iron (131), steel (94), high-nickel alloy (331), copper-base alloy (43), and permanent magnet alloy (16).

PRICES

The producer list prices in effect throughout the year were $3.20 per pound for cathode (melting) nickel, $3.12 per pound for ferronickel and nickel oxide sinter (charge nickel), and $3.29 per pound for plating-grade material. However, these prices held little significance in 1982, because consumers bought nickel at free market prices throughout the year from traders and producers. The monthend spot price reached its nadir in November at $1.50 per pound for cathode nickel, and London Metal Exchange prices broke the $1.50 per pound mark on several days toward yearend, after starting the year at about $2.60 per pound. This collapse in prices reflected the oversupply and depressed demand conditions in the nickel industry. Imports of nickel from the U.S.S.R. at very low price levels contributed to the decline.

FOREIGN TRADE

The estimated contained nickel in U.S. exports of unwrought nickel, powders, flakes, and anodes in 1982 was 36% of total primary demand, compared with 13% in 1981. The high exports were attributed to capacity production of unwrought nickel at Port Nickel, La., being sold principally in the European market. Production was maximized because of contractual obligations for purchase of feedstock.

Canada remained the principal supplier of nickel to the United States in 1982 and accounted for 40% of total imports. The next most important sources in decreasing order of magnitude were Australia, Botswana (matte for domestic refining), Norway, the Republic of South Africa, the Philippines, Finland, New Caledonia, and the U.S.S.R. In the aggregate, these nine countries accounted for 93% of U.S. imports. Imports declined for the first year since 1979, reflecting the extremely weak market. World consumption of primary nickel was 540,000 tons in 1982 compared with approximately 720,000 tons consumed in 1981.

Table 7.—U.S. exports of nickel and nickel alloy products, by class

Class	1980		1981		1982	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Unwrought	13,886	$114,779	16,298	$116,494	33,772	$178,337
Bars, rods, angles, shapes, sections	3,443	48,270	2,463	39,066	2,589	28,018
Plates, sheets, strip	7,113	82,865	8,057	81,648	2,218	29,460
Anodes	139	979	94	909	127	1,231
Wire	1,087	11,766	660	8,262	481	6,011
Powders and flakes	5,438	37,101	r3,282	23,929	3,457	22,441
Catalysts	3,530	18,559	3,890	25,601	2,874	19,654
Tubes, pipes, blanks, and fittings thereof, hollow bars	1,416	18,512	1,333	16,164	488	9,807
Waste and scrap	20,623	38,652	10,759	21,595	11,023	20,136
Total	56,675	371,483	r46,836	333,668	57,029	315,095

rRevised.

Table 8.—U.S. imports for consumption of nickel products, by class

Class	1980		1981		1982	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Ore	1,124	$13	513	$42	--	--
Unwrought	116,193	708,693	123,141	747,920	82,297	$446,850
Oxide and oxide sinter	4,182	21,753	4,330	21,779	3,144	13,461
Slurry[1]	77,459	208,742	r94,786	223,060	58,568	105,633
Bars, plates, sheets, anodes	2,396	20,918	1,011	9,321	1,384	11,217
Rods and wire	2,635	21,583	2,198	18,317	2,362	19,217
Shapes, sections, angles	83	892	21	552	8	226
Pipes, tubes, fittings	717	11,554	634	8,707	1,366	19,688
Powder	15,129	98,001	13,909	91,944	11,953	71,825
Flakes	115	665	215	1,381	179	1,020
Waste and scrap	3,572	18,481	5,226	17,496	4,300	13,349
Ferronickel	51,741	104,156	69,853	119,321	21,352	28,215
Total (gross weight)	275,346	1,215,451	r315,837	1,259,840	186,913	730,701
Nickel content[2]	189,188	XX	r209,008	XX	129,787	XX

rRevised. XX Not applicable.

[1]Nickel-containing material in slurry, or any form derived from ore by chemical, physical, or any other means, and requiring further processing to recover nickel or other metals; principally matte for refining; also includes salts and compounds.

[2]Estimated from gross weight of primary nickel products.

Table 9.—U.S. imports for consumption of new nickel products, by country

(Short tons of nickel)

Country	Metal		Powder and flakes		Oxide and oxide sinter		Ferronickel		Slurry and other[e] [1]	
	1981	1982	1981	1982	1981	1982	1981	1982	1981	1982
Australia	10,659	8,618	1,804	2,450	7	29	5	--	10,147	9,868
Botswana	--	--	--	--	--	--	--	--	24,625	14,072
Canada	62,414	42,440	8,659	6,956	3,085	1,908	525	--	1,711	727
Dominican Republic	--	--	--	--	--	--	9,390	--	--	--
Finland	3,122	3,318	--	--	--	--	--	--	106	154
France	604	730	--	--	31	77	--	--	1	--
Germany, Federal Republic of	56	1,272	167	116	136	--	38	1	75	28
Japan	799	95	--	--	--	--	3,586	2,041	23	18
Netherlands	77	79	--	--	--	--	--	--	43	3
New Caledonia	--	--	--	--	--	--	5,294	3,213	2,710	--
Norway	22,223	12,859	58	78	11	3	7	--	--	--
Philippines	9,740	2,616	1,830	1,415	--	--	--	--	--	--
South Africa, Republic of	4,353	4,217	816	698	--	--	12	6	[r]8,660	2,636
Sweden	--	--	--	--	--	--	--	--	4	--
U.S.S.R	6,638	2,463	--	--	--	--	--	--	--	--
United Kingdom	696	608	786	400	--	--	--	--	--	2
Zimbabwe	1,492	2,981	--	--	--	--	--	--	--	--
Other	268	1	4	19	64	404	1,391	83	56	85
Total	123,141	82,297	14,124	12,132	3,334	2,421	20,248	5,344	[r]48,161	27,593

[e]Estimated nickel content. [r]Revised.

[1]Nickel-containing material in slurry or in any other form derived from ore by chemical, physical, or any other means and requiring further processing; principally matte for further refining; includes nickel in laterite ores for testing purposes; excludes bars, plates, sheets, and anodes.

WORLD REVIEW

Mine and plant closings and temporary shutdowns were experienced in many countries, including Australia, Canada, the Dominican Republic, Finland, the Philippines, Japan, and Zimbabwe. Production was curtailed in Indonesia, New Caledonia, and Australia in response to very weak demand. In spite of the poor market, several new projects were brought onstream: Cerro Matoso ferronickel in Colombia, Kavadarci ferronickel in Yugoslavia, and Empresa de Desenvolvmento de Recursos Minerais S.A. (CODEMIN) ferronickel in Brazil. Governments gained control or pledged support of mining operations in Botswana and Greece. Construction of the 30,000-ton-per-year nickel refinery in Punta Gorda, Cuba, continued. Japan began the purchase of nickel for its national stockpile.

Albania.—Late in the year, the Albanian Government awarded a contract to the Federal Republic of Germany firm Salzgitter Industriebau for construction of a 6,000-ton-per-year electrolytic nickel refinery in the Elbasan region. Inco Technology, Ltd., a subsidiary of Inco, Ltd., was to provide technology, laboratory services, design engineering, and training. Feedstock for the new plant was to be domestically produced as a byproduct of nickeliferous iron ore mining and was shipped to Sered, Czechoslovakia, for processing. A nickel carbonate was also produced in Albania. Nickel metal and cobalt oxide would be produced at the new plant, which was expected to be completed in 1985. Nickel mining capacity, about 10,000 tons per year, would not be changed.

Australia.—About 70% of Australia's nickel output was from the nickel sulfide operations in Western Australia. Greenvale's lateritic mine in Queensland made up the remainder.

Metals Exploration Ltd. and Freeport Queensland, Ltd., reported significant losses for the first half of 1982. Sintered nickel oxide (95% Ni) and nickel-cobalt sulfide are produced at Yabulu in Queensland as part of the Greenvale operation. All of Greenvale's ore dryers at the Yabulu treatment plant were converted from oil to coal by the beginning of the year, and conversion of the boilers was completed by midyear. This was to help reduce escalating power costs and partially offset lower prices for metal.

In Western Australia, Western Mining Corp. (WMC), which operates the Kambalda mines, maintained a large flash smelter at Kalgoorlie that treated the Kambalda, Agnew, and Nepean Mine ores to produce nickel matte. On the coast, near Perth, the large Kwinana facility produced nickel metal and nickel-cobalt sulfide. WMC signed a $750 million contract with Sumitomo Metal Mining Co. Ltd. of Japan for the supply of 16,500 short tons of nickel matte to Sumitomo each year. The contract amount represented 30% of the total production of nickel mines situated near Kalgoorlie and Kambalda and 90% of Sumitomo's needs. Since 1967, WMC had delivered approximately 175,000 short tons of nickel concentrate and matte to Sumitomo. Since 1973, the deliveries had been entirely matte. According to Metals Exploration officials, the Western Australia Nepean nickel mine near Kalgoorlie was scheduled to close early in 1983 for at least 12 months. The closure effectively would remove about 4,000 tons of nickel from the market.

Botswana.—BCL reportedly achieved a 67% increase in output of concentrate and a 21% increase in output of nickel-copper matte over 2 years as a result of modifications to plant equipment. Also, by making maximum use of local coal, almost total independence from imported oil was realized. Mill circuit development included the use of wet magnetic separators, and smelter developments included upgrading the spray drying plant, a revised flash furnace feed system, the installation of a 230-ton-per-day oxygen plant, and increased slag granulation and handling capacity. The modifications began in 1980 and resulted in a 75% increase in smelter capacity for new concentrate.

AMAX Nickel reduced its nickel matte purchases from Botswana by 25% in 1982. The company obtained relief from a contract with its supplier, BCL. Under terms of the contract, AMAX Nickel was required to purchase 40,000 tons of BCL's annual output. The nickel-copper matte is processed at AMAX Nickel's Port Nickel, La., refinery. Negotiations for the contract amendment began in 1981. About 10,000 tons of matte was to be diverted to the Falconbridge refinery in Kristiansand, Norway, and Rio Tinto Zinc's nickel facility (Eiffel Flats) in Zimbabwe. The new agreement was to extend over a 27-month period.

The National Assembly of Botswana passed a bill in April, making the Government the financial guarantor of BCL. Major shareholders in the mine, including AMAX Nickel (30%), Anglo American, Ltd. (30%), and the Botswana Government (40%), held discussions in March on the third restructuring of the project's debt load. Under the plan, worked out in September, all parties made substantial sacrifices. The length of repayment of debt would be significant.

Brazil.—The third Brazilian lateritic nickel mine and smelter came onstream late in the year. CODEMIN, owned by the Hochschild Group and Anglo American Corp. of Brazil, was to mine from a deposit situated in the Serra da Mantiqueira Mountains, 112 miles north of Brazilia and not far from deposits being mined by Cia. Níquel Tocantins. The plant capacity was about 6,000 short tons of nickel contained in ferronickel. Nickel content of the ore ranged from 1.4% to 1.8%, and reserves were sufficient to last 20 years at maximum production rates. Plans called for the development of three open pits during the life of the mine. Power for the reduction and refining furnaces was supplied by hydroelectric sources in southeast Brazil. An overall nickel recovery rate of about 85% was expected to be achieved.

Morro do Niquel exported part of its ferronickel production because of poor domestic demand and problems in Morro's oxygen plant. These problems resulted in greater production of low-grade ferronickel, which the domestic market could not absorb.

Brazil's state-owned Cia. Vale do Rio Doce opened, for exploration, land containing extensive nickel reserves. The property was situated in the Amazon's mineral-rich Carajas Mountain area. The area contains an estimated 52 million tons of nickel.

Burundi.—A German exploration team under the United Nations Development Program explored for nickel in the Musongati, Nyabikere, and Waga areas, continuing a project that began in 1981.

Canada.—Mine, mill, smelter, and refinery workers at Inco Ltd.'s Sudbury and Port Colborne, Ontario, operations went on strike May 31, halting production of nickel by Inco Ltd. in the Province. The workers were members of the United Steelworkers of America (USW) Local 6500 in the Sudbury region and USW Local 6200 at the Port Colborne refinery. A 3-year pact that offered a $3.68 per hour cost of living increase over the term of the contract was rejected. Although the strike ended July 2, the facilities remained closed through year-end and were not scheduled to reopen until April 1983. USW members voted in favor of a 3-year pact that was retroactive to June 27. About 80% of those voting approved the new contract that called for a $5.25 per hour increase over 3 years and continued a cost of living adjustment. Lack of leverage for the workers in negotiations, owing to the poor nickel market, combined with an inducement of eligibility for $250 per week unemployment benefits (instead of $40 per week strike pay), brought about an early resolution of the strike. The strike lasted just 5 weeks. The Thompson Mine and refinery were closed during November and December only.

On August 18, Inco Ltd. announced further reductions in its staff and labor force as a result of continuing depressed market conditions. In the Ontario Div., the total work force was to be reduced by about 1,185, including 235 staff employees. For the hourly workers, the layoff would not begin until January 24, 1983. At Sudbury, Ontario, the company suspended production from the upper portion of the Levack Mine and reduced production to a one-shift-per-day basis in the rest of the mine. This resulted in a 50% reduction in output at the mine. In addition, Inco Ltd. planned to proceed with redesigning the upper portion for lower cost bulk mining methods, and accelerated the changeover from the undercut-and-fill method of mining to lower cost vertical-retreat mining in other parts of the mine. The Copper Cliff North Mine was reactivated as a commercial-scale mine research facility with about 120 employees. New mining methods and equipment were to be developed at the facility to make Inco Ltd.'s other mines more productive and cost competitive.

By yearend, Inco Ltd.'s employment worldwide was reduced by 22%. By 1988, the Sudbury work force was to be reduced to 9,500 from the 1982 level of 12,000. This was expected to result in a reduction of effective capacity at Sudbury of 20,000 tons to 120,000 tons.

Inco Ltd. restructured its management by dissolving Inco Metals Co., which had been responsible for mining, processing, and marketing of the company's primary metals. Inco Metals' functions were assumed by Inco Ltd. Inco Ltd. also made definite plans to sell all of its Rayovac battery operations and sold its Exide Electronics Div., thereby eliminating the Inco Electroenergy Corp.

In another cost-cutting move, Inco Ltd. delayed the scheduled completion of the Thompson open pit mine project until early 1986. The Thompson open pit development, announced in October 1981, was intended to replace the existing Pipe Mine, which will be depleted by 1985. The deferral cut about $9 million from 1982 capital cost requirements for the project's $72 million first phase. Falconbridge also shut down its Canadian operations from June 27 through yearend. A 3-year contract between Falconbridge and the Mine, Mill, and Smelter Workers' Union expired August 21 during a previously planned 13-week shutdown. Falconbridge reduced its long-term production capacity at Sudbury to about 25,000 tons per year with the reduction in its work force by about 1,400 personnel.

Colombia.—The Cerro Matoso nickel laterite project in Colombia, which was commissioned in June, began significant production in August after initial mechanical problems were overcome. The $400 million open pit mine and processing plant was designed to produce 22,600 tons of ferronickel annually. Feasibility studies for the mine were initiated in 1966, but construction did not actually begin until 1979. Located in the tropical lowlands, about 250 miles northwest of Bogotá, the mine has established reserves of 23 million tons of ore at an average grade of about 2.7% nickel. The smelter, situated near the mine, produced about 1,000 tons of nickel in ferronickel monthly during the last quarter. The ferronickel contains 35% to 40% nickel.

Coal is used as a reducing agent in a rotary kiln-electric furnace process employed at the site. The smelter consumed hydroelectric power, accounting for 75% of the project's total energy supplies. The remaining 25% was met by natural gas and other sources, used principally for ore drying. Cerro Matoso, S.A., is a Colombian corporation composed of Empresa Colombiana de Niquel, a Colombian Government corporation (45%); Hanna (20%); and Billiton Overseas Ltd. (35%), a member of the Royal Dutch/Shell Group. Aside from shareholder equity, project funding was provided by a group of commercial banks. These loans totaled about $226 million, comprised of $120 million from Chase Manhattan Bank, $80 million from the International Bank for Reconstruction and Development (World Bank), and $25.6 million from the Export-Import Bank.

Cuba.—The 30,000-ton-per-year Punta Gorda nickel plant was about 55% complete in September, but would not come onstream until 1984. The $100 million facility was being built with assistance from the U.S.S.R. Construction of the Las Camariocas plant was scheduled to begin by yearend. Production from all current and projected capacity could reach 107,000 tons by 1990.

At Punta Gorda, a 20-ton-per-day pilot plant, to be used for research studies in the processing of nickel-cobalt laterite ores, was under construction and was expected to be completed by mid-1983. Research at the pilot plant was to be directed toward the study of process treatment conditions for new laterite deposits, the testing and evaluation of alternate processes, the development of process control systems, and the testing of new equipment. The original conceptual design and specifications were completed in late 1979 with the assistance of a Canadian company. The design was based on the Nicaro process, which includes reduction roasting, nickel leaching with ammonia-ammonium carbonate, cobalt recovery, and nickel precipitation by distillation.

Dominican Republic.—In mid-January, Falconbridge announced the temporary closing of its ferronickel operation, Falconbridge Dominicana, C por A. The facility, with a designed annual capacity of 33,000 tons, employs 2,000 workers. Prior to the shutdown, the plant was operating at about 35% of capacity. After the shutdown, Falconbridge, the Western World's second largest producer, was operating at less than 50% of capacity, including cutbacks at its nickel mining operations in Canada. Falconbridge and ARMCO, Inc., of Middletown, Ohio, the other major shareholder in the Dominican company, made payments of $43 million over the previous 1-1/2 years to cover operating deficit and debt service.

Falconbridge announced September 16 that it would resume production at its Dominican ferronickel operations immediately. The Dominican subsidiary planned to operate at about 50% of capacity, and about two-thirds of the personnel at the site returned to work. According to company officials, the facility was reopened because of the country's unbalanced inventory position, ferronickel stocks being much lower than those of electrolytic nickel.

Greece.—The Government of Greece took over control of Larco S.A., the nickel and steel company of the Bodossakis Group. Two state-owned banks, the National Bank of Greece and the Commercial Bank of Greece, took over 80% of the company's shares. The nationalization was a part of the Government's plan to buy up stocks of companies facing bankruptcy. The plant has a capacity of about 27,000 tons per year of nickel in ferronickel.

India.—The Canadian International Development Agency became involved in the proposed Sukinda nickel project in Orissa Province. The agency made a preliminary evaluation of the available data.

The Minerals and Metals Trading Corp. issued a tender in October for 248 tons of nickel. Nickel consumption in India grew from about 4,000 tons in 1970 to a peak of about 8,000 tons in 1981, with a decline in 1982 owing to the recession.

Indonesia.—P.T. International Nickel Indonesia, the 98% owned subsidiary of Inco Ltd. of Canada, cut back production at its Soroako, Sulawesi, facility to less than 40% of capacity. One of two operating process lines was shut down on February 1. A third line remained inactive because of poor market conditions. Most of the production was exported to Japan. The smelting operations came onstream in 1977 and were hampered by technical problems. Early in 1980, Inco Ltd. of Canada revised production capacity of the facility downward from 100 to 75 million pounds because of technical problems associated with the acidic nature of relatively high-grade ores at the site. During most of the year, nickel was produced from only one furnace. Japanese consumers negotiated a reduction in prices paid for ore with Japan's other nickel producer, Aneka Tambang, Ltd., to $2.21 per pound.

Ivory Coast.—Relatively large nickel deposits were found in the Giankouman-Sipilou region near the town of Man in the west-central part of the country. Falconbridge explored an area estimated to encompass a 200-million-ton deposit containing about 1.6% nickel. Recoverable cobalt occurs beneath the nickel oxides.

Japan.—The Ministry of International Trade and Industry (MITI) began stockpiling 5 rare metals as part of a plan to stockpile 11 such metals over a period of 5 years. The five metals are nickel, cobalt, chromium, tungsten, and molybdenum. The stockpile inventory objectives are equivalent to 2 months of consumption in Japan (about 51,500 tons for nickel). According to the plan, the equivalent of a 12-day consumption would be purchased each year. The stockpiling authority was to be the Federation of Mining and Metals, under the control of MITI. Other metals to be included were manganese, vanadium, palladium, strontium, and antimony. Funds for the $288 million program were to be supplied from open markets by issuance of Government-guaranteed bonds. The Japan Rare Metal Stockpiling Association, a private group coordinating with the Government, was to make an initial purchase of 3,244 short tons of nickel, composed of 1,266 tons of nickel metal, 1,786 tons of ferronickel, and 192 tons of oxide sinter.

Shimura Kako Co., a ferronickel producer in Date, Hokkaido Province, ceased operations at the end of the year because of the poor market conditions. Annual capacity was about 5,000 tons of contained nickel.

Shimura's parent company was Inco Ltd. of Canada. About 140 employees were laid off.

New Caledonia.—Further cutbacks were announced at Société Le Nickel's S.A. (SLN) Doniambo facility to less than 40% of capacity. Output in 1982 was estimated at 31,000 tons of nickel in ferronickel. In addition, SLN planned to reduce annual nickel cathode production at its Sandouville refinery in France, which is supplied by New Caledonia raw material (matte). The new annual rate was 5,500 short tons, down from 9,900 tons in 1981. During the year, the French Government took over control of SLN's parent company, IMETAL.

An agreement was reached between SLN and Japanese ferronickel smelters to hold New Caledonia ore prices at 1981 levels, unless the market situation changed drastically. Also, import volume from new Caledonia to Japan should not fall below one-half of Japan's total nickel ore imports. In addition, SLN was successful in negotiating with the Japanese Government in lowering the Japanese tariff on New Caledonian ore from 11% to 9.3% as of April 1.

New Guinea.—Nord Resources Corp. announced that continued exploration of the nickel-chromium-cobalt deposits on the Ramu River indicated the presence of an estimated 115 million tons of nickel ore with an average grade of about 1.2% nickel. Bechtel Corp. conducted a feasibility study on the project and estimated capital costs at about $1.1 billion to produce 25,000 tons of nickel, 3,000 tons of cobalt, and 500,000 tons of chromite annually.

New Zealand.—New Zealand was proposed as a site for a $100 million nickel smelter by a private group (New Zealand Nickel Smelters, Ltd.). Hydroelectric power from the Cluthe River project would be utilized to process New Caledonian nickel ores.

Philippines.—Marinduque Mining and Industrial Corp. operated at a greatly reduced rate and was closed during the first quarter of the year. Capacity was about 34,000 tons of nickel per year. The company completed conversion of equipment for use of coal rather than oil as an energy source. Also, Marinduque raised recovery rates to about 85% compared with 65% when the operation first came onstream. Nevertheless, losses remained heavy during the year. The facility was able to remain open through Government financial assistance.

Taiwan.—Inco Ltd. announced plans in September to construct a nickel reduction plant with an annual capacity to produce 7,700 tons of nickel in the form of metal, ferronickel, and nickel sulfide. The plant was to be built by International Nickel BV of the Netherlands and a Japanese partnership. Inco Ltd., was to supply the $6 million plant with nickel oxide feed and provide technology for the facility. The market for nickel was expected to experience a high rate of growth, and this facility could supply all of Taiwan's anticipated needs. Nickel metal in shot and pig form will be supplied to a stainless steel plant of Tang Eng Iron Works Co. Ltd. Inco Ltd., was to provide $1 million of the $5.7 million investment in the nickel plant, which was to be completed by midyear 1983.

United Kingdom.—In late April, Inco Europe, Ltd., curtailed nickel powder and pellet production at its Clydach, Wales, refinery. A complete halt in production was accomplished by May 10. The closure was officially stated to be temporary, contingent upon improvement in nickel demand, but remained in effect through yearend. The refinery, with an annual capacity of about 60,000 tons of nickel, normally produces about 15% of Inco Europe's Class I products. However, the plant had been operating at only about 50% of capacity for the previous 1-1/2 years before stopping production. Inventory on hand was adequate to meet Inco Europe's customer requirements for the immediate future. Production of nickel chemicals at the facility was to continue. The refinery produced all of the principal commercial nickel products: charge, melting, and electroplating materials. On August 18, an announcement was made that the total work force at Clydach would be reduced by 80.

Yugoslavia.—The Kavadarci open pit mine and smelter in Macedonia Province began production in April. Rated capacity of the plant was 17,600 tons of nickel per year in ferronickel. The smelter only produced for the domestic market during the year, operating at about one-third of capacity. The nickel mine, which is in southern Yugoslavia, is located about 25 miles from the smelter at Kavadarci. The smelter is about 112 miles southwest of Skopje. The $350 million plant consisted of two lines and produced ferronickel containing 25% nickel in the last quarter. Initially, owing to startup problems, a 12% to 15% nickel raw material was produced. Full production is not expected until 1985.

Zimbabwe.—In October, Rio Tinto Mining Zimbabwe, Ltd. (RTMZ), received a $1.7 million loan from the Zimbabwe Government to keep the Empress nickel mine open until yearend. Instability of the rock being mined and declining ore grade resulted in a $3.6 million loss for the first half of the year. At yearend, a decision was made to close the mine, idling 1,180 workers. RTMZ's 5,000-ton-per-year Eiffel Flats refinery at Gatooma remained in operation. BCL of Botswana agreed to sell about 4,200 tons per year of its matte output to RTMZ, which will complement ore received from the Perseverance Mine at Chatari.

Table 10.—Nickel: World mine production, by country[1]

(Short tons)

Country	1978	1979	1980	1981[p]	1982[e]
Albania[e]	5,600	5,800	6,100	6,200	6,400
Australia (content of concentrate)	90,785	76,841	81,927	82,095	90,610
Botswana	17,691	17,828	17,022	18,200	[2]19,573
Brazil (content of ore)	3,968	3,267	6,435	7,239	6,200
Burma (content of speiss)	20	19	15	22	22
Canada[3]	141,437	139,422	203,709	176,642	97,824
China[e]	12,000	12,000	12,000	12,000	12,000
Cuba (content of oxide and sulfide)	[r]36,733	[r]34,275	40,363	42,532	39,258
Dominican Republic	15,765	27,680	18,019	20,601	6,600
Finland (content of concentrate)	[r]7,904	6,393	7,199	7,566	7,600
German Democratic Republic[e]	3,000	2,800	3,000	3,000	3,000
Greece (recoverable content of ore)[4]	20,431	22,214	16,796	17,200	16,800
Guatemala	1,189	6,833	7,650	--	--
Indonesia (content of ore)[4]	34,628	34,212	33,895	34,242	32,000
Mexico (content of ore)	24	1	--	--	--
Morocco (content of nickel ore and cobalt ore)	192	176	148	140	110
New Caledonia (recoverable)	71,839	88,696	95,451	86,079	65,000
Norway (content of concentrate)	591	[e]550	[e]550	[e]550	550
Philippines	32,549	36,693	51,934	33,948	22,000
Poland (content of ore)[e]	[r]2,600	[r]2,300	[r]2,300	[r]2,300	2,300
South Africa, Republic of	31,636	33,339	28,329	29,100	24,250
U.S.S.R. (content of ore)[e]	164,000	166,000	170,000	174,000	187,000
United States (content of ore shipped)	13,509	15,065	14,653	12,099	3,203
Yugoslavia[e]	NA	1,650	2,200	4,400	13,200
Zimbabwe (content of concentrate)	17,307	16,084	16,617	14,350	14,300
Total	[r]725,398	[r]750,138	836,312	784,505	669,800

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.

[1]Insofar as possible, this table represents recoverable mine production of nickel; where data relate to some more highly processed form, the figure given has been used in lieu of unreported actual mine output to provide some indication of the magnitude of mine output, and is so noted parenthetically following the country name, or by footnote. Table includes data available through Apr. 25, 1983.

[2]Reported figure.

[3]Refined nickel content of oxides and salts produced, plus recoverable nickel in exported matte and speiss.

[4]Includes a small amount of cobalt not reported or recovered separately.

Table 11.—Nickel: World smelter production, by country[1]

(Short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Australia[3]	41,146	43,366	38,921	46,854	55,900
Brazil[4]	2,522	2,715	2,760	2,574	2,200
Canada[5]	98,360	92,315	167,881	127,000	69,900
China[e]	11,000	11,000	11,000	11,000	10,000
Cuba[6]	[r]8,173	[r]8,923	8,773	9,370	9,500
Czechoslovakia	[e]2,400	2,202	2,240	2,425	2,425
Dominican Republic[4]	15,765	27,680	18,019	20,601	6,600
Finland	8,268	[r]12,632	14,117	14,672	14,300
France[5]	8,543	3,660	10,802	11,000	9,900
German Democratic Republic[e]	3,300	3,300	3,300	3,300	3,300
Germany, Federal Republic of[7]	993	1,348	1,361	[e]1,320	1,320

See footnotes at end of table.

Table 11.—Nickel: World smelter production, by country[1] —Continued

(Short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Greece	16,410	16,129	15,300	14,000	13,800
Indonesia[4]	4,959	4,409	4,625	5,300	4,400
Japan	87,303	111,333	108,428	95,679	92,300
Mexico	24	1	--	--	--
New Caledonia[4]	21,924	33,480	35,913	30,852	31,000
Norway	[r]26,168	[r]33,826	[8]40,921	[8]40,890	40,800
Philippines	20,654	23,675	27,978	26,376	12,900
Poland[e]	[r]2,600	[r]2,300	[r]2,300	[r]2,300	2,300
South Africa, Republic of	24,802	8,863	19,950	19,800	15,900
U.S.S.R.[e]	[r]184,100	[r]186,300	[r]189,600	[r]194,000	209,400
United Kingdom	23,553	20,793	21,275	27,999	7,600
United States[9]	37,298	44,191	44,225	48,805	44,956
Yugoslavia	--	--	--	--	8,800
Zimbabwe[e]	14,300	14,600	15,500	[r]13,200	13,200
Total	[r]664,565	[r]709,041	805,189	769,317	682,701

[e]Estimated. [p]Preliminary. [r]Revised.

[1]Refined nickel plus nickel content of ferronickel produced from ore and/or concentrates unless otherwise specified. Table includes data available through Apr. 21, 1983.

[2]In addition to the countries listed, Albania is known to have initiated smelter production in 1978, and North Korea is believed to have produced metallic nickel and/or ferronickel, but information is inadequate for formulation of reliable estimates of output levels. Several countries produce nickel-containing matte, but output of nickel in such materials have been excluded from this table in order to avoid double counting. Countries producing matte include the following, with output indicated in short tons of contained nickel: Australia: 1978—36,045; 1979—42,626; 1980—35,825; 1981—36,223; and 1982—36,900 (estimated); Botswana: 1978—17,691; 1979—17,828; 1980—17,022; 1981—20,150; and 1982—19,573; Indonesia: 1978—none; 1979—7,402; 1980—17,428; 1981—16,499; and 1982—11,200 (estimated); New Caledonia: 1978—18,853; 1979—13,517; 1980—17,063; 1981—16,954; and 1982—8,800 (estimated).

[3]Refined nickel plus the nickel content of oxide.

[4]Nickel content of ferronickel only. (No refined nickel is produced.)

[5]Includes nickel content of refined nickel, nickel oxide, and nickel matte.

[6]Content of granular nickel oxide and powder only; Cuba also produces nickel oxide sinter and a processed sulfide, but these are not included in order to avoid double counting, as they may be processed to metal elsewhere. Output of sinter was as follows in short tons: 1978—10,423; 1979—11,828; 1980—13,065; 1981—13,394 (estimated); and 1982—13,068 (estimated). Output of processed sulfide was as follows in short tons: 1978—16,793; 1979—13,524; 1980—18,525; 1981—19,768 (estimated); and 1982—16,711 (estimated).

[7]Includes nickel content of nickel alloys.

[8]Data derived from estimated metal content of reported concentrate.

[9]Byproduct of metal refining, including that derived from both domestic ores and imported materials.

TECHNOLOGY

Joslyn Stainless Steels, Inc., Fort Wayne, Ind., adopted a technique developed by the Bureau of Mines for in-plant recycling of stainless steel furnace dusts, mill scale, and grinding swarf. Through experimentation, Bureau researchers showed that these wastes could be pelletized and returned to the arc furnaces as a means of recovering the contained valuable metals, while coincidentally solving the problems of storage and waste disposal.[2] The procedure recommended as being most economical was the direct addition of pelletized waste to the arc furnace as 10% to 20% of the total charge for production heats, instead of part of the usual scrap or alloy charge. The dusts, scale, and swarf can be mixed and pelletized with little difficulty, providing a means for adding carbon to the mix and a vehicle for charging the furnace. Only conventional equipment was used for agglomeration. Usual recoveries of substantially greater than 90% of the nickel and iron were obtained, and about 90% of the chromium and molybdenum appeared to be consistently recoverable with proper control of variables. Using the technique, no problems were encountered in commercial stainless production heats.

As part of the first order assessment of the potential of reject waste materials from nickel-bearing manganese nodule processing, the Bureau of Mines estimated the physical and chemical characteristics of reject waste materials that would be generated from each of five potential process flowsheets.[3] On the basis of the results obtained, it appeared that the reject waste material generated by the five outlined processes may have only minor environmental implications. According to the study, leachates of two ammoniacal leach wastes, a sulfuric acid leach waste, and a smelting leach waste should be well below maximum limits for classification as hazardous waste.

The National Association of Recycling Industries (NARI) and the Bureau of Mines continued a $2 million cooperative research program, wherein subcommittees of NARI recommend research projects to the Bureau, including those in superalloys. The research and development in superalloy elements is concentrated in several areas: assessment of strategic metals in waste catalysts, recovery of these metals from superalloy scrap and grinding waste, and creating intermetallic compounds from superalloy scrap to recover strategic metals.[4]

Caro's acid, H_2SO_5, prepared directly from hydrogen peroxide and strong sulfuric acid, was reported to overcome many of the problems associated with the conventional method of cobalt and nickel separation by selective oxidation of cobalt as cobalt (III) hydroxide.[5] Near quantitative removal of cobalt was possible from solutions that ranged widely in both cobalt-to-nickel ratio and overall metal concentration. Greater ease of operation and lower cost of effluent were also claimed.

Two companies developed systems for treatment of complexed waste waters, including removal of nickel from electroless plating effluent. One, manufactured by Ethone Corp., was claimed to be highly selective in removing copper and nickel using ion-exchange resin technology. One cubic foot of resin could remove up to 1 pound of metal. A moving bed technology allows simultaneous sorption and regeneration of resin, permitting continuous operation. Another, manufactured by MacDermid, Inc., utilized a high-efficiency electrolytic technique to recover metals from waste water, principally the rinse water in the plating industry. Nickel removal of 96 grams per hour was achieved for typical conditions found in an electroplating installation.[6]

The severely corrosive environments and high temperatures and pressures found in deep oil and natural gas (sour gas) wells have produced a demand for nickel alloy tubular products to counter sulfide stress cracking and hydrogen-induced cracking.[7] Incoloy 805 (42% Ni), developed by Huntington Alloys, Inc., was one alloy that qualified for use in the environment after extensive testing by several oil companies. Hastelloy Alloy C-276 (16% Ni), developed by Cabot Corp., also qualified, particularly for very deep wells of over 20,000 feet. Areas where these alloys have been used are the Jackson Dome region of Mississippi, the Overthrust Belt in Colorado, and the Tuscaloosa fields in Louisiana.

National Steel Corp., Pittsburgh, Pa., continued testing of nickel-coated can stock as a replacement for tin coating. The nickel coating was produced on converted electrolytic tin plating lines. Because of the acidic quality of some foods, testing can take up to 2 years. National, the Nation's sixth largest steel producer, had applied for several patents on the nickel coating process.[8]

Tests of nickel-iron batteries for use in electric vehicles continued with encouraging results.[9] Eagle-Picher Industries, Inc., and Westinghouse Electric Co. conducted tests. However, before commercialization, more research was needed. Electricity required for charging had to be reduced, and a considerably higher price for gasoline was essential.

Research on a possible substitute for the austenitic stainless steel (Fe-Ni-Cr) alloys was carried out. The replacement was an Fe-Mn-Al-Si-C-X alloy that showed excellent oxidation resistance at 500° and 700° C.[10] The object of the alloy design was to obtain an Fe-Mn-Al base alloy with as much aluminum as possible retained in the austenitic solid solution. Meanwhile, the use of stainless steel in automobile engine exhaust systems was reported to be increasing, mostly of the low- or zero-nickel types (400 Series). Nickel-bearing stainless steels of the 300 Series were used for catalyst supports, fasteners, and springs. For transverse-mounted engines, Type 309 fasteners are used to couple the pipe to the manifold.[11]

Carpenter Technology Corp. developed a new alloy, designated 20Mo-6, for applications requiring resistance for highly acidic environments. The alloy contains 33% to 37% nickel and was designed for applications in which both sulfuric acid and chlorides are present. It was expected to be used in the pollution control equipment market and the chemical processing industry.[12]

Research aimed at improving the ductility of nickel aluminides was carried out at Tohoku University, Japan, and Oak Ridge National Laboratory.[13] Boron additions were found to be beneficial in overcoming low ductility and brittle grain boundary fracture. To produce structural members with high ductility, microalloying and thermoammoniacal processing techniques were also critical. If this research proves successful, a new class of high-temperature alloys could be produced.

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[1]Physical scientist, Division of Ferrous Metals.

[2]Higley, L. W., Jr., R. L. Crosby, and L. A. Neumeier. In-Plant Recycling of Stainless and Other Specialty Steelmaking Wastes. BuMines RI 8724, 1982, 16 pp.

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Nitrogen

By Charles L. Davis[1]

Total U.S. production of fixed nitrogen in the form of ammonia decreased during 1982 from that of 1981. Production for each month was less than the respective monthly production in 1981. The highest monthly level in 1982, 1.52 million short tons, occurred in May. Value of ammonia produced in 1982 decreased 35% to $2 billion, compared with the 1981 value of $3.1 billion. Value of U.S. ammonia consumption decreased 36% in 1982, to $2.1 billion, from the $3.3 billion value in 1981. Production and apparent consumption values were based on average annual 1981 and 1982 f.o.b. gulf coast prices. Total tonnage of exported ammonia increased in 1982, compared with 1981 tonnage, and by October 1982, imports had exceeded the 1981 total.

Domestic Data Coverage.—Domestic production data for ammonia were developed by the Bureau of the Census, U.S. Department of Commerce, and published monthly in Current Industrial Reports, Inorganic Fertilizer Materials and Related Products (M28B). The Department of Commerce surveyed approximately 133 firms manufacturing inorganic fertilizer chemicals. Production estimates were supplied for reports not received in time for tabulation.

Table 1.—Salient ammonia statistics

(Thousand short tons of contained nitrogen)

	1978	1979	1980	1981	1982[p]
United States:					
Production[1 2]	14,169	15,420	16,244	15,619	12,742
Exports	434	649	681	506	610
Imports for consumption	1,247	1,603	1,921	1,719	1,737
Consumption[2 3]	15,270	16,574	17,664	16,355	13,858
World: Production	[r]74,101	[r]78,533	81,515	[p]81,573	[e]80,078

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Synthetic anhydrous ammonia and coke oven ammonia.
[2]Coke oven ammonia not available after 1980.
[3]Includes producers' stock changes in synthetic anhydrous ammonia and coke oven ammonia.

DOMESTIC PRODUCTION

U.S. production of ammonia in 1982 was 12.7 million tons of contained nitrogen. This was 18.4% below 1981 production. Total anhydrous ammonia plant capacity was reduced by as much as 5.5 million tons during 1982. Many plants were idled, and some were closed and dismantled because of high operating costs. Production at some idled plants resumed after periods of inactivity. Obsolete equipment, which resulted in plant inefficiencies, and rapidly increasing prices for natural gas were major reasons for the high operating costs. The average price of 1,000 standard cubic feet of natural gas in 1982 was $2.63, or nearly 75% of the total production cost per ton of ammonia. In 1975, the price for the same volume of natural gas was $0.62, and contributed about 46% of the total production cost. Production was expected to remain depressed until the imbalance between the relatively high cost and relatively low demand was adjusted.

Table 2.—Fixed nitrogen production in the United States

(Thousand short tons of contained nitrogen)

	1978	1979	1980	1981	1982[p]
Anhydrous ammonia, synthetic plants[1]	14,072	15,317	16,155	15,619	12,742
Ammonium compounds, coking plants:					
Ammonia liquor	7	7	7	NA	NA
Ammonium sulfate	90	96	82	NA	NA
Ammonium phosphates	(2)	(2)	(2)	NA	NA
Total	14,169	15,420	16,244	15,619	12,742

[p]Preliminary. NA Not available.
[1]Current Industrial Reports, U.S. Department of Commerce, Bureau of the Census.
[2]Included with ammonium sulfate to avoid disclosing company proprietary data.

Table 3.—Major nitrogen compounds produced in the United States

(Thousand short tons, gross weight)

Compound	1980	1981	1982[p]
Acrylonitrile	915	1,003	1,008
Ammonium nitrate	9,127	8,791	7,331
Ammonium sulfate	[1]2,236	[2]2,111	[2]1,790
Ammonium phosphates	13,378	12,289	10,307
Nitric acid	9,231	9,040	7,589
Urea	7,830	7,632	5,931

[p]Preliminary.
[1]Includes ammonium sulfate from coking plants.
[2]Excludes ammonium sulfate from coking plants.

Sources: Bureau of the Census and International Trade Commission.

Table 4.—Domestic producers of anhydrous ammonia in 1982

(Thousand short tons per year of ammonia)

Company	Location	Capacity
Agrico Chemical Co	Blytheville, Ark	407
Do	Donaldsonville, La	468
Do	Verdigris, Okla	840
Air Products & Chemicals, Inc	New Orleans, La	210
Do	Pace Junction, Fla	100
Allied Chemical Corp	LaPlatte, Nebr	172
Do	Hopewell, Va	340
American Cyanamid Co	Fortier, La	580
Atlas Chemical Industries, Inc	Joplin, Mo	136
Beker Industries Corp	Conda, Idaho	100
Cargill, Inc	Columbus, Miss	68
CF Industries, Inc	Donaldsonville, La	750
Chevron Chemical Co	Pascagoula, Miss	530
Do	El Segundo, Calif	20
Columbia Nitrogen Corp	Augusta, Ga	510
Cominco American	Boger, Tex	400
Diamond Shamrock Chemical Corp	Dumas, Tex	160
The Dow Chemical Co	Freeport, Tex	115
E. I. du Pont de Nemours & Co	Beaumont, Tex	340
Do	Victoria, Tex	100
Farmland Industries, Inc	Hastings, Nebr	140
Do	Enid, Okla	840
Do	Lawrence, Kans	340
Felmont Oil Corp	Olean, N.Y	85
Gardinier, Inc	Tampa, Fla	120
Georgia Pacific Corp	Plaquemine, La	196
Goodpasture, Inc	Dimmitt, Tex	40

Table 4.—Domestic producers of anhydrous ammonia in 1982 —Continued

(Thousand short tons per year of ammonia)

Company	Location	Capacity
W. R. Grace & Co	Woodstock, Tenn	340
Green Valley Chemical Co	Creston, Iowa	35
Hawkeye Chemical Co	Clinton, Iowa	220
Hercules, Inc	Louisiana, Mo	70
Hooker Chemical Co	Tacoma, Wash	28
International Minerals & Chemical Corp	Sterlington, La	400
Jupiter Chemical Co	Lake Charles, La	78
Kaiser Agricultural Chemicals Co	Pryor, Okla	68
Mississippi Chemical Corp	Yazoo City, Miss	393
Monsanto Co	Luling, La	850
The New Jersey Zinc Co., Inc	Palmerton, Pa	35
N-Ren Corp	Pryor, Okla	94
Do	East Dubuque, Ill	238
Do	Carlsbad, N. Mex	68
Oklahoma Nitrogen	Woodward, Okla	450
Olin Corp	Lake Charles, La	490
Pennwalt Chemical Co	Portland, Oreg	8
Phillips Pacific Chemical Co	Kennewick, Wash	155
Phillips Petroleum Co	Beatrice, Nebr	210
PPG Industries, Inc	Natrium, W. Va	50
Reichhold Chemicals, Inc	St. Helens, Oreg	90
J. R. Simplot Co	Pocatello, Idaho	108
Tennessee Valley Authority	Muscle Shoals, Ala	74
Terra Chemicals International, Inc	Port Neal, Iowa	210
Triad Chemical Co	Donaldsonville, La	340
Union Chemical Co	Kenai, Alaska	1,100
Do	Brea, Calif	250
U.S.S. Agri-Chemicals, Inc	Cherokee, Ala	175
Do	Geneva, Utah	70
Wycon Chemical Co	Cheyenne, Wyo	134
Total		14,938

Source: Economics and Marketing Research Section, Tennessee Valley Authority. World Fertilizer Capacity, Ammonia. Muscle Shoals, Ala., Feb. 25, 1983.

CONSUMPTION AND USES

Domestic ammonia consumption decreased 15%, to about 14 million tons in 1982. The decrease was attributed to low demand influenced by high interest rates and relatively low crop prices. Approximately 80% of the ammonia produced was used in fertilizers that include anhydrous ammonia, urea, ammonium phosphate, ammonium nitrate, and other nitrogen compounds. Ammonia also was used to produce plastics, fibers, and resins, 10%; explosives, 4%; and numerous other chemicals, 6%.

STOCKS

Stocks of ammonia on hand at the beginning of 1982 totaled 1.96 million tons of contained nitrogen. At yearend 1982, producers' stocks totaled 1.97 million tons of contained nitrogen. The quantities were nearly the same, reflecting an effort during the year to control excess stocks on hand, because of uncertain market conditions.

PRICES

Low prices for farm commodities contributed to the depression of fertilizer sales, and thereby demand for ammonia, early in the year. Ammonia demand and prices increased temporarily in March when Mexico curtailed shipments of ammonia to U.S. customers. After reaching a peak of $162 per ton, ammonia prices declined to $115 per ton as demand gradually fell. Prices remained depressed throughout the remainder of 1982. Other causes for depressed ammonia prices were high interest rates and competition from imported ammonia.

Table 5.—Price quotations for major nitrogen compounds at yearend 1982

(Dollars per short ton)

Compound	Price
Anhydrous ammonia:	
F.o.b. gulf coast	115- 120
Delivered Corn Belt	155- 165
Ammonium sulfate: F.o.b. Corn Belt	89- 91
Ammonium nitrate: Delivered Corn Belt	125- 145
Urea:	
F.o.b. gulf coast	122- 125
Delivered Corn Belt	135- 145
Diammonium phosphate: F.o.b. Tampa	145- 148

FOREIGN TRADE

The United States exported 742,000 tons of anhydrous ammonia in 1982. This was a 17% increase over the 616,000 tons exported in 1981. The combined gross weight of downstream ammonium compounds exported for industrial and fertilizer uses decreased nearly 7%, compared with 1981 exports. Diammonium phosphate and urea led in export tonnage of nitrogen compounds.

U.S. imports of ammonia in 1982 were nearly the same as in 1981. The U.S.S.R. was the leading foreign supplier of ammonia to the United States, with more than 605,000 tons. Mexico supplied about 584,000 tons; Canada, more than 579,000 tons; and Trinidad and Tobago, 291,000 tons. Ammonia imports from Trinidad and Tobago and the U.S.S.R. decreased from those of 1981, whereas ammonia imports from Mexico and Canada increased.

Table 6.—U.S. exports and imports for consumption of major nitrogen compounds in 1982

(Thousand short tons and thousand dollars)

Compound	Gross weight	Nitrogen content	Value
EXPORTS			
Industrial chemicals:			
Ammonia, aqua (ammonia content)	2	2	281
Ammonium nitrate	14	5	870
Ammonium phosphate	4	1	4,418
Ammonium sulfate	5	1	239
Fertilizer materials:			
Ammonium nitrate	61	20	8,174
Diammonium phosphates	4,086	735	678,685
Other ammonium phosphates	277	30	49,657
Ammonium sulfates	555	117	45,864
Anhydrous ammonia	742	610	100,525
Sodium nitrate	15	2	2,465
Urea	1,651	759	226,861
Nitrogen solutions	256	82	35,114
Other nitrogen fertilizers	70	14	8,970
Mixed chemical fertilizers	68	7	16,617
Total	7,806	2,385	1,178,740
IMPORTS			
Industrial chemicals:			
Anhydrous ammonia and chemical-grade aqua	25	21	3,117
Ammonium nitrate	174	61	19,975
Ammonium phosphate	2	(1)	1,002
Ammonium sulfate	(1)	(1)	54
Fertilizer materials:			
Ammonium nitrate	262	88	34,872
Ammonium nitrate-limestone mixtures	(1)	(1)	9
Diammonium phosphates	69	13	12,170

See footnotes at end of table.

Table 6.—U.S. exports and imports for consumption of major nitrogen compounds in 1982 —Continued

(Thousand short tons and thousand dollars)

Compound	Gross weight	Nitrogen content	Value
IMPORTS —Continued			
Fertilizer materials —Continued			
Other ammonium phosphates	175	19	33,835
Ammonium sulfate	319	67	28,032
Calcium cyanamide or lime nitrogen	(1)	(1)	170
Calcium nitrate	121	18	8,727
Nitrogen solutions	128	41	15,437
Anhydrous ammonia	2,113	1,737	293,042
Potassium nitrate	25	3	6,873
Potassium nitrate-sodium nitrate mixtures	15	2	1,886
Sodium nitrate	131	21	14,663
Urea	1,107	509	173,259
Other nitrogenous fertilizers	52	10	9,670
Mixed chemical fertilizers	123	12	24,575
Total	4,841	2,622	681,368

[1]Less than 1/2 unit.

WORLD REVIEW

World ammonia production was approximately 80 million tons in 1982. More than 5 million tons per year of ammonia plant capacity throughout the world was inactive in 1982, most of it in the United States. Many of these plants were expected to remain idle unless ammonia prices increase or energy prices decrease. World demand for ammonia was not expected to increase before late 1984. However, production capacity increased in Canada, China, India, Mexico, Pakistan, the Persian Gulf, the U.S.S.R., and Yugoslavia.

Western European ammonia producers had to increase the efficiency of their plants by decreasing energy requirements to offset the high price of their feedstock. These energy conservation projects may enhance Western European competitiveness in the future world ammonia market, although the industry prefers to concentrate on European markets and export only surplus ammonia. Western Europe also experienced a decline in real farm income, which affected demand for ammonia in 1982.

The countries of Eastern Europe apparently concerned themselves more with increasing foreign exchange than production efficiency and profitability. The U.S.S.R. increased its ammonia capacity from 9.3 million tons of contained nitrogen in 1970 to 24 million tons in 1980, but produced only 16.2 million tons in 1980.

Canada, Mexico, and Trinidad and Tobago had access to large supplies of natural gas at lower prices than those in the United States. These countries have potential to increase their market share at the expense of the United States.

The use of nitrogen has grown faster in developing countries than in industrialized countries over the past 10 years. The largest consumers were Africa, the Far East, the Near East, and Latin America.

Bahrain.—The Gulf Petrochemical Industries Co. contracted for the second phase of a $400 million ammonia-methanol complex at Sitra. The plant was to produce 1,100 tons per day each of ammonia and methanol, and was to come on-stream in late 1984.[2]

Bangladesh.—Financing was obtained for two ammonia-urea complexes at Chittagong. Each plant was to have a capacity of 262,000 tons per year.[3]

Canada.—C-I-L, Inc., planned a 411,000-ton-per-year ammonia plant at its facility at Courtbright, Ontario, near Sarina. This plant would bring C-I-L's annual ammonia production capacity to 797,000 metric tons. Construction began in March 1982 with completion scheduled for October 1984.[4]

Greece.—A contract was signed in November 1982 for the construction of the Nea Kavala 400-ton-per-day ammonia plant. The plant was to be built 9 kilometers east of Nea Kavala in northern Greece. The natural gas feedstock was to come from the Prinos Oilfield.[5]

India.—Ground was broken for the $1.8 billion urea-ammonia complex at Hazira. The complex was expected to come on-stream in 1984. It will have two ammonia units with a total production capacity of 1,600 tons per day and four urea units, each with a production capacity of 1,200 tons per day.[6] Deepack Fertilizers and Petrochemicals Corp. was constructing a 300-ton-per-day ammonia plant at Tajola near Bombay. The $61.2 million project was the first merchant ammonia plant in India planned to supply both fertilizer and industrial consumers.[7]

Indonesia.—P.T. Kalimantan Timur, a Government-owned fertilizer complex, awarded a $350 million contract to Kellogg Overseas Corp. and two Japanese companies to construct a 1,650-ton-per-day ammonia plant at Bontang. The plant, which will also produce 1,900 tons per day of prilled urea, was expected to come on-stream in 1985.[8]

Kuwait.—The contract for a fourth ammonia plant at the industrial region of Shuaiba in Kuwait was won by Technipetrol of Italy. The combined capacity of the four plants will be 543,000 tons per year. Construction continued at the new plant, with a planned capacity of 300,000 tons per year of nitrogen content. The plant was scheduled for startup in 1984.[9]

Netherlands.—Norsk Hydro AS was to build a 550,000-ton-per-year ammonia plant at Sluiskil, Netherlands. The provisional startup date was planned for 1984. The plant was expected to provide the country self-sufficiency in ammonia supply for manufacturing activities.[10]

New Zealand.—The Petrochemical Corp. of New Zealand, Ltd., opened, in December 1982, an ammonia-urea plant at Kapuni. The plant capacity was 100,000 tons per year of ammonia and 170,000 tons per year of urea.[11]

Syria.—A new fertilizer complex was completed at Homs. Part of the complex was an ammonia-urea plant with a capacity of 330,000 tons per year of ammonia and 345,000 tons per year of urea.[12]

Tanzania.—Agrico Chemical Co. and the Government of Tanzania established a joint-venture organization, Kilwa Ammonia Co., to build and operate a nitrogen fertilizer plant on the coast, 125 miles south of Dar es Salaam. The plant, with a design capacity of 400,000 tons per year of ammonia, was expected to start production in 1985.[13]

Thailand.—A Scandinavian consortium was awarded a contract for the construction of a $590 million fertilizer complex at Rayong. The complex was designed to produce 1,500 tons per day of ammonia using natural gas as feedstock and fuel. Urea production would consume up to 1,000 tons per day of ammonia.[14]

U.S.S.R.—Chemoproject of Czechoslovakia was under contract to build four new 1,000-ton-per-day urea plants. Two of the plants were to be at Odessa, and one each at Grodno and Dzerzhinsk.[15]

Table 7.—Ammonia: World production, by country[1]

(Thousand short tons of contained nitrogen)

Country	1978	1979	1980	1981[p]	1982[e]
Afghanistan[e]	30	30	11	10	9
Albania[e]	83	79	83	[r]84	84
Algeria	50	23	33	47	47
Argentina	52	67	72	[e]44	70
Australia	324	340	389	384	386
Austria	518	573	540	536	551
Bangladesh	116	184	154	168	194
Belgium	595	[r]584	596	648	661
Brazil	224	293	388	414	413
Bulgaria	868	860	912	924	926
Burma[e]	61	61	66	[r]65	56
Canada	2,123	2,184	2,200	[e]2,404	2,766
China[e]	[r]8,418	[r]9,723	[r]11,012	[r]10,869	11,306
Colombia	70	77	77	101	101
Cuba	43	171	150	184	114
Czechoslovakia	892	883	930	937	937
Denmark	36	36	34	34	34
Egypt	[r]276	290	441	571	722
Finland	165	126	77	76	76
France	[r]2,223	[e]2,370	[e]2,298	[r] [e]2,205	2,205
German Democratic Republic	1,253	1,188	1,303	1,328	1,323
Germany, Federal Republic of	2,155	2,382	2,253	2,162	2,205
Greece	252	316	249	248	248
Hungary	822	885	876	902	904

See footnotes at end of table.

Table 7.—Ammonia: World production, by country[1] —Continued

(Thousand short tons of contained nitrogen)

Country	1978	1979	1980	1981^{p}	1982^{e}
Iceland^{e}	8	8	8	8	8
India[2]	2,447	2,487	2,448	3,520	4,023
Indonesia	^{r}1,208	^{r}687	1,034	1,014	1,124
Iran	^{r}197	202	240	220	231
Iraq	200	^{r}496	551	88	88
Ireland	26	188	280	276	276
Israel	75	76	60	47	55
Italy	^{r}1,669	^{r}1,603	1,549	1,331	1,323
Japan	^{r}2,610	^{r}2,566	2,326	2,020	1,841
Korea, North^{e}	500	500	500	500	500
Korea, Republic of	989	1,059	935	823	598
Kuwait	475	^{e}480	485	420	331
Libya^{e}	^{r}88	147	165	165	209
Malaysia	44	57	45	41	41
Mexico	1,437	1,498	1,706	1,902	2,183
Netherlands	2,368	^{r}2,112	2,066	2,000	2,094
Norway	580	600	568	601	601
Pakistan	341	425	474	654	[3]491
Peru^{e}	89	^{r}88	68	^{r}107	110
Philippines	^{e}45	44	43	36	36
Poland	1,776	1,681	1,701	1,531	1,433
Portugal	278	245	^{e}220	^{e}220	198
Qatar	183	334	461	419	386
Romania	2,488	^{r}2,574	2,478	2,425	2,370
Saudi Arabia	154	171	184	187	220
South Africa, Republic of	621	^{r}621	605	608	606
Spain	970	904	$^{r\ e}$882	$^{r\ e}$882	827
Sweden	^{r}106	^{r}98	95	87	87
Switzerland	50	50	50	36	33
Syria	21	84	53	66	165
Taiwan	483	431	457	448	[4]350
Thailand^{e}	10	--	--	--	--
Trinidad and Tobago	442	428	506	384	386
Turkey	239	226	168	252	254
U.S.S.R	12,456	13,448	13,889	14,220	14,440
United Kingdom	1,764	1,836	1,800	1,962	1,962
United States	14,169	15,420	16,244	15,619	12,742
Venezuela	299	285	397	457	457
Vietnam^{e}	([5])	([5])	([5])	([5])	([5])
Yugoslavia	459	^{r}561	542	564	573
Zambia	$^{r\ e}$22	$^{r\ e}$22	22	$^{r\ e}$22	22
Zimbabwe^{e}	^{r}66	^{r}66	66	^{r}66	66
Total	^{r}74,101	^{r}78,533	81,515	81,573	80,078

^{e}Estimated. ^{p}Preliminary. ^{r}Revised.
[1]Table includes data available through May 25, 1983.
[2]Data are for years beginning Apr. 1 of that stated.
[3]Data as reported by Pakistan in fiscal year July 1 through June 30; production for 1982 includes some other forms of nitrogen.
[4]Reported figure.
[5]Nitrogen (N content of ammonia) production capacity in Vietnam is 54,000 metric tons per year; actual plant output is not known.

TECHNOLOGY

A process for the production of nitric oxides from air was developed by an Israeli researcher. The development was a modification of the Birkeland and Eyde process developed by Norsk Hydro in the early 1900's and requires only air, water, and electrical supply. Air is passed at supersonic speed over an arc discharge to form nitric oxides, which are used to produce nitric acid. To improve efficiency, part of the nitric oxide is recycled to the reaction chamber to act as a seed for the reaction. Mobile units were proposed to produce fertilizer on-site where it is needed, thereby avoiding the cost of transportation, distribution, and storage of the fertilizer products.[16]

Researchers at the Israel Institute of Technology developed a less costly process for ammonia production. The new process reportedly reduced the cost of energy input, led to more efficient production, and could easily be adapted to existing plants.[17]

Norsk Hydro was to market an ammonia synthesis catalyst that it developed and had been using in its own plants since 1977. The new catalyst offers the advantages of longer life and greater activity than other catalysts.[18]

Bergbau-Forschung GmbH, a Federal Republic of Germany manufacturer, introduced a new carbon molecular sieve that produces nitrogen from air by absorbing oxygen and allowing nitrogen to pass. The PSA Nitrogen System is claimed to produce nitrogen at one-half the previous cost. In the positive-pressure system, compressed air forced through the adsorption columns results in higher efficiency from faster flow rates through the columns.[19]

The Tennessee Valley Authority's National Fertilizer Development Center produced a new high-nitrogen fertilizer. The nitrate suspension contains 36% nitrogen, compared with 31% nitrogen in other nitrate suspensions. The material contains less water and remains free flowing. It is produced by mixing 87% urea and ammonium nitrate solutions, cooling, adding a clay gelling agent, and then spray-drying to form solid fertilizer particles.[20]

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Peat

By Charles L. Davis[1]

The U.S. peat industry increased production of all types of peat by 5% in 1982. Michigan, Florida, Indiana, Illinois, and Colorado were the major peat-producing States. Michigan produced more peat than any other State, accounting for 30% of the U.S. total. Reed-sedge peat accounted for 55% of U.S. domestic peat production. Humus peat amounted to 24%, hypnum moss peat to 6%, sphagnum moss peat to 5%, and other unclassified types to 10%.

Peat sales in the United States by domestic producers decreased 11% in value compared with that of 1981. The five States leading in sales were also Michigan, Florida, Indiana, Illinois, and Colorado. About 65% of domestic peat sold in 1982 was packaged. The average apparent peat price, per ton, f.o.b. plant, was nearly 8% below that of 1981.

U.S. apparent consumption of peat was unchanged from that of 1981. Peat was used predominantly for agricultural and horticultural purposes, but 210 tons was used for fuel in 1982. Imports contributed about 34% of apparent consumption tonnage and 74% of apparent consumption value. Peat imports increased 8% in 1982 compared with that of 1981. About 99% of these imports were premium-grade sphagnum moss peat from Canada.

World peat production increased 5% in 1982. The U.S.S.R. produced about 97% of the total.

Domestic Data Coverage.—Domestic production data for peat are developed by the Bureau of Mines from a voluntary survey of U.S. operations. Of the 89 operations to which a survey request was sent, 63 responded, representing 71% of the total production shown in table 1. Production for the remaining 26 nonrespondents was estimated using prior year production levels adjusted by trends in employment and other guidelines.

Table 1.—Salient peat statistics

	1979	1980	1981	1982
United States:				
Number of active operations	97	96	90	89
Production thousand short tons	825	785	686	721
Sales by producers do	798	788	757	730
Bulk do	324	298	276	253
Packaged do	474	491	481	477
Value of sales thousands	$15,517	$16,190	$18,784	$16,702
Average per ton	$19.44	$20.54	$24.82	$22.89
Average per ton—bulk	$15.05	$15.46	$17.28	$16.21
Average per ton—packaged or baled	$22.46	$23.61	$29.14	$26.43
Imports thousand short tons	381	402	342	370
Apparent consumption[1] do	1,179	1,190	1,099	1,100
Yearend producers' stocks do	350	330	269	374
World: Production do	[r]297,572	337,091	[p]387,226	[e]408,190

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Sales plus imports.

DOMESTIC PRODUCTION

Peat was produced by 89 active mines in the United States in 1982. Approximately 50% of U.S. production was from six large mines with annual capacities greater than 25,000 tons. These operations included two reed-sedge mines in Michigan and one each in Florida and Indiana, one humus mine in New York, and one unclassified peat mine in Florida.

Reed-sedge production increased 14% and was 55% of 1982 total peat production. Humus production increased 11% and was 24% of total peat production.

Table 2.—Relative size of peat operations in the United States

Size in tons per year	Number of active plants		Production (thousand tons)	
	1981	1982	1981	1982
25,000 and over	6	6	316	358
15,000 to 24,999	6	6	106	116
10,000 to 14,999	4	7	53	85
5,000 to 9,999	19	12	134	79
2,000 to 4,999	15	18	49	58
1,000 to 1,999	12	11	17	16
Under 1,000	28	29	11	9
Total	90	89	686	721

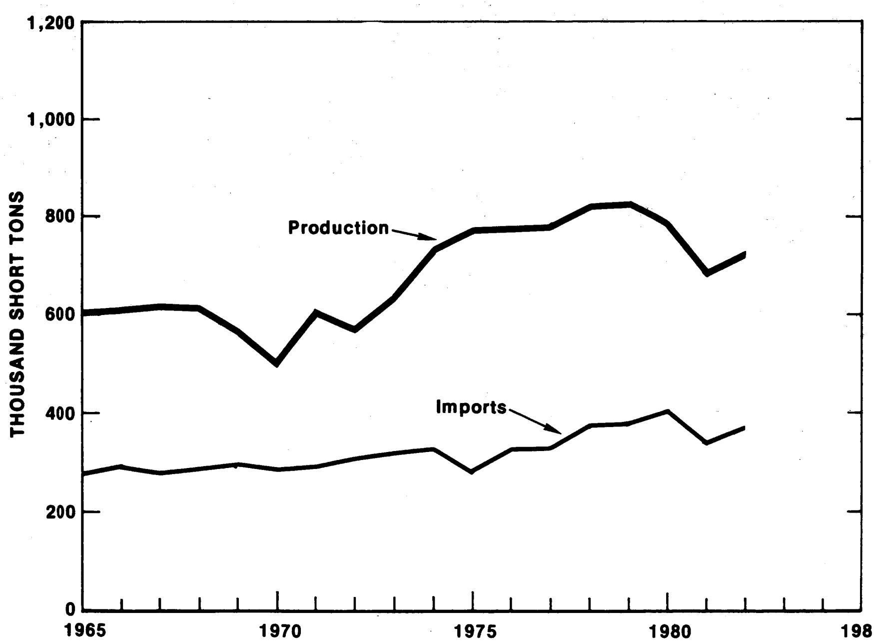

Figure 1.—Production and imports of peat in the United States.

CONSUMPTION AND USES

Domestic sales by U.S. peat producers decreased 4% from that of 1981. Peat sold in packaged form was 65% of sales, about the same as that of 1981. The percentage of each peat type packaged in 1982 was reed-sedge, 80%; sphagnum moss, 73%; hypnum moss, 56%; humus, 48%; and other unclassified peat, less than 1%. Bulk sales, at 35% of total sales, declined 8% from that of 1981 and accounted for most of the decrease in total sales.

Domestic peat sales for soil conditioning increased 9% compared with that of 1981. Sales of peat for potting soils decreased 9% from that of 1981. Apparent consumption of peat remained the same as in 1981.

Table 3.—U.S. peat sales by producers in 1982, by use

Use	In bulk		In packages		Total[1]	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Earthworm culture medium	2,833	$34	8,439	$405	11,272	$439
General soil improvement	107,358	1,667	378,804	7,893	486,162	9,560
Golf course	15,345	369	4,382	191	19,727	560
Ingredient for potting soils	72,659	1,137	44,468	1,718	117,127	2,855
Mixed fertilizers	14,770	137	6,646	134	21,416	270
Mushroom beds	836	28	5,067	142	5,903	170
Nursery	30,487	551	18,222	638	48,709	1,190
Packing flowers, plants, shrubs, etc	400	3	4,365	218	4,765	222
Seed inoculant	173	33	4,560	1,235	4,733	1,268
Vegetable growing	3,225	36	338	24	3,563	59
Other	4,876	106	1,530	5	6,406	111
Total[1]	252,962	4,100	476,821	12,602	729,783	16,702

[1]Data may not add to totals shown because of independent rounding.

PRICES AND SPECIFICATIONS

The average domestic price per ton for all types of peat, f.o.b. mine, was $22.89, a decrease of 8% from that of 1981. The average domestic price per ton for bulk peat decreased 6% from that of 1981. The average domestic price per ton for packaged or baled peat decreased 9% from that of 1981.

Table 4.—U.S. peat sales by producers in 1982, by State

State	Quantity (short tons)	Value[1] (thousands)	Percent packaged
Colorado	46,606	$275	1
Florida	119,739	1,575	41
Indiana	89,017	2,112	82
Michigan	241,315	4,917	83
Pennsylvania	26,974	669	20
Wisconsin	9,281	W	40
Other[2]	196,851	7,155	XX
Total	729,783	[3]16,702	65

W Withheld to avoid disclosing company proprietary data; included with "Other." XX Not applicable.

[1]Values are f.o.b. producing plant.

[2]Includes California, Georgia, Illinois, Iowa, Maine, Massachusetts, Minnesota, Montana, New Jersey, New York, North Carolina, North Dakota, Ohio, Washington, and item indicated by symbol W.

[3]Data do not add to total shown because of independent rounding.

Table 5.—U.S. peat sales by producers in 1982, by use and kind

Use	Sphagnum moss: Quantity: Weight (short tons)	Sphagnum moss: Quantity: Volume[1] (cubic yards)	Sphagnum moss: Value (thousands)	Hypnum moss: Quantity: Weight (short tons)	Hypnum moss: Quantity: Volume (cubic yards)	Hypnum moss: Value (thousands)	Reed-sedge: Quantity: Weight (short tons)	Reed-sedge: Quantity: Volume (cubic yards)	Reed-sedge: Value (thousands)
Earthworm culture medium	180	600	$5	--	--	--	9,029	24,219	$411
General soil improvement	23,264	134,756	1,197	35,136	82,798	$1,115	318,053	691,013	5,551
Golf course	845	8,445	24	590	1,180	8	12,099	24,203	343
Ingredient for potting soils	6,323	17,575	29	1,676	3,940	19	55,242	121,394	1,787
Mixed fertilizers	845	8,445	24	--	--	--	170	425	7
Mushroom beds	5,067	50,670	142	383	1,275	19	135	270	2
Nursery	3,378	33,780	95	1,248	2,475	24	18,258	40,723	459
Packing flowers, plants, shrubs, etc	845	8,445	24	--	--	--	3,520	9,233	195
Seed inoculant	845	8,445	24	--	--	--	3,500	6,648	1,155
Vegetable growing	338	3,378	24	--	--	--	855	1,751	11
Other	110	274	2	638	2,125	32	2,608	7,255	29
Total[2]	42,040	274,813	1,587	39,671	93,793	1,216	423,469	927,134	9,949

Use	Humus: Quantity: Weight (short tons)	Humus: Quantity: Volume (cubic yards)	Humus: Value (thousands)	Other: Quantity: Weight (short tons)	Other: Quantity: Volume (cubic yards)	Other: Value (thousands)	Total[2]: Quantity: Weight (short tons)	Total[2]: Quantity: Volume (cubic yards)	Total[2]: Value (thousands)
Earthworm culture medium	1,872	3,134	$20	191	425	$3	11,272	28,378	$439
General soil improvement	89,426	170,174	1,652	20,283	34,300	45	486,162	1,113,041	9,560
Golf course	6,193	13,358	186	--	--	--	19,727	47,186	560
Ingredient for potting soils	27,302	88,285	474	26,584	59,075	546	117,127	290,269	2,855
Mixed fertilizers	20,401	36,270	240	--	--	--	21,416	45,140	270
Mushroom beds	318	465	7	--	--	--	5,903	52,680	170
Nursery	23,215	50,895	562	2,610	5,259	50	48,709	133,132	1,190
Packing flowers, plants, shrubs, etc	400	700	3	--	--	--	4,765	18,378	222
Seed inoculant	388	535	89	--	--	--	4,733	15,628	1,268
Vegetable growing	2,370	4,570	24	--	--	--	3,563	9,699	59
Other	--	--	--	3,050	6,344	49	6,406	15,998	111
Total[2]	171,885	368,386	3,257	52,718	105,403	693	729,783	1,769,529	16,702

[1]Volume of nearly all sphagnum moss was measured after compaction and packaging.
[2]Data may not add to totals shown because of independent rounding.

Table 6.—Prices for peat in 1982,[1] by type

(Dollars per unit)

	Sphagnum moss	Hypnum moss	Reed-sedge	Humus	Other	Average
Domestic:						
Bulk:						
Per ton	10.10	16.56	22.36	12.96	13.13	16.21
Per cubic yard	5.69	7.78	10.71	5.77	6.57	7.67
Packaged or baled:						
Per ton	47.75	41.83	23.77	25.34	15.97	26.43
Per cubic yard	5.78	16.39	10.74	12.45	8.00	10.21
Average:						
Per ton	37.75	30.65	23.49	18.95	13.15	22.89
Per cubic yard	5.78	12.97	10.73	8.84	6.57	9.44
Imported, total, per ton[2]	125.29	XX	XX	XX	XX	125.29

XX Not applicable.
[1]Prices are f.o.b. mine.
[2]Average customs price.

Table 7.—Average density of domestic peat sold in 1982

(Pounds per cubic yard)

	Sphagnum moss	Hypnum moss	Reed-sedge	Humus	Other
Bulk	1,126	940	958	891	1,000
Packaged	242	784	903	983	1,002
Bulk and packaged	306	846	914	933	1,000

FOREIGN TRADE

Peat imports in 1982 were 8% greater than those of 1981. More than 99% of the imports were from Canada. Canadian sphagnum moss peat has more desirable qualities than most domestically produced peat. Large quantities of Canadian peat entered the United States through customs districts in Maine, Michigan, Montana, New York, North Dakota, Vermont, and Washington. Minor amounts of peat were imported from the Federal Republic of Germany.

Table 8.—U.S. imports for consumption of peat moss in 1982, by country

Country	Poultry- and stable-grade		Fertilizer-grade		Total	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Canada	60,436	$7,698	309,168	$38,535	369,604	$46,233
France	6	13	5	(1)	11	13
Germany, Federal Republic of	69	10	203	25	272	35
Ireland	2	2	--	--	2	2
Mexico	18	29	--	--	18	29
Netherlands	2	1	--	--	2	1
Norway	--	--	16	38	16	38
Sweden	--	--	18	2	18	2
United Kingdom	--	--	57	5	57	5
Total[2]	60,533	7,752	309,467	38,605	370,000	46,357

[1]Less than 1/2 unit.
[2]Data may not add to totals shown because of independent rounding.

Source: Bureau of the Census.

Table 9.—U.S. imports for consumption of peat moss in 1982, by customs district

Customs district	Poultry- and stable-grade		Fertilizer-grade		Total	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Boston, Mass	1	$2	--	--	1	$2
Bridgeport, Conn	22	1	--	--	22	1
Buffalo, N.Y.[1]	25,783	3,639	4,689	$507	30,472	4,146
Chicago, Ill	--	--	17	3	17	3
Detroit, Mich.[1]	33,378	3,868	4,736	678	38,114	4,546
Duluth, Minn.[1]	--	--	1,122	210	1,122	210
Great Falls, Mont.[1]	178	22	37,518	5,138	37,696	5,160
Laredo, Tex	18	29	--	--	18	29
Los Angeles, Calif	--	--	200	25	200	25
New Orleans, La	6	13	--	--	6	13
New York, N.Y.[1]	70	9	--	--	70	9
Norfolk, Va	2	1	--	--	2	1
Ogdensburg, N.Y.[1]	667	91	135,621	14,693	136,288	14,784
Pembina, N. Dak.[1]	249	39	44,687	7,206	44,936	7,245
Portland, Maine[1]	34	2	27,760	3,467	27,794	3,469
San Francisco, Calif.[1]	20	5	16	3	36	8
San Juan, P.R.[1]	68	24	77	54	145	78
Savannah, Ga.[1]	--	--	20	1	20	1
Seattle, Wash.[1]	--	--	32,836	4,306	32,836	4,306
St. Albans, Vt.[1]	20	3	20,164	2,314	20,184	2,317
Virgin Islands[1]	16	4	4	1	20	5
Total[2]	60,533	7,752	309,467	38,605	370,000	46,357

[1]Predominately of Canadian origin.
[2]Data may not add to totals shown because of independent rounding.

WORLD REVIEW

High costs of traditional energy sources motivated some countries to look more closely at developing technologies for using their peat reserves to produce energy. In addition, some developing as well as industrialized countries were increasing their use of peat in horticulture and for domestic heating.

World production of peat increased approximately 5% in 1982. The U.S.S.R. produced approximately 97% of the world total. Ireland, the Federal Republic of Germany, Finland, and the United States were also significant producers.

Burundi.—Burundi was evaluating peat as an energy source. Peat deposits were located in the Akanyara River valley in the northern Ngozi region. The U.S. Agency for International Development was involved in a study to determine the economic feasibility of using peat as a fuel substitute in Burundi.[2]

Finland.—Thermal powerplants were the main users of peat in Finland. In 1982, Finland consumed 9 million cubic meters of peat to generate electricity.[3] Two additional peat-fired thermal plants, each with an annual capacity of about 1.5 million megawatts, were under construction.

Table 10.—Peat: World production, by country[1]

(Thousand short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Argentina: Agricultural use	5	4	5	3	3
Australia	7	13	13	13	13
Canada: Agricultural use	480	529	[e]538	509	493
Denmark: Agricultural use[3]	52	50	34	36	36
Finland:					
Agricultural use	224	852	637	225	220
Fuel	2,061	1,710	2,029	1,436	1,433
France: Agricultural use[e]	155	155	155	155	143
Germany, Federal Republic of:					
Agricultural use	2,256	2,038	1,607	1,920	1,984
Fuel	251	254	308	271	276
Hungary: Agricultural use[e]	[r]77	[r]77	[r]77	[r]77	77
Ireland:					
Agricultural use	[r]90	[r]100	97	89	89
Fuel	[r]5,075	[r]4,041	4,879	5,906	4,804
Israel: Agricultural use[e]	22	20	22	22	22
Netherlands[e]	[r]441	[r]441	[r]441	[r]441	441
Norway:[e]					
Agricultural use	66	66	66	66	66
Fuel	1	1	1	1	1
Poland:					
Fuel and agricultural use[e]	220	220	[r]223	[r]222	220
Spain	35	51	49	43	43
Sweden:					
Agricultural use	105	[e]105	[e]105	[e]105	105
Fuel	33	--	--	--	--
U.S.S.R.:					
Agricultural use	[r]182,000	[r]220,000	259,000	309,000	331,000
Fuel[e]	66,000	66,000	66,000	66,000	66,000
United States: Agricultural use	822	825	785	686	[4]721
Venezuela: Agricultural use[e]	20	20	20	NA	NA
Total	[r]260,498	[r]297,572	337,091	387,226	408,190
Fuel peat included in total	[r]73,641	[r]72,226	73,440	73,836	72,734

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.
[1]Table includes data available through June 1, 1983.
[2]In addition to the countries listed, Austria, Iceland, and Italy produce negligible quantities of fuel peat, and the German Democratic Republic is a major producer, but output is not officially reported, and available information is inadequate for formulation of reliable estimates of output levels.
[3]Sales.
[4]Reported figure.

TECHNOLOGY

Peat has not been used for industrial fuel or domestic heating in the United States since the beginning of the 19th century. However, two utility companies conducted test burns of peat in steam boilers to evaluate its use as a fuel to replace coal and oil. Also, the Block Island Economic Development Foundation sponsored a program to evaluate peat as a househeating fuel. Progress was made toward providing Federal Government financial support to a company to produce methanol from peat for use in automotive fuels and in the chemical industry.

The Swedish Royal Institute of Technology in Stockholm received a $1 million Government grant to conduct experiments on the feasibility of extracting a tar-like product from wet peat. The wet peat was treated with hydrogen gas and carbon monoxide under high pressure. The intermediate product formed was upgraded to a liquefied fuel similar to crude oil.[4]

A pilot plant to test the gasification of biomass, including peat, in the presence of oxygen was under construction at Studsuik, Sweden. The process produces synthesis gas for use in methanol production.[5]

In Saskatchewan, Canada, feasibility tests for replacing home heating oil with peat were underway. A new, quick-drying technique of producing peat logs and briquets was being tested at Buffalo Narrows in cooperation with the National Research Council.[6]

[1]Physical scientist, Division of Industrial Minerals.
[2]Mining Magazine (London). V. 147, No. 6, December 1982, p. 527.
[3]Mining Journal (London). V. 299, No. 7689, Dec. 31, 1982, p. 463.
[4]European Chemical News. V. 39, No. 1054, Oct. 18, 1982, p. 20.
[5]———. V. 39, No. 1042, July 26, 1982, p. 18.
[6]The Northern Miner (Toronto, Ontario, Canada). V. 14, No. 6, Apr. 15, 1982, p. B11.

Perlite

By A. C. Meisinger[1]

U.S. production of both processed and expanded perlite declined in 1982 for the fourth straight year. Compared with that of 1981, processed perlite sold and used by producers decreased 14% to 506,000 short tons valued at about $16 million. Expanded perlite sales from 70 plants in 32 States decreased 12% to 428,000 tons valued at nearly $64 million.

Crude perlite ore was mined by 10 companies in 6 Western States in 1982, and the output of 623,000 tons was the lowest in 10 years. As in 1981, New Mexico mines accounted for 83% of the total ore mined.

Domestic Data Coverage.—Domestic production data for perlite are developed by the Bureau of Mines from two separate voluntary surveys, one for domestic mine operations and the other for plant operations. Of the 12 mining operations to which a request was sent, 8, or 67%, responded, representing 89% of the total processed ore sold and used shown in table 1. Mine data for the four nonrespondents were estimated using reported prior year production levels adjusted by trends in employment and other guidelines. Of the 70 expanding plants to which a request was sent, 41 plants, or 59%, responded, representing 69% of the total expanded perlite sold and used shown in table 1. Plant data for the remaining 29 nonrespondents were estimated using reported prior year production levels adjusted by trends in employment and other guidelines.

Table 1.—Perlite mined, processed, expanded, and sold and used by producers in the United States

(Thousand short tons and thousand dollars)

Year	Perlite mined[1]	Processed perlite					Expanded perlite		
		Sold to expanders		Used at own plant to make expanded material		Total quantity sold and used	Quantity produced	Sold and used	
		Quantity	Value	Quantity	Value			Quantity	Value
1978	939	320	6,813	321	6,927	641	553	546	64,300
1979	847	322	7,996	338	8,439	660	551	543	61,200
1980	824	334	9,053	304	7,447	638	544	537	69,200
1981	710	324	r9,928	267	7,530	591	r494	r485	r66,300
1982	623	263	8,755	243	7,289	506	433	428	63,600

rRevised.
1Crude ore mined and stockpiled for processing.

DOMESTIC PRODUCTION

Processed Perlite.—The quantity of perlite mined for processing by 10 companies from 12 operations in 6 Western States in 1982 was 623,000 tons, the lowest tonnage during the past decade. New Mexico mines accounted for 83% of the U.S. total; the remaining 17% was produced from seven mines in Arizona, California, Colorado, Idaho, and Nevada.

Production of processed perlite sold and used by producers in 1982 decreased 14% to 506,000 tons valued at $16 million compared with that of 1981.

Perlite ore producers in 1982 were Harborlite Corp. and Sil-Flo, Inc., in Arizona; American Perlite Co. in California; Persolite Products, Inc., in Colorado; Oneida Perlite Corp. in Idaho; Delamor Perlite Co. and United States Gypsum Co. in Nevada; and Grefco, Inc., Manville Products Corp., Silbrico Corp., and United States Gypsum in New Mexico. Filter's International, Inc., sold its mining operations in Pinal County, Ariz., to Sil-Flo, Inc., of New York, in November 1982. The mine of Mountain Maid, Inc., in Utah, was inactive during the year.

Expanded Perlite.—Seventy plants produced expanded perlite in 32 States in 1982. The quantity produced decreased 12% from that produced in 73 plants in 1981.

Leading States in descending order of expanded perlite produced in 1982 were California, Mississippi, Pennsylvania, Illinois, Texas, Florida, Virginia, Kentucky, New Jersey, Colorado, and Indiana. For comparison, the leading States (revised) in 1981 were New Jersey, Illinois, Mississippi, California, Texas, Pennsylvania, Virginia, Colorado, Florida, Kentucky, and Indiana. The leading States in descending order of value of expanded perlite sold and used in 1982, were California, Illinois, Texas, Pennsylvania, Mississippi, Florida, Indiana, Virginia, New Jersey, Michigan, Colorado, and Kentucky.

During the year, California and Texas each had seven active plants, followed by Pennsylvania with six, Indiana with five, and Florida with four. Harborlite, with plants in both California and Michigan, announced plans for the construction in 1983 of a third filter-aid expanding plant to be located in the Green River area of Wyoming.

Table 2.—Expanded perlite produced and sold and used by producers in the United States, by State

State	1981				1982			
	Quantity produced (short tons)	Sold and used			Quantity produced (short tons)	Sold and used		
		Quantity (short tons)	Value (thousands)	Average value per ton[r 1]		Quantity (short tons)	Value (thousands)	Average value per ton[1]
Arkansas	1,000	1,000	W	W	800	800	W	W
California	[r]42,500	[r]41,000	[r]$6,156	$150	43,400	42,400	$6,162	$145
Florida	29,900	29,700	3,859	130	28,400	28,300	3,967	140
Illinois	44,500	43,100	7,591	176	W	W	W	W
Indiana	20,100	19,800	3,555	180	18,800	19,000	3,840	202
Massachusetts	2,400	2,400	649	270	2,200	2,000	756	378
New York	5,900	5,600	1,007	180	4,300	4,100	782	191
Pennsylvania	36,500	36,300	4,816	133	38,700	38,600	5,751	149
Texas	39,900	38,900	7,044	181	30,300	29,600	5,907	200
Other[2]	[r]271,000	[r]267,100	[r]31,659	119	266,500	263,500	36,428	138
Total[3]	[r]494,000	[r]485,000	[r]66,300	137	433,000	428,000	63,600	149

[r]Revised. W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Average value based on unrounded data and rounded to nearest dollar.
[2]Includes Alabama, Colorado, Georgia, Idaho, Iowa, Kansas, Kentucky, Louisiana, Maine, Michigan, Minnesota, Mississippi, Missouri, Nevada, New Jersey, North Carolina, Ohio, Oregon, Tennessee, Utah, Virginia, Wisconsin, Wyoming, and items indicated by symbol W.
[3]Data may not add to totals shown because of independent rounding.

CONSUMPTION AND USES

Domestic consumption of expanded perlite declined in 1982 for the fourth straight year. The 12% decrease was somewhat greater than the 1980-81 decline. Construction-industry-related uses, such as concrete and plaster aggregates, formed products, and loose-fill insulation, continued to account for about two-thirds of sales. All principal end uses of expanded perlite (table 3), except for "Other" uses, declined for the second straight year. The significant decreases were 42% for low-temperature insulation, 36% for masonry and cavity-fill insulation, 30% each for concrete and horticultural aggregates, and 24% for fillers.

Table 3.—Expanded perlite sold and used by producers in the United States, by use

(Short tons)

Use	1981	1982
Concrete aggregate	21,800	15,200
Fillers	6,200	4,700
Filter aid	[r]100,500	83,700
Formed products[1]	[r]259,600	245,800
Horticultural aggregate[2]	40,200	28,200
Low-temperature insulation	5,900	3,400
Masonry and cavity-fill insulation	20,000	12,700
Plaster aggregate	16,700	14,400
Other[3]	14,100	20,300
Total	[r]485,000	[4]428,000

[r]Revised.
[1]Includes acoustic ceiling tile, pipe insulation, roof insulation board, and unspecified formed products.
[2]Includes fertilizer carriers.
[3]Includes fines, high-temperature insulation, paint texturizer, refractories, and various nonspecified industrial uses.
[4]Data do not add to total shown because of independent rounding.

PRICES

Processed perlite sold to expanders in 1982 had an average price of $33.29 per ton, a 9% increase over the average price in 1981. The average unit price of this material used by producers in captive expanding plants was $30, a 6% increase over the 1981 price. The average value of all processed perlite sold and used in 1982 was $31.71 per ton.

The value of expanded perlite sold and used in 1982 averaged $149 per ton, an increase of 9% over that of 1981. Average values ranged from $94 to $379 per ton compared with the 1981 revised range of $64 to $260 per ton.

WORLD REVIEW

Production of crude and/or processed perlite by the principal producing countries in 1982 decreased 6% from the 1981 estimated production. Three countries, the United States, the U.S.S.R., and Greece, continued to account for more than 70% of the world's output.

Production of processed perlite in Greece in 1982 decreased slightly and approximately 16,000 tons was exported to the United States.

[1]Industry economist, Division of Industrial Minerals.

Table 4.—Perlite: World production, by country[1]

(Thousand short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Australia[3]	2	2	2	2	2
Czechoslovakia[e]	22	33	44	[r]46	44
Greece	166	189	163	145	143
Hungary[3]	102	108	109	[e]110	110
Italy[e]	100	100	100	[r]94	88
Japan[e]	80	83	85	83	85
Mexico[3]	27	46	49	63	61
New Zealand[3]	1	2	1	1	1
Philippines	3	4	9	8	8
Turkey	30	33	28	[e]29	33
U.S.S.R.[e]	400	400	400	400	400
United States (processed ore sold and used by producers)	641	660	638	591	506
Total	1,574	1,660	1,628	1,572	1,481

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Unless otherwise specified, figures represent processed ore output. Table includes data available through June 8, 1983.
[2]In addition to the countries listed, Algeria, Bulgaria, China, Iceland, Mozambique, the Republic of South Africa, and Yugoslavia are believed to have produced perlite during 1977-81, but output data are not reported and available information is inadequate for formulation of reliable estimates of output levels.
[3]Crude ore.

Phosphate Rock

By William F. Stowasser[1]

From a peak of 54.4 million metric tons in 1980, production of marketable phosphate rock declined for the second successive year to 37.4 million tons in 1982. The value of marketable phosphate rock declined to approximately $1 billion from the record high of $1.4 billion in 1981. As demand for farm products weakened during the year, prices for farm commodities fell below production costs, and many of the factors that reduced fertilizer trade in 1981 continued to depress trade in 1982. With the decline in domestic demand for phosphate fertilizer and phosphate chemicals, and a decline in the export market as well, producers in Florida found it necessary to close mines and plants to limit growing inventories of phosphate rock. At one point during the year, the employment level of the Florida phosphate industry was only 25% of the normal level because of plant closings and reduced work schedules.

The imbalance between supply and demand for phosphate rock caused the industry to rethink plans for new mines and expansion of existing mines. By yearend, producers had deferred or canceled most plans for mines scheduled for startup in the early or mid-1980's.

Domestic Data Coverage.—Domestic production data for phosphate rock are developed by the Bureau of Mines by means of two separate, voluntary surveys. Typical of these surveys is the phosphate rock semiannual survey. Of 25 canvassed operations to which a survey request was made, 100% responded and 100% of the total production data shown in table 1 was represented.

Table 1.—Salient phosphate rock statistics

(Thousand metric tons and thousand dollars unless otherwise specified)

	1978	1979	1980	1981	1982
United States:					
Mine production	173,429	185,757	209,883	183,733	104,135
Marketable production	50,037	51,611	54,415	53,624	37,414
Value	$928,820	$1,045,655	$1,256,947	$1,437,986	$950,326
Average per metric ton	$18.56	$20.26	$23.10	$26.82	$25.40
Sold or used by producers	48,774	53,063	54,581	45,526	38,571
Value	$901,378	$1,063,517	$1,243,297	$1,212,433	$983,465
Average per metric ton	$18.48	$20.04	$22.78	$26.63	$25.50
Exports[1]	12,870	14,358	14,276	10,395	9,842
P_2O_5 content	4,118	4,611	4,554	3,300	3,138
Value	$297,357	$356,481	$431,419	$373,192	$293,626
Average per metric ton	$23.10	$24.83	$30.22	$35.90	$29.83
Imports for consumption[2]	908	886	486	13	31
Customs value	$24,379	$21,595	$12,856	$420	$1,302
Average per metric ton	$26.85	$24.37	$26.45	$32.31	$42.00
Consumption[3]	36,812	39,591	40,791	35,144	28,760
World: Production	[r]125,022	[r]132,010	139,604	[p]137,524	[e]122,633

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Exports reported to the Bureau of Mines by companies.
[2]Bureau of the Census data.
[3]Measured by sold or used plus imports minus exports.

Legislation and Government Programs.—The Florida Wilderness Act of 1982, H.R. 9, was passed by the U.S. Senate in December, thus clearing the measure for the President. The bill designated components of the National Wilderness Preservation System in Florida. In addition, section 4 of the bill directed the U. S. Department of the Interior not to issue phosphate leases in the Osceola National Forest unless and until the President recommended to Congress that phosphate leasing be permitted in specified areas of the forest. The President vetoed the bill in early 1983; however, the bill was reintroduced early in the 98th session of Congress.

DOMESTIC PRODUCTION

Marketable phosphate rock production and value are shown in table 1. In 1982, Florida and North Carolina produced 31.7 million tons, 85% of the total marketable phosphate rock production; the Western States produced 4.8 million tons, 13%; and Tennessee produced 0.9 million tons, 2%.

Florida and North Carolina.—Production and value of phosphate rock are shown in table 2. Agrico Chemical Co., Amax Chemical, Inc., Beker Phosphate Corp., Brewster Phosphates, CF Industries, Inc., Estech, Inc., Gardinier, Inc., W. R. Grace & Co., International Minerals & Chemical Corp. (IMC), Mobil Chemical Co., and USS Agri-Chemical Co. produced marketable phosphate rock from the Bone Valley Formation in central Florida. Occidental Chemical Co. produced marketable phosphate rock from a matrix similar to that of central Florida in Hamilton County, in north Florida.

Several small companies in north-central Florida intermittently mined soft phosphate rock from tailing ponds associated with old inactive hard-rock mines. The companies have an estimated 45,000-ton-per-year capacity that is seldom achieved. The low-fluorine soft rock was sold in the animal feed supplement market.

In North Carolina, Texasgulf Chemicals Co., a subsidiary of Société Nationale Elf Aquitaine, operated the Lee Creek Mine and an extensive fertilizer complex near Aurora, N.C. Hydraulic dredges removed overburden, and draglines removed lower levels of overburden and the phosphate matrix.

North Carolina Phosphate Corp. has deferred plans to produce phosphate rock in eastern North Carolina until at least 1987. North Carolina Phosphate, wholly owned by Agrico Chemical, had created two 50-50 partnerships with Française de l'Azote for 19% of the mine and with Azienda Nazionale Idrogenazione Combustible S.p.A., the Italian state-owned company, for 21.6%.

In central Florida, Agrico Chemical operated the Fort Green/Pebbledale Mine and the Payne Creek Mine. The Saddle Creek Mine was not operated in 1982; however, several million tons were expected to be recovered before the mine is closed permanently in the mid-1980's. Amax Chemical operated the Big 4 Mine in Hillsborough County for part of the year. Plans to open the Pine Level Mine have been deferred to 1989 when the Big 4 Mine is scheduled to be depleted. The Pine Level Mine capacity was to be about 2.3 million tons per year.

Beker Phosphate, which operated the Wingate Creek Mine in Manatee County during 1982, was gradually increasing the production rate to over 800,000 tons per year.

Brewster Phosphates, a partnership of American Cyanamid Co. and Kerr-McGee Corp., operated the Haynsworth and Lonesome Mines. The Haynsworth Mine in Polk County was scheduled to produce through 1990, and the Lonesome Mine in Hillsborough County was to operate into the mid-1990's. Most of Brewster's phosphate rock was transported by barge from Tampa to the phosphoric acid plant at Uncle Sam, La.

CF Industries' phosphate rock mine in Hardee County, Fla., produced less than design capacity. Although the Bartow, Fla., fertilizer complex was to be closed in early 1983, the mine was to continue supplying phosphate to the Plant City, Fla., plant. As far as is known, the design and engineering of the Hardee Complex II in Hardee County was proceeding on schedule, with the new beneficiation plant and mine scheduled to operate in 1986 to furnish CF Industries with another 2 million tons per year of concentrates.

Estech operated the Silver City and Watson Mines in 1982. According to long-range plans, the two mines were to operate through 1990, and a replacement mine, the Duette deposit in Manatee County, was to start producing in 1987. However, as phosphate rock demand weakened in 1982, Estech decided to close the Silver City Mine in early 1983.

The combination of weak demand for phosphate rock and the withholding of ground water permits by the State caused Farmland Industries, Inc., to delay plans to open a 1.8-million-ton-per-year phosphate rock mine near Ona, Fla. The mine startup, originally planned for 1984, was rescheduled for 1987.

Gardinier interrupted production of phosphate rock from the Fort Meade Mine for 3 months during the summer of 1982. A new mine in south Hardee County was planned for startup in 1990 with design capacity of 2.7 million tons per year.

The Four Corners Mine of W. R. Grace and IMC, a 4.5-million-ton-per-year mine, was rescheduled to start producing in 1984; however, the startup date was predicated on demand for the product. W. R. Grace's Bonny Lake Mine was nearing exhaustion. W. R. Grace's Hookers Prairie Mine was scheduled to operate through 1994 before the deposit becomes depleted.

In addition to its participation in the Four Corners Mine, IMC operated the Clear Springs, Noralyn, and Kingsford Mines in Polk County, Fla., with a combined 1982 capacity of 11.5 million tons per year of phosphate rock. If mining plans are followed, Clear Springs is expected to operate through 1995; Kingsford, through 1997; and Noralyn, through 1988. IMC planned a new mine in southeast Hillsborough County to replace the Noralyn Mine in 1989, and another new mine in Hardee County to replace the Clear Springs and Kingsford Mines near the end of the century.

Mobil Chemical operated the Fort Meade and Nichols Mines in Polk County, Fla. The Fort Meade Mine was scheduled to operate through 1988 and the Nichols Mine, through 1995. Mobil Chemical made plans to open the South Fort Meade Mine in 1988 to replace production from the Fort Meade Mine and thereby maintain the company's capability to supply phosphate rock to domestic and export markets.

USS Agri-Chemicals and Freeport Phosphate Rock Co. produced phosphate rock from the Rockland/Little Payne Mine. The Rockland Mine was closed from June through August and again in November and December to manage inventory buildup. The Rockland Mine was forecast to operate through 1994. When depleted, the Rockland Mine will be replaced by a mine on the Waters and Manson Jenkins deposits.

Tennessee.—Production and value of phosphate rock in Tennessee are shown in table 2. Hooker Chemical Co., Monsanto Co., and Stauffer Chemical Co. mined and beneficiated phosphate rock in Tennessee for reduction to elemental phosphorus in electric furnaces near Columbia and Mt. Pleasant, Tenn. Monsanto operated a mine in Alabama to supplement production from its Tennessee mines. Production of marketable phosphate rock in Tennessee declined steadily from 1.9 million tons in 1979 to 0.9 million tons in 1982. Both Monsanto and Stauffer preferred to produce phosphorus in Western U.S. electric furnaces, which benefit from lower power rates, than from Tennessee furnaces.

Western States.—Production tonnage and value of marketable phosphate rock are shown in table 2. Phosphate rock sold or used for agricultural purposes was 1.9 million tons, and 2.2 million tons was used in electric furnaces.

The Conda Partnership, an association of Beker Phosphate and Western Cooperation Fertilizers, Ltd., headquartered in Conda, Idaho, operated the Mabie Canyon Mine in Caribou County. The recession in the fertilizer industry caused the partnership to reduce production at the Mabie Canyon Mine and limit shipments to the Western Cooperation Fertilizers plant in Canada. The partnership planned to open the Champ Williams Mine in Caribou County, Idaho, in September 1983. The oxidized ore from the Champ Williams Mine will be blended with unoxidized ore from the lower depths of the Mabie Canyon Mine.

Table 2.—Production of phosphate rock in the United States, by State

(Thousand metric tons and thousand dollars)

	Mine production		Mine production used directly		Beneficiated production		Marketable production		
	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content	Value
1981:									
Florida and North Carolina	173,898	21,434	27	5	46,254	14,283	46,281	14,288	1,290,134
Tennessee	2,547	516	--	--	1,328	340	1,328	340	16,201
Western States[1]	7,288	1,809	2,809	741	3,205	996	6,015	1,737	131,651
Total[2]	183,733	23,759	2,836	746	50,788	15,619	53,624	16,365	1,437,986
1982:									
Florida and North Carolina	98,045	11,988	4,362	1,304	27,357	8,594	31,724	9,897	820,849
Tennessee	1,597	324	--	--	897	229	897	229	11,596
Western States[1]	4,493	1,116	2,231	592	2,561	785	4,793	1,377	117,881
Total[2]	104,135	13,428	6,594	1,896	30,815	9,608	37,414	11,504	950,326

[1]Includes Alabama, Idaho, Montana, and Utah.
[2]Data may not add to totals shown because of independent rounding.

Monsanto, through a contractor, operated the Henry Mine located about 26 kilometers northeast of Soda Springs, Idaho. The ore was selectively mined and trucked to Monsanto's electric furnace plant at Soda Springs. The deposit is about 9 kilometers long, and the mine extends for about 2,300 meters. As in prior years, the mine operated from April to October during daylight hours only, when formation contacts were visible. Mine production capacity of about 900,000 tons per year was approached in 1982.

Stauffer operated the Wooley Valley Mine northeast of Soda Springs, Idaho. All the ore was shipped to the Stauffer electric furnace plant at Silver Bow, Mont. The mine operated well below capacity in 1982.

Chevron Resources Co. delayed plans for at least 2 years to expand production from the phosphate rock mine at Vernal, Utah, and construct a fertilizer complex near Rock Springs, Wyo., because of the unprecedented downturn in fertilizer demand. The Vernal Mine produced at less than capacity in 1982. The phosphate-bearing ore was ground in a wet semiautogenous mill and deslimed in classifiers prior to recovery of the phosphate mineral from sand in a series of flotation cells. The flotation concentrates were dewatered, filtered, and dried before shipment to Phoston, Utah.

J. R. Simplot Co. operated the Gay Mine in a joint venture with FMC Corp. to supply acid-grade ore to Simplot's phosphoric acid plant at Pocatello, Idaho, and lower grade ore to FMC's electric furnace plant at Pocatello. Simplot also operated the nearly depleted Conda Mine, which was scheduled to be replaced in 1984 by the Smokey Canyon Mine near Afton, Wyo. The capacity of the new mine was designed to be 1.8 million tons per year. The concentrates will be pumped from Smokey Canyon to Conda, the nearest railhead, in a 203-millimeter (8-inch) diameter slurry pipeline.

Cominco American, Inc., operated the only underground phosphate mine in the United States. The phosphate rock was crushed and shipped by rail from Montana to Kimberley, British Columbia, for conversion into phosphoric acid.

CONSUMPTION AND USES

Consumption of marketable phosphate rock, defined as the quantity sold or used plus imports minus exports, is shown in table 1. Table 1 also reports the quantity of phosphate rock sold or used.

The consumption pattern as reported by producers is shown in table 7.

The percent distribution by grade of marketable phosphate rock consumed in the United States and sold in the export market in 1982 is compared with the distribution patterns for prior years 1978-81 in table 3. Trends in U.S. grade distribution patterns of phosphate rock are somewhat disguised in these data because of the mix of furnace and wet-process phosphoric acid-phosphate rock feed in the total distribution pattern.

Table 9 shows the phosphate rock sold or used by producers by use, domestic (agricultural and industrial) and exports, and by State groupings.

The recent history of phosphate rock sold or used by producers is in tables 10, 11, and 12 for Florida and North Carolina, Tennessee, and the Western States, respectively.

Florida and North Carolina.—The quantity of phosphate rock sold or used is shown in table 8. Table 9 shows the distribution of phosphate rock sold or used in Florida and North Carolina by domestic and export tonnages.

The percent distribution by grade of the marketable phosphate rock sold or used from Florida and North Carolina, including exports, is shown in table 4 for 1978-82.

Table 3.—U. S. phosphate rock grade distribution pattern

Grade (percent BPL[1] content)	Distribution (percent)				
	1978	1979	1980	1981	1982
Less than 60	6.2	5.4	5.3	5.6	4.9
60 to 66	13.3	14.2	15.7	15.7	15.6
66 to 70	54.3	56.3	56.7	60.1	63.8
70 to 72	13.3	13.6	12.7	9.6	5.8
72 to 74	8.6	6.6	6.0	6.0	6.1
Over 74	4.3	3.9	3.6	3.0	3.8

[1]1.0% BPL (bone phosphate of lime or tricalcium phosphate)=0.458% P_2O_5.

Table 4.—Florida and North Carolina phosphate rock grade distribution pattern

Grade (percent BPL[1] content)	Distribution (percent)				
	1978	1979	1980	1981	1982
Less than 60	0.1	0.2	0.1	0.2	0.6
60 to 66	11.9	12.6	15.3	14.4	12.2
66 to 70	60.8	62.4	62.2	67.0	68.5
70 to 72	15.7	12.7	11.2	7.7	6.9
72 to 74	6.5	7.6	7.0	7.1	7.2
Over 74	5.0	4.6	4.2	3.6	4.5

[1]1.0% BPL (bone phosphate of lime or tricalcium phosphate)=0.458% P_2O_5.

Tennessee.—The quantity and value of marketable phosphate rock sold or used is shown in tables 8 and 9. All of this rock was used in electric furnaces to produce elemental phosphorus and industrial chemicals. Most of the phosphorus was converted into intermediate phosphoric acid, the base for a large number of sodium, calcium, and potassium chemicals.

The percent distribution by grade of marketable phosphate rock sold or used in Tennessee during 1978-82 is shown in table 5.

Table 5.—Tennessee phosphate rock grade distribution pattern

Grade (percent BPL[1] content)	Distribution (percent)				
	1978	1979	1980	1981	1982
Less than 60	68.3	60.3	75.3	50.6	38.0
60 to 66	31.7	37.0	24.7	49.4	62.0
66 to 70	--	2.7	--	--	--

[1]1.0% BPL (bone phosphate of lime or tricalcium phosphate)=0.458% P_2O_5.

Western States.—The quantity of marketable phosphate rock sold or used is shown in tables 8 and 9. In 1982, 80% was consumed in the United States, and 20% was exported to Canada. The percent distribution by grade of marketable phosphate rock sold or used from the Western States during 1978-82 is shown in table 6.

Table 6.—Western States phosphate rock grade distribution pattern

Grade (percent BPL[1] content)	Distribution (percent)				
	1978	1979	1980	1981	1982
Less than 60	32.6	27.4	27.7	31.4	27.2
60 to 66	17.9	18.9	16.5	16.0	29.4
66 to 70	23.2	26.8	27.7	28.5	43.4
70 to 72	--	26.5	28.1	24.1	--
72 to 74	26.3	.4	--	--	--

[1]1.0% BPL (bone phosphate of lime or tricalcium phosphate)=0.458% P_2O_5.

Table 7.—Phosphate rock sold or used by producers in the United States, by use

(Thousand metric tons)

Use	1981		1982	
	Rock	P_2O_5 content	Rock	P_2O_5 content
Domestic:[1]				
Wet-process phosphoric acid	29,085	8,956	24,223	7,423
Normal superphosphate	184	60	100	33
Triple superphosphate	1,198	378	876	280
Defluorinated rock	492	166	184	67
Direct applications	27	6	61	19
Elemental phosphorus	4,055	1,049	3,259	847
Ferrophosphorus	89	22	25	7
Total[2]	35,131	10,638	28,729	8,676
Exports[3]	10,395	3,300	9,842	3,138
Grand total[2]	45,526	13,939	38,571	11,814

[1]Includes rock converted to products and exported.
[2]Data may not add to totals shown because of independent rounding.
[3]Exports reported to the Bureau of Mines by companies.

Table 8.—Phosphate rock sold or used by producers in the United States, by grade and State in 1982

(Thousand metric tons and thousand dollars)

Grade (percent BPL[1] content)	Florida and North Carolina			Tennessee		
	Rock	P_2O_5 content	Value	Rock	P_2O_5 content	Value
Below 60	193	51	5,527	365	85	3,027
60 to 66	4,016	1,128	114,078	595	162	9,945
66 to 70	22,551	6,985	544,616	--	--	--
70 to 72	2,227	729	68,175	--	--	--
72 to 74	2,350	789	69,789	--	--	--
Plus 74	1,468	509	48,609	--	--	--
Total[2]	32,806	10,192	850,794	960	248	12,972
	Western States			**Total United States**		
	Rock	P_2O_5 content	Value	Rock	P_2O_5 content	Value
Below 60	1,306	321	15,163	1,864	457	23,717
60 to 66	1,411	400	23,733	6,022	1,690	147,756
66 to 70	2,089	655	80,803	24,640	7,640	625,419
70 to 72	--	--	--	2,227	729	68,175
72 to 74	--	--	--	2,350	789	69,789
Plus 74	--	--	--	1,468	509	48,609
Total[2]	4,807	1,375	119,699	38,571	11,814	983,465

[1]1.0% BPL (bone phosphate of lime or tricalcium phosphate)=0.458% P_2O_5.
[2]Data may not add to totals shown because of independent rounding.

Table 9.—Phosphate rock sold or used by producers, by use and State

(Thousand metric tons)

Use	Florida and North Carolina		Tennessee		Western States		Total United States[1]	
	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content
1981:								
Domestic:[2]								
Agricultural	29,021	8,944	--	--	1,965	623	30,986	9,566
Industrial	222	62	1,379	357	2,544	653	4,145	1,072
Total[1]	29,243	9,006	1,379	357	4,509	1,276	35,131	10,638
Exports[3]	9,232	2,933	--	--	1,163	368	10,395	3,300
Total[1]	38,475	11,938	1,379	357	5,672	1,644	45,526	13,939
1982:								
Domestic:[2]								
Agricultural	23,544	7,236	--	--	1,901	586	25,444	7,822
Industrial	106	32	960	248	2,219	575	3,284	854
Total	23,650	7,268	960	248	4,120	1,161	28,728	8,676
Exports[3]	9,156	2,924	--	--	687	214	9,842	3,138
Total[1]	32,806	10,192	960	248	4,807	1,375	38,571	11,814

[1]Data may not add to totals shown because of independent rounding.
[2]Includes rock converted to products and exported.
[3]Exports reported to the Bureau of Mines by companies.

Table 10.—Florida and North Carolina phosphate rock sold or used by producers

Year	Rock (thousand metric tons)	P_2O_5 content (thousand metric tons)	Value: Total (thousands)	Value: Average per ton
1978	41,388	12,861	$778,339	$18.81
1979	45,459	14,189	935,127	20.57
1980	47,171	14,690	1,108,991	23.51
1981	38,458	11,935	1,064,459	27.68
1982	32,806	10,192	850,794	25.93

Table 11.—Tennessee phosphate rock sold or used by producers

Year	Rock (thousand metric tons)	P_2O_5 content (thousand metric tons)	Value: Total (thousands)	Value: Average per ton
1978	1,688	434	$13,833	$8.19
1979	2,140	545	17,008	7.95
1980	1,665	432	13,330	8.01
1981	1,379	357	17,401	12.62
1982	960	248	12,972	13.51

Table 12.—Western States phosphate rock sold or used by producers

Year	Rock (thousand metric tons)	P_2O_5 content (thousand metric tons)	Value: Total (thousands)	Value: Average per ton
1978	5,671	1,647	$108,669	$19.16
1979	5,439	1,585	110,837	20.38
1980	5,713	1,681	120,309	21.06
1981	5,672	1,644	130,194	22.95
1982	4,807	1,375	119,699	24.90

STOCKS

Inventories of marketable phosphate rock are reported to the Bureau of Mines by producing companies on a monthly and semiannual basis. The monthly reports enable the Bureau to publish stock trends in its monthly Phosphate Rock Mineral Industry Surveys (MIS). The semiannual reports provide the data for stock levels reported in the annual MIS, crop year MIS, and Minerals Yearbook. Producers' stocks over the past 10 years are shown in table 13.

Table 13.—Marketable phosphate rock yearend stocks

(Million metric tons)

Year	Quantity
1973	8.4
1974	5.8
1975	9.9
1976	15.2
1977	13.7
1978	15.7
1979	14.5
1980	13.8
1981	20.2
1982	18.3

PRICES

Estimated export prices for Florida and Moroccan phosphate rock are shown in tables 14 and 15, respectively. Included in the export prices are applicable severance taxes, rail freight costs from mine to port, and port loading and weighing charges.

Phosphate rock is sold according to contracts negotiated between buyers and sellers. Although list prices are published on occasion by the Florida Phosphate Rock Export Association, Tampa, Fla., and the Moroccan Office Cherifien des Phosphates, Casablanca, Morocco, actual contract prices negotiated between buyers and sellers are not published.

The Bureau of Mines obtains the f.o.b. mine price or value of phosphate rock from a semiannual survey of the producing mines. The weighted average price for each grade of phosphate rock is calculated for domestic and export markets. These prices are shown in tables 16 through 19.

Table 14.—Phosphate rock estimated export prices per metric ton, unground, f.o.b. vessel Tampa Range or Jacksonville, Fla.

Grade (percent BPL[1] content)	1979[2]	1980[3]	1981[r 4]	1982[5]
77	$38.00	--	--	--
75	34.00	$44.00	$43.00	$34.00
72	30.00	40.00	36.00	27.00
70	26.00	36.00	30.50	23.50
68	25.00	34.00	30.00	23.00
66	25.00	34.00	NA	NA

[r] Revised. NA Not available.
[1] 1.0% BPL (bone phosphate of lime or tricalcium phosphate) = 0.458% P_2O_5.
[2] Estimated selling price including $1.15 severance tax.
[3] Estimated selling price including $1.54 severance tax.
[4] Estimated selling price including $1.84 severance tax.
[5] Estimated selling price including $2.03 severance tax.

Table 15.—Moroccan phosphate rock export prices, U.S. dollars per metric ton, f.a.s. Safi or Casablanca[e]

Grade (percent BPL[1] content)	1979	1980	1981[r]	1982
Khouribga:				
76 to 77	43.00	56.00	58.00	50.00
75 to 76	42.00	54.00	--	--
72 to 73	40.00	52.00	--	--
70 to 71	43.00	48.50	52.00	42.00
Youssoufia:				
68 to 69	35.25	45.50	44.00	38.00
74 to 75	42.00	53.00	56.00	47.00

[e] Estimated. [r] Revised.
[1] 1.0% BPL (bone phosphate of lime or tricalcium phosphate) = 0.458% P_2O_5.

Table 16.—Price or value of Florida and North Carolina phosphate rock

(Dollars per metric ton, f.o.b. mine)

Grade (percent BPL[1] content)	1981			1982		
	Domestic	Export	Average	Domestic	Export	Average
Less than 60	16.04	--	16.04	28.58	--	28.58
60 to 66	31.66	27.54	30.88	29.23	26.60	28.40
66 to 70	23.57	31.29	24.86	23.25	28.33	24.15
70 to 72	25.26	33.93	30.26	31.59	29.54	30.61
72 to 74	32.81	37.93	37.02	29.74	29.69	20.70
Over 74	32.00	45.54	43.77	34.11	32.45	33.11
Average	25.17	33.74	27.68	24.78	28.92	25.93

[1]1.0% BPL (bone phosphate of lime or tricalcium phosphate)=0.458% P_2O_5.

Table 17.—Price or value of Western States phosphate rock

(Dollars per metric ton, f.o.b. mine)

Grade (percent BPL[1] content)	1981			1982		
	Domestic	Export	Average	Domestic	Export	Average
Less than 60	9.54	--	9.54	11.61	--	11.61
60 to 66	10.46	35.33	15.71	14.22	41.83	16.82
66 to 70	24.25	37.88	28.71	37.47	42.05	38.68
70 to 72	35.94	37.08	38.44	--	--	--
Average	18.06	37.09	22.95	22.05	42.00	24.90

[1]1.0% BPL (bone phosphate of lime or tricalcium phosphate)=0.458% P_2O_5.

Table 18.—Price or value of Tennessee phosphate rock

(Dollars per metric ton, f.o.b. mine)

Grade (percent BPL[1] content)	1981	1982
Less than 60	8.21	8.30
60 to 66	17.15	16.71
66 to 70	--	--
Average	12.62	13.51

[1]1.0% BPL (bone phosphate of lime or tricalcium phosphate)=0.458% P_2O_5.

Table 19.—Price or value of U. S. phosphate rock

(Dollars per metric ton, f.o.b. mine)

Grade (percent BPL[1] content)	1981			1982		
	Domestic	Export	Average	Domestic	Export	Average
Less than 60	9.38	--	9.38	12.72	--	12.72
60 to 66	27.11	28.15	27.64	23.48	28.04	24.53
66 to 70	23.60	31.75	25.09	24.33	30.00	25.38
70 to 72	28.35	34.36	32.83	31.59	29.54	30.61
72 to 74	32.81	37.93	37.02	29.74	29.69	29.70
Over 74	32.00	45.54	43.77	34.11	32.45	33.11
Average	23.82	33.93	26.63	24.01	29.83	25.50

[1]1.0% BPL (bone phosphate of lime or tricalcium phosphate)=0.458% P_2O_5.

FOREIGN TRADE

In 1982, U.S. producers reported that their exports of phosphate rock were 10 million tons. Phosphate rock exports were 14.4, 14.3, and 10.4 million tons in 1979, 1980, and 1981, respectively. The decline in phosphate rock exports from a peak in 1979 to lower levels in recent years can be attributed to a number of causes: a worldwide recession in the fertilizer industry reduced demand for phosphate rock in 1981-82; increased phosphoric acid production in phosphate rock-producing countries, for both domestic and export markets, contributed to the decline in demand for phosphate rock in international trade; and competition from foreign exporters of both phosphate rock and phosphoric acid reduced the demand for U.S. phosphate rock in 1981-82.

Except for 8,172 tons from the Netherlands Antilles, 23,009 tons from Mexico, and a sample from India and Senegal imported in September, no other phosphate rock imports were reported by the U.S. Bureau of the Census in 1982.

Tables 20 through 26 show exports of phosphate rock, phosphate fertilizers, phosphate intermediates, and elemental phosphorus from the United States in 1982.

Table 27 lists phosphate fertilizers and chemicals imported during 1982.

Table 20.—U.S. exports of phosphate rock, by country

(Thousand metric tons and thousand dollars)

Destination	1981		1982	
	Quantity	Value[1]	Quantity	Value[1]
Australia	126	4,855	203	6,958
Austria	208	10,823	109	5,088
Belgium-Luxembourg	849	35,959	451	16,902
Brazil	115	5,563	85	3,466
Canada	3,080	106,483	2,334	91,847
Denmark	68	3,170	--	--
Finland	62	3,080	120	5,038
France	763	29,375	672	24,627
Germany, Federal Republic of	430	16,861	596	22,916
India	263	11,921	256	9,678
Italy	120	4,480	115	4,083
Japan	1,365	61,204	1,132	49,724
Korea, Republic of	993	36,701	1,549	57,958
Mexico	325	15,800	396	20,106
Netherlands	851	29,568	672	23,833
New Zealand	97	4,834	79	2,811
Norway	52	1,859	15	633
Philippines	124	6,472	49	2,394
Poland	187	6,691	432	15,712
Romania	136	6,397	125	5,225
Sweden	138	6,391	102	4,108
Taiwan	41	1,969	42	1,803
United Kingdom	15	614	52	2,229
Other	148	8,933	148	6,415
Total[2]	10,554	419,999	9,735	383,554

[1]All values f.a.s. (free alongside ship).
[2]Data may not add to totals shown because of independent rounding.

Source: U.S. Bureau of the Census.

Table 21.—U.S. exports of superphosphates, more than 40% P_2O_5, by country

(Thousand metric tons and thousand dollars)

Destination	1981		1982	
	Quantity	Value[1]	Quantity	Value[1]
Argentina	9	1,570	10	1,472
Belgium-Luxembourg	77	10,811	52	6,958
Brazil	104	16,737	50	6,919
Bulgaria	196	29,872	86	11,264
Burma	53	9,766	30	4,627
Canada	140	18,242	50	6,953
Chile	84	14,219	35	5,120
China	203	32,579	48	6,198
Colombia	20	3,788	12	1,997
Costa Rica	4	648	7	948
Dominican Republic	9	1,890	6	1,117
France	48	7,875	32	1,933
Germany, Federal Republic of	171	26,930	99	13,388
Hungary	45	7,278	15	2,099
Indonesia	67	13,376	130	19,960
Ireland	41	6,345	16	2,150
Italy	10	1,468	--	--
Japan	25	3,739	31	5,092
Kenya	10	1,847	--	--

See footnotes at end of table.

Table 21.—U.S. exports of superphosphates, more than 40% P_2O_5, by country —Continued

(Thousand metric tons and thousand dollars)

Destination	1981		1982	
	Quantity	Value[1]	Quantity	Value[1]
Peru	15	1,976	12	1,780
Singapore	(2)	121	30	4,020
Uruguay	7	1,133	5	739
Venezuela	10	1,928	17	4,077
Other	149	30,561	340	48,451
Total[3]	1,499	244,701	1,112	157,262

[1]All values f.a.s. (free alongside ship).
[2]Less than 1/2 unit.
[3]Data may not add to totals shown because of independent rounding.

Source: U.S. Bureau of the Census.

Table 22.—U.S. exports of superphosphates, less than 40% P_2O_5, by country

Destination	1981		1982	
	Quantity (metric tons)	Value[1] (thousands)	Quantity (metric tons)	Value[1] (thousands)
Brazil	2,626	$250	--	--
Canada	17,716	385	34,258	$738
Other	256	6	2,110	140
Total	20,598	[2]640	36,368	878

[1]All values f.a.s. (free alongside ship).
[2]Data do not add to total shown because of independent rounding.

Source: U.S. Bureau of the Census.

Table 23.—U.S. exports of diammonium phosphates, by country

(Thousand metric tons and thousand dollars)

Destination	1981		1982	
	Quantity	Value[1]	Quantity	Value[1]
Argentina	83	15,579	79	14,808
Australia	60	13,177	116	21,912
Bangladesh	59	14,714	42	8,449
Belgium-Luxembourg	347	66,789	418	65,025
Brazil	149	28,351	88	16,143
Canada	116	23,184	117	21,586
Chile	44	9,057	9	1,491
China	348	76,411	458	85,797
Colombia	39	7,709	52	9,816
Costa Rica	16	3,127	20	3,788
Dominican Republic	15	2,980	28	5,100
Ecuador	20	4,407	23	4,562
Ethiopia	--	--	45	8,346
Finland	17	3,373	--	--
France	83	16,657	31	6,127
Germany, Federal Republic of	79	11,846	36	6,231
Guatemala	20	4,584	2	304
India	787	155,909	182	34,549
Ireland	56	10,992	43	8,075
Italy	457	89,216	178	32,416
Japan	185	33,213	304	53,371
Mexico	232	49,473	238	45,279
Mozambique	6	1,231	--	--
Netherlands	49	9,605	72	13,281
New Zealand	25	4,744	36	6,489
Nicaragua	--	--	13	2,470
Pakistan	40	11,063	319	62,206
Spain	82	15,293	24	4,367
Thailand	40	7,987	45	8,386

See footnotes at end of table.

Table 23.—U.S. exports of diammonium phosphates, by country —Continued

(Thousand metric tons and thousand dollars)

Destination	1981 Quantity	1981 Value[1]	1982 Quantity	1982 Value[1]
Turkey	44	9,145	--	--
Uruguay	31	5,883	36	6,371
Yugoslavia	120	24,080	94	18,167
Other	291	59,990	558	103,772
Total[2]	3,942	789,770	3,707	678,685

[1]All values f.a.s. (free alongside ship).
[2]Data may not add to totals shown because of independent rounding.

Source: U.S. Bureau of the Census.

Table 24.—U.S. exports of phosphoric acid, less than 65% P_2O_5, by country

(Thousand metric tons and thousand dollars)

Destination	1981 Quantity	1981 Value[1]	1982 Quantity	1982 Value[1]
Brazil	204	65,171	47	9,897
Canada	3	466	1	165
Colombia	19	4,054	10	2,534
Germany, Federal Republic of	15	3,821	--	--
India	208	42,241	264	55,889
Indonesia	125	38,335	64	18,620
Mexico	(2)	18	60	10,857
Turkey	150	47,301	29	7,209
U.S.S.R	231	88,249	--	--
Venezuela	46	12,764	55	12,575
Other	3	971	(2)	38
Total[3]	1,004	303,390	530	117,785

[1]All values f.a.s. (free alongside ship).
[2]Less than 1/2 unit.
[3]Data may not add to totals shown because of independent rounding.

Source: U.S. Bureau of the Census.

Table 25.—U.S. exports of phosphoric acid, more than 65% P_2O_5, by country

(Thousand metric tons and thousand dollars)

Destination	1981 Quantity	1981 Value[1]	1982 Quantity	1982 Value[1]
Brazil	--	--	14	4,079
Canada	23	5,925	42	9,038
Colombia	9	2,084	--	--
U.S.S.R	498	168,898	808	268,485
Other	20	6,600	29	7,694
Total[2]	549	183,506	893	289,296

[1]All values f.a.s. (free alongside ship).
[2]Data may not add to totals shown because of independent rounding.

Source: U.S. Bureau of the Census.

Table 26.—U.S. exports of elemental phosphorus, by country

Destination	1981 Quantity (metric tons)	1981 Value[1] (thousands)	1982 Quantity (metric tons)	1982 Value[1] (thousands)
Argentina	20	$44	20	$38
Australia	2	3	--	--
Belgium	17	26	186	291
Brazil	7,049	11,459	5,749	10,153
Canada	1,777	2,656	1,125	1,315
Japan	6,493	10,139	6,855	11,167
Korea, Republic of	324	502	543	730
Mexico	11,754	17,055	236	396
Taiwan	422	594	175	299
Other	88	271	195	736
Total	r27,946	r42,749	15,084	25,125

rRevised.
[1]All values f.a.s. (free alongside ship).

Source: U.S. Bureau of the Census.

Table 27.—U.S. imports for consumption of phosphate rock and phosphatic materials

(Thousand metric tons and thousand dollars)

Fertilizer	1981		1982	
	Quantity	Value[1]	Quantity	Value[1]
Phosphates, crude and apatite	[r]16	[r]673	(2)	1,302
Phosphatic fertilizers and fertilizer materials	16	3,112	8	1,672
Ammonium phosphates, used as fertilizers	--	--	--	--
Dicalcium phosphate	1	958	(2)	353
Phosphorus	(2)	1,247	(2)	1,017
Phosphoric acid	2	816	5	1,684
Phosphoric acid, fertilizer grade	56	7,791	14	1,143
Normal superphosphate	20	3,855	11	2,198
Triple superphosphate	13	2,051	11	1,434

[r]Revised.
[1]Declared customs valuation.
[2]Less than 1/2 unit.

Source: U.S. Bureau of the Census.

WORLD REVIEW

World phosphate rock production in 1982 was an estimated 123 million tons. Production decreased because expected high demand for phosphate fertilizers did not materialize during the year. Although demand was weak for phosphate products, expansion plans were unaffected in some producing countries, whereas most U.S. expansion plans were deferred or canceled. The principal producing countries were the United States, the U.S.S.R., Morocco, and China. In phosphate rock-producing countries with centrally planned economies or developing countries with Government-controlled phosphate complexes, long-range plans to increase phosphate rock capacity were not altered because of the 1982 recession in the phosphate industry.

Algeria.—The principal sources of phosphate rock were the Djebel Onk and El Kouif Mines. The Algerians were planning to process locally a larger share of their phosphate rock production rather than export the 28.5% P_2O_5 rock produced from the Djebel Onk Mine. A Polish group and a Japanese consortium obtained contracts to construct phosphate fertilizer plants at Annaba and at Tebessa.

Angola.—A new phosphate mine was reportedly being developed with Bulgarian assistance at Kondonakasi.[3]

Australia.—Small deposits of phosphate rock have been worked intermittently in South Australia. The ore occurs in a 300-kilometer belt from Carrieton to Myponga. The phosphate occurs for the most part as an anhydrous lime ore that is unsuitable for manufacturing superphosphates because of its high iron and aluminum content. It is primarily used locally for direct application. Mining phosphate rock from the Duchess Mine in northwest Queensland resumed in late 1981. Western Mining Co. planned phosphate rock production at a rate of 200,000 tons per year.

Brazil.—Consumption of phosphate rock increased markedly during the 1970's and 1980's as the agricultural sector realized the benefits of phosphate fertilizer. Although the new Goiasfertil Mine started production, other producing mines did not operate near capacity. Total production in 1982 was expected to approximate 2.5 million tons.

China.—The record indicates that during 1972-81, production of P_2O_5 increased from 1,249,000 to 2,508,000 tons. During the same period, China imported 12,000 to 500,000 tons of P_2O_5. In 1981, China produced 1.78 million tons of normal superphosphates, 692,000 tons of calcium-magnesium phosphates, and 36,000 tons of miscellaneous phosphates. An estimated 1982 production of 12.5 million tons of phosphate rock was processed into phosphate fertilizers or ground in hundreds of local plants for direct application. In the next 5 years, emphasis was expected to be placed on developing domestic phosphate resources to increase production of normal superphosphates, fused calcium and magnesium phosphates, dicalcium phosphates, ammonium phosphates, nitrophosphates, and nitrogen, phosphorus, and potash (NPK) complex fertilizers.

Christmas Island.—The Phosphate Mining Co. of Christmas Island Ltd. (PMCI) was formed in 1981 as the successor organization to the British Phosphate Commissioners. As of 1981, PMCI goals were to produce 1.1 to 1.4 million tons of A Grade phosphate rock per year from a resource of 8.5 million tons, 0.2 to 0.5 million tons per year of B Grade rock from a resource of 40 million tons, and 40,000 to 70,000 tons of granulated dust recovered from the drying plant. Grade C resources, estimated to be 140 million tons, were scraped from the surface and dumped into adjacent mined-out areas.

Egypt.—A new grassroots fertilizer complex was planned for Safaga on the Red Sea coast. The plans were to be implemented by a consortium of two French companies—CdF Chimie and Technip—and Technipetrol of Italy. The complex design included a 1,000-ton-per-day ammonia unit, a 1,000-ton-per-day urea unit, a 3,000-ton-per-day, two-line sulfuric acid plant, a 1,050-ton-per-day P_2O_5 phosphoric acid plant, a 1,600-ton-per-day diammonium phosphate plant, and 1,800 tons per day of NPK capacity. The proposed plant would consume 1 million tons per year of phosphate rock from the Abu Tartur deposit. A railroad between Abu Tartur in the Western Desert and the Red Sea coast will have to be constructed.[3]

Finland.—The Siilinjarvi deposit in eastern Finland near Kuopio is 400 kilometers north of Helsinki. The deposit, containing 10% apatite, is one of the oldest carbonatite complexes in the world, with ore reserves suitable for open pit mining of an estimated 1 billion tons. During the first year of operation after commissioning in 1980, the mine and plant produced 132,000 tons of concentrates. During the second year, the designed annual capacity of 200,000 tons was reached. The concentrates were used successfully in the phosphoric acid plant and performed similarly to Kola apatite.[4]

Iraq.—The Akashat Mine was designed to produce about 3 million tons per year during the first phase and twice as much during the second phase. The flat topography of the area facilitates overburden stripping with 10-cubic-yard draglines. The 10 meters of phosphate ore are highly weathered and average 22% P_2O_5. The lower of three layers is 1 meter thick and assays 28% P_2O_5; the middle is 4 meters thick, and the upper layer is 5 meters thick. The phosphate rock is shipped to Al Kaim for beneficiation and calcining. The ore is crushed and ground to minus 15 millimeters and calcined in rotary kilns at 950° C. The cooled calcine is slaked with water, milled, and classified to recover the phosphate concentrate. Analyses of the concentrate range from 30% to 33% P_2O_5.

Israel.—Negev Phosphates Ltd., owned by Israel Chemicals Ltd., a Government-owned holding company, was conducting an intensive drilling program to determine the extent of a phosphate deposit discovered in the Beersheva Valley. Early assessment indicated a deposit of at least 150 million tons of 28% to 32% P_2O_5 and low levels of organics and chlorides. Development of the Beersheva deposit in the Negev Desert could increase Israel's phosphate rock production to 6 million tons per year and justify a 500,000-ton-per-year P_2O_5 phosphoric acid plant by the end of this decade.[5]

Jordan.—Phosphate rock mines at El Hassa, Ruseifa, and Wadi el Abyad have the capacity to produce 4.5 million tons per year. The Jordanian Ministry of Trade and Industry intends to increase capacity of the three operating mines 10% per year to 6 million tons by 1985. By 1990, Jordan expects to have 10 million tons per year of capacity after developing the Shidiya phosphate deposit in southern Jordan, close to the Port of Aqaba. The ore will be blasted, trucked to a crushing plant, and classified by washing a minus 1/2-inch by 0 crushed ore to minus 1/2-inch by 53-micrometer product for export or domestic consumption.

Mexico.—After the 1976 discovery of phosphate deposits at San Juan de la Costa in Baja California, mine development was very rapid, and production started in January 1981. The San Juan deposit has proven resources in the ground of 45 million tons averaging 18% P_2O_5. Initial production was 24,000 tons per month of 31% P_2O_5 concentrates. Planned 1982 production of 60,000 tons per month was expected to significantly reduce the need for Mexico to continue importing phosphate rock at past levels.

Work continued on developing the Santo Domingo phosphate rock deposit also located in Baja California. This deposit has proven resources of 1.45 billion tons of 4.5% P_2O_5 crude ore. Mine startup was projected for late 1982; however, the world recession delayed this schedule. When completed, the first stage of this project was projected to produce 1.5 million tons per year. A new production schedule for this mine has not yet been announced.

Morocco.—The Moroccan Office Cherifien des Phosphates (OCP) estimated 1982 production at about 23 million tons of phosphate rock. Operating at about 67% of capacity, 14 million tons was exported, 4 million tons was used in Moroccan chemical plants, and 5 million tons was stockpiled. OCP planned to have phosphate rock mine capacities of 38 million tons in 1987, 50.4 million in 1992, 61.9 million in 1997, and 76.9 million in 2002. Future expansion plans included the startup in 1986-87 of the Sidi Hajjaj Mine on the Oulad Abdoun Plateau with an initial capacity of 3 million tons per year and the potential to expand to 6 million tons per year as demand increases. In the Khouribga area, 1982 production was from Recette 4, Mera el Arech, and Sidi Daoui, with capacities of 3 million, 3 million, and 12 million tons per year, respectively. The Sidi Daoui Mine was scheduled to be replaced in 1988 by the Sidi Chennane Mine, with initial capacity of 3 million tons per year. It will have the potential to expand to 12 million tons per year. The Mera el Arech Sud Mine was scheduled to produce 3 million tons per year in 1982 and replace the Mera el Arech Mine. The Mera el Arech Sud Mine was planned to expand eventually to 10 million tons per year. Recette 10 was scheduled to open in 1996 and produce 3 million tons per year to offset lost production from Khouribga underground mines.

At Youssoufia, capacity of calcined black rock from the Loubirat deposit was scheduled to increase from 600,000 to 6 million tons per year by 1990.

In the Western Sahara, the Bu-Craa Mine was to expand capacity by opening a third pit, and increasing capacity from 4 to 6 million tons per year by 1990.

Senegal.—Phosphate rock, one of the primary minerals produced in Senegal, is a major part of the industrial base of the country formerly known as French West Africa. In 1982, the Government operated the only commercial aluminum phosphate mine in the world. The aluminum phosphate was converted into fertilizer by heat treatment and exported. Aluminum phosphate was mined by Société Senegalaise des Phosphates de Thies, which has an annual capacity of 1.2 million tons. Calcium phosphate ore was mined from two small pits at Thies; however, the principal calcium phosphate mine was that of Compagnie Senegalaise des Phosphates de Taiba at Taiba. The capacity of the beneficiation plant is 1.5 million tons per year.

South Africa, Republic of.—The Phosphate Development Corp. Ltd. (Foskor) mined phosphate rock from the foskorite and pyroxenite areas surrounding the copper-mineralized central plug of Phalaborwa carbonatite. Foskor installed a self-contained mobile crushing plant with a gyratory crusher to reduce run-of-mine ore to minus 250 millimeters. To reduce water consumption, Foskor was testing dry, high-intensity magnetic separators operating in stages to utilize the paramagnetic properties of pyroxenite ore in producing apatite concentrate. In the flotation circuits, Foskor replaced imported gum arabic, a dispersant reagent, with local, less costly guar gum.

Syria.—The Syrians have an estimated 600 million tons of relatively high-chlorine (0.15% to 0.25%) phosphate rock reserves. Production of 20,000 tons per year started in 1971 from plants located at Sharkia and Kneifis, near Palmyra in central Syria. Production in both 1980 and 1981 reached 1.3 million tons, but declined in 1982 as world demand decreased.

During the past 3 years, a railway was constructed from the phosphate mines, through Homs, to the Port of Tartous. A new 450,000-ton-per-day triple superphosphate plant was constructed by a Romanian company at Tartous.

Togo.—In 1981, after large investments were made to increase phosphate rock capacity, the demand for phosphate rock sharply declined, and Togo could not develop markets for the 3.4-million-ton-per-year installed capacity. For this reason, the Government of Togo intentionally limited production in 1981 and 1982 to reduce operating costs and avoid the expense of building stocks.

Tunisia.—The state-owned Cie. des Phosphates de Gafsa planned to increase phosphate rock mine capacity from 4.9 to 6.8 million tons per year during 1982-86. New washing plants were planned for Moulares, Redeyef, and M'Rata in the Gafsa region, and new mines for Kef Eddour and Oum el Kecheb. Production from Kef Eschafaier, Sehib, and M'Dilla was to be increased. The Jellabia Mzinaa and the Sra Ouertane Mines were scheduled to come into production during 1986-90.[6]

U.S.S.R.—According to recent Soviet data, reserves of phosphate rock were an estimated 1.5 billion tons of P_2O_5 in 14 billion tons of ore. In addition, 550 million tons of P_2O_5 in marginal and subeconomic resources totaled a reserve base of 2 billion tons of P_2O_5. Based on an average P_2O_5 level of 13%, the reserves recoverable at a cost of less than $30 per ton were estimated to be 6.5 billion tons, and the reserve base, about 8 billion tons. About 60 known phosphate and apatite deposits in the U.S.S.R. that were being mined, under development, or to be developed, comprised the reserve base. Included were 45 deposits in the Kara Tau Basin, of which 5 deposits contain one-half the reserves of Kara Tau. Other deposits in the U.S.S.R. include the Khibiny, Vyatsko-Kamsk, Polpinskoye, Yegor'yevsk, Lopatino, Oshurkovo, Gimmel'faebovskoye, Toolse, Kovdor, Belaya Zima, Teleksoye, Belkinskoye, Maymecha-Kotuyskaya, and Seligdar.[7]

Table 28.—Phosphate rock, basic slag, and guano: World production, by country[1]

(Thousand metric tons)

Commodity and country[2]	Gross weight					P_2O_5 content				
	1978	1979	1980	1981[p]	1982[e]	1978	1979	1980	1981[p]	1982[e]
Phosphate rock:										
Algeria	1,136	1,084	1,025	858	[3]947	313	337	317	262	289
Australia	248	[r]7	7	14	[3]212	79	2	2	5	69
Brazil[4]	1,096	1,628	2,612	2,764	[3]2,732	377	603	989	979	968
China[e]	[r]4,695	[r]8,517	10,726	11,500	12,500	1,033	1,874	2,360	2,530	2,750
Christmas Island (Indian Ocean)	[r]1,400	[r]1,367	1,713	1,423	[3]1,328	511	491	602	499	466
Colombia	[r]2	[r]6	5	15	15	([5])	2	1	4	4
Egypt	639	[r]645	658	720	[3]711	177	182	184	203	200
Finland	[r]4	[r]3	138	201	[3]231	1	1	50	72	83
France	25	12	14	12	13	2	1	1	1	1
India	789	681	541	560	560	246	210	167	173	173
Indonesia	6	5	11	11	12	2	2	4	4	4
Iraq	--	--	--	--	363	--	--	--	--	81
Israel	1,725	2,086	2,307	1,919	2,300	561	678	750	624	748
Jordan	2,303	2,825	3,911	4,244	[3]4,431	749	919	1,281	1,390	1,451
Kiribati	465	420	--	--	--	177	160	--	--	--
Korea, North[e]	500	[r]500	[r]500	[r]500	500	150	150	150	150	150
Mexico	322	[r]274	397	251	415	97	82	119	75	124
Morocco[6]	19,713	20,032	18,824	18,562	[3]17,754	[e]6,111	[e]6,210	[e]5,835	[e]5,958	5,700
Nauru	1,999	1,828	2,087	1,480	[3]1,359	770	704	803	503	523
Netherlands Antilles	81	49	--	--	--	22	15	--	--	--
Philippines	1	2	17	8	10	([5])	([5])	4	2	3
Senegal[7]	1,759	1,835	1,632	1,699	[3]975	[e]537	[e]562	[e]497	[e]518	352
South Africa, Republic of	2,699	3,221	[8]3,185	[8]2,618	[8]3,173	[e]972	[e]1,171	[e]1,147	[e]942	1,149
Sri Lanka	NA	NA	NA	14	15	--	--	--	5	5
Sweden[9]	83	58	88	124	[3]131	32	23	34	48	50
Syria	800	1,272	1,319	1,321	[3]1,455	248	356	402	402	443
Thailand	3	5	6	3	3	1	2	2	1	1
Togo	2,827	2,920	2,933	2,215	[3]2,128	1,039	1,056	1,061	806	775
Tunisia	3,712	4,154	4,582	4,596	[3]4,196	1,022	1,164	1,283	1,287	1,213
Turkey	32	27	21	43	30	7	6	4	13	9
Uganda[e]	5	--	--	--	([5])	2	--	--	--	([5])
U.S.S.R.[e]	[r]23,900	[r]24,400	[r]25,300	[r]25,600	26,100	8,300	8,400	8,800	8,900	9,100
United States	50,037	51,611	54,415	53,624	[3]37,414	15,332	15,843	16,711	16,365	[3]11,504
Venezuela	109	--	--	--	--	49	--	--	--	--

See footnotes at end of table.

Vietnam[e]	1,800	400	500	[r]500	500	630	140	175	175	175
Zimbabwe	107	136	130	125	[3]120	37	48	45	44	42
Total	[r]125,022	[r]132,010	139,604	137,524	122,633	39,586	41,394	43,780	42,940	38,605
Basic (Thomas) slag:										
Argentina	[e]3	7	4	1	1	1	1	1	(5)	(5)
Belgium	928	1,052	893	496	470	167	189	161	89	85
Egypt	[e]45	9	10	[e]10	10	8	2	2	[e]2	2
France	2,042	2,072	1,865	1,451	1,400	367	373	303	261	252
Germany, Federal Republic of	833	806	900	767	750	150	145	162	138	135
Luxembourg	627	634	677	[e]700	700	113	114	122	126	126
United Kingdom	[e]20	13	(5)	4	4	[e]4	2	(5)	1	1
Total	4,498	4,593	4,349	3,429	3,335	810	826	751	617	601
Guano:										
Chile	(5)	--	--	1	1	(5)	--	--	(5)	(5)
Kenya	20	--	--	--	(5)	6	--	--	--	(5)
Philippines	1	3	25	2	3	(5)	1	5	(5)	1
Seychelles Islands[10]	6	7	4	5	5	2	2	1	2	2
Total	27	10	29	8	9	8	3	6	2	3

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.

[1]Data for major phosphate rock producing countries obtained in part from the International Fertilizer Industry Association; other figures are from official country sources where available. Table includes data available through Apr. 11, 1983.

[2]In addition to the countries listed, Belgium and Tanzania may have produced small quantities of phosphate rock, and Namibia may have produced small quantities of guano, but output is not officially reported, and available information is inadequate for formulation of reliable estimates of output levels.

[3]Reported figure.

[4]Figure represents total of direct sales of run-of-mine product plus output of marketable concentrate. Direct sales of run-of-mine product were as follows, in thousand metric tons: 1978—27; 1979—39; 1980—50; 1981—40 (estimated); and 1982—40 (estimated). Total output of crude ore reported in Brazilian sources is far higher than figures presented here, but such figures are not equivalent to data shown for other countries in this table.

[5]Less than 1/2 unit.

[6]Production from Western Sahara area included with Morocco.

[7]Includes aluminum phosphate as follows, in thousand metric tons: 1978—204; 1979—184; 1980—224; 1981—200; and 1982—200 (estimated). Data do not include figures for output of several types of manufactured phosphate fertilizers that are produced from the reported calcic phosphate and aluminum phosphate to avoid double counting.

[8]Total of local sales and exports as reported by Minerals Bureau of the Republic of South Africa.

[9]As reported by the International Fertilizer Industry Association; official Swedish statistics show no production of phosphate rock; this material is byproduct apatite concentrate derived from iron ore.

[10]Exports.

TECHNOLOGY

The Bureau of Mines Research Centers continued a number of investigations and programs to assist in the recovery of phosphate minerals and reduce the environmental impact of mining.

A new mining technique, borehole mining, was tested to recover phosphate matrix from deposits 75 meters below the surface in St. Johns County, Fla. The borehole mining method was designed to replace conventional procedures, which disturb the land and alter hydrology. The borehole mining of Florida phosphate rock was evaluated for the Bureau by Flow Industries, Inc., Kent, Wash.

The device, placed at the bottom of the borehole, generates a high-pressure water jet that slurries the matrix in the formed cavity. The slurry is pumped to the surface for conventional beneficiation, and the recovered water is reused. Waste fractions from washing and flotation can be returned to the borehole cavities, thereby reducing the need for surface disposal sites and minimizing potential ground subsidence above the mined cavities. In Florida, the mining device was tested in a water-filled cavity and in a drained cavity. In a second flooded cavity test, an air shroud surrounded the water jet to reduce the effect of water resistance on the cutting action. Mining in a drained cavity caused the roof to collapse. It did not collapse in the flooded cavity tests, and the cavity radius increased from 4.6 to 5.5 meters when the air shroud was added.[8]

The Bureau of Mines tested its carbonate-silicate flotation technology on phosphate ore feed from a Western U.S. beneficiation plant. In pilot plant tests, the plant feed ore was screened and classified to produce a minus 150-mesh by 20-micrometer sized feed for a flotation circuit. The plus 150-mesh fraction met concentrate grade requirements, and the minus 20-micrometer slime tailings were wasted. The flotation feed was conditioned with fluosilicic acid to depress phosphate minerals, and an aqueous tall-oil fatty acid emulsion was used to float carbonate minerals. The fluosilicic acid creates a hydrophilic surface on the phosphate minerals to prevent absorption of the fatty acid. The fatty acid becomes a selective collector for carbonate minerals. After carbonate flotation, an amine reagent was added as a collector for selective flotation of the silica from the phosphates. The amine was added without further pulp conditioning or preparation. Tests in a 22-kilogram-per-hour continuous circuit produced a 28.9% P_2O_5 concentrate with 44.9% CaO, 14% SiO_2, and 0.91% MgO with a recovery of 70%. The final product, a mix of the plus 150-mesh feed ore fraction and the flotation concentrate, analyzed 30% P_2O_5, 45% CaO, 12% SiO_2, and 0.8% MgO. The P_2O_5 recovery was 80%.[9]

The Bureau of Mines studied the feasibility of roasting and leaching tailings from a western phosphate rock beneficiation plant to recover vanadium. The tailings analyzed approximately 13% P_2O_5 and 0.23% vanadium. Sulfuric acid leaching was tested with tailings either in dilute suspension or dried or roasted with or without sodium chloride (NaCl) added during the roast. More than 90% of the vanadium was dissolved by roasting at 850° C for 2 hours with 8% NaCl and leaching for 2 hours with an excess of 2*N* sulfuric acid.[10]

The Bureau of Mines continued work to recover water and dewatered solids suitable for land reclamation from colloidal slurry wastes from phosphate washing plants. The Bureau's Field Test Unit treated "blue gumbo" clays associated with north Florida phosphate deposits. Blue gumbo clays are characterized as those that contain monovalent cations that occupy some of the exchange sites and are not fully oxidized. Treatment with lime and aeration prior to polyethylene oxide addition made the clay amenable to dewatering on the screens of the Field Test Unit. Slurries treated for 16 hours with lime and aerated yielded dewatered material at 22% to 24% solids with the addition of 452 grams of polyethylene oxide per ton.[11]

The Florida Institute of Phosphate Research and the Bureau of Mines cosponsored research to develop a high-volume end use such as road construction for phosphogypsum. Phosphogypsum can be used as a filler in asphalt concrete, but because of its fine size consist, it cannot replace all of the sand in the paving mixture. Mixtures of phosphogypsum, hydrated lime, and fly ash produced high-compressive-strength aggregate materials suitable for use in road construction as aggregates or in concrete.[12]

Studies were in progress by the Bureau of Mines to review and evaluate the state of the art for treatment and storage of phosphatic clay wastes in the central Florida land pebble district. Twenty separate clay disposal sites were drilled and sampled to establish the degree of active drainage in the clay mass and the permeability and consolidation of the clay. Other studies were made to identify and review the regulatory, environmental, and technological problems confronting the Florida phosphate mining industry. Leading the list is the disposition and storage of phosphatic waste clays, followed by deep-well water consumption, environmental restrictions, and regulatory requirements.

Bureau of Mines researchers studied samples of high-magnesium (dolomitic) Florida phosphate rock deposits to determine if acceptable quality concentrates could be produced. Test results indicated that concentrates of more than 30% P_2O_5 and less than 1% MgO can be produced by grinding the ore to pass 35-mesh and desliming, but P_2O_5 recovery was significantly below standard.[13]

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[1]Physical scientist, Division of Industrial Minerals.

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Platinum-Group Metals

By J. Roger Loebenstein[1]

World production of platinum-group metals (PGM) in 1982 was estimated at 6.5 million troy ounces, below the level of 1981. World demand for PGM declined from the 1981 level, prompting producers in the Republic of South Africa to further reduce production. Production of PGM in the U.S.S.R. was estimated to continue to increase, owing to expansion of nickel-copper mines at Noril'sk-Talnakh. Low nickel demand led to reduced PGM byproduct output in Canada.

The Republic of South Africa remained the leading producer of platinum, and the U.S.S.R. remained the leading producer of palladium.

Domestic Data Coverage.—Domestic production data for PGM are developed by the Bureau of Mines from a voluntary survey of U.S. refiners. Of the 29 operations to which a survey request was sent, 72% responded, representing an estimated 96% of the total production shown in tables 1, 2, and 9. Production for the remaining eight nonrespondents was estimated using reported prior year production levels.

Table 1.—Salient platinum-group metals[1] statistics

(Troy ounces)

	1978	1979	1980	1981	1982
United States:					
Mine production[2]	8,246	7,300	3,348	r7,318	8,033
Value	$759,925	$1,288,155	$923,423	r$1,570,938	$1,278,195
Refinery production:					
Primary nontoll-refined metal	8,303	8,392	2,300	5,607	7,078
Secondary nontoll-refined metal	257,191	309,022	330,923	391,637	343,020
Toll-refined metal	1,023,314	1,090,678	1,079,813	1,192,315	870,238
Total refined metal	1,288,808	1,408,092	1,413,036	1,589,559	1,220,336
Exports (except manufactured goods)	702,547	899,598	764,964	863,365	862,145
Imports for consumption	2,921,411	3,479,128	3,501,782	2,849,617	2,493,706
Stocks Dec. 31: Refiner, importer, dealer	861,411	761,282	973,261	r918,178	1,106,628
Consumption (sales)	2,259,558	2,756,021	2,205,910	1,920,672	1,854,917
World: Production	6,440,190	r6,487,325	6,838,469	p6,923,495	e6,454,341

eEstimated. pPreliminary. rRevised.
[1]The platinum group comprises six metals: Platinum, palladium, iridium, osmium, rhodium, and ruthenium.
[2]Recovered from platinum placers and as byproducts of copper refining.

Legislation and Government Programs.—Beginning in 1982, the General Services Administration purchased 6,600 ounces of iridium for the National Defense Stockpile at an average price of $387 per ounce. The quantities, in troy ounces, held in the stockpile and the goals at yearend were as follows:

	Goal	Inventory
Platinum	1,310,000	452,642
Palladium	3,000,000	1,255,003
Iridium	98,000	[1]21,190

[1]Excludes 2,400 troy ounces purchased but not yet added to inventory.

Source: General Services Administration.

The Environmental Protection Agency (EPA) decided to postpone until 1987 the 0.2-gram-per-mile particulate emission standard for diesel cars and light trucks that was scheduled to go into effect in 1985. The postponed standard is stricter than the present standard and may require the use of PGM-containing catalytic filters on diesel-powered cars and light trucks.[2]

DOMESTIC PRODUCTION

Domestic output of primary PGM in 1982, all of which was a byproduct of copper refining, was insignificant when compared with total world mine production. Platinum and palladium were recovered from copper ores by U.S. Metals Refining Co., a subsidiary of AMAX Copper Inc., ASARCO Incorporated, and Kennecott. Good News Platinum Co. of Spokane, Wash., experienced technical problems early in the year and produced no PGM from dredging operations in Alaska. Numerous refiners processed PGM scrap on either a toll or nontoll basis. Toll-refined metal was refined for a charge and returned to the owner, but nontoll-refined metal was purchased by the refiner. Most scrap was refined on a toll basis. The largest scrap processors in the United States were Engelhard Minerals and Chemicals Corp., Johnson Matthey Inc., and U.S. Metals Refining Co.

In January 1983, Johnson Matthey opened a new 200,000-square-foot chemicals division at West Deptford, N.J. The plant had a capacity of 1 million ounces of PGM per year.[3] The new $40 million plant was scheduled to refine PGM primarily on a toll basis, and to produce PGM-based chemicals and electronic materials. The West Deptford plant was expected to replace similar operations at Johnson Matthey's Devon, Pa., and Winslow, N.J., plants.

Stillwater PGM Resources, a joint venture of Manville International Corp. and Chevron USA, Inc., continued exploration for PGM within the Stillwater Complex, in Montana. The parent company of Manville International, Manville Corp., filed for bankruptcy under Chapter 11 of the Federal Bankruptcy Code in August 1982. A decision by PGM Resources on whether to develop its mine was expected by 1985.

The Anaconda Company also continued development work on its PGM claim in the Stillwater Complex. Anaconda and PGM Resources reportedly had preliminary discussions about forming a joint venture.

Table 2.—Platinum-group metals refined in the United States

(Troy ounces)

Year	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
PRIMARY METAL							
Nontoll-refined:							
1978	1,081	7,222	--	--	--	--	8,303
1979	1,980	6,412	--	--	--	--	8,392
1980	535	1,765	--	--	--	--	2,300
1981	1,005	4,602	--	--	--	--	5,607
1982	947	6,131	--	--	--	--	7,078
Toll-refined:							
1978	177	1,177	--	--	--	--	1,354
1979	56	420	--	--	--	--	476
1980	128	673	--	--	--	--	801
1981	235	934	--	--	--	--	1,169
1982	434	1,421	--	--	--	--	1,855
SECONDARY METAL							
Nontoll-refined:							
1978	75,585	166,371	1,565	3	8,266	5,401	257,191
1979	75,038	220,639	1,647	--	7,964	3,734	309,022
1980	154,075	162,408	3,186	13	10,106	1,135	330,923
1981	187,883	185,764	3,318	64	11,317	3,291	391,637
1982	190,109	138,286	2,896	--	11,302	427	343,020
Toll-refined:							
1978	630,961	344,022	6,599	667	35,914	3,797	1,021,960
1979	585,932	446,189	5,487	--	38,875	13,719	1,090,202
1980	533,101	498,905	4,933	1,371	33,362	7,340	1,079,012

Table 2.—Platinum-group metals refined in the United States —Continued

(Troy ounces)

Year	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
SECONDARY METAL —Continued							
Toll-refined —Continued							
1981	520,717	607,397	7,826	1,865	34,870	18,471	1,191,146
1982	393,832	430,564	10,108	885	26,693	6,301	868,383
1981 TOTALS							
Total primary	1,240	5,536	--	--	--	--	6,776
Total secondary	708,600	793,161	11,144	1,929	46,187	21,762	1,582,783
Grand total	709,840	798,697	11,144	1,929	46,187	21,762	1,589,559
1982 TOTALS							
Total primary	1,381	7,552	--	--	--	--	8,933
Total secondary	583,941	568,850	13,004	885	37,995	6,728	1,211,403
Grand total	585,322	576,402	13,004	885	37,995	6,728	1,220,336

CONSUMPTION AND USES

Reported sales of PGM in 1982 decreased from the 1981 level, primarily as a result of decreased sales to the electrical and petroleum industries. Sales of PGM to both the automotive and chemical industries changed little in 1982. The automotive industry remained the largest purchaser of PGM, accounting for 34% of sales in 1982.

The principal domestic uses of PGM in 1982 were in catalysts to control automobile exhaust emissions, in reforming catalysts to upgrade the octane rating of gasolines, in catalysts to produce acids and organic chemicals, in electrical contacts and relays, in bushings for glass fiber manufacture, and in dental alloys for orthodontic and prosthodontic uses.

Uses of platinum and palladium in 1982 are shown in figure 1. Catalysts are used in the automotive, chemical, and petroleum refining industries. Corrosion resistance is of importance to the dental and medical and the glass industries.

Table 3.—Platinum-group metals[1] sold to consuming industries in the United States

(Troy ounces)

Year and industry	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
1978	1,196,341	917,928	16,839	817	69,640	57,993	2,259,558
1979	1,408,925	1,132,621	17,301	974	83,470	112,730	2,756,021
1980	1,118,231	911,967	23,584	819	73,528	77,781	2,205,910
1981:							
Automotive	446,677	129,214	83	--	30,009	1,300	607,283
Chemical	78,134	90,272	999	413	8,899	51,843	230,560
Dental and medical	18,739	255,114	173	250	35	233	274,544
Electrical	111,697	345,365	3,551	--	12,050	27,323	499,986
Glass	29,272	2,922	--	--	3,950	--	36,144
Jewelry and decorative	27,604	14,772	558	--	3,618	700	47,252
Petroleum	88,314	20,877	1,874	--	--	170	111,235
Miscellaneous	72,202	30,650	1,178	--	3,549	6,089	113,668
Total	872,639	889,186	8,416	663	62,110	87,658	1,920,672
1982:							
Automotive	477,774	118,445	23	--	26,323	--	622,565
Chemical	63,601	128,778	981	332	6,873	63,600	264,165
Dental and medical	22,806	310,754	103	1,026	7	226	334,922
Electrical	89,994	312,372	5,450	--	9,392	21,178	438,386
Glass	20,595	213	2	--	2,005	--	22,815
Jewelry and decorative	15,995	7,866	1,059	--	3,372	361	28,653
Petroleum	21,576	20,845	892	--	4	--	43,317
Miscellaneous	67,805	27,031	2,090	--	1,939	1,229	100,094
Total	780,146	926,304	10,600	1,358	49,915	86,594	1,854,917

[1]Comprises primary and nontoll-refined secondary metals.

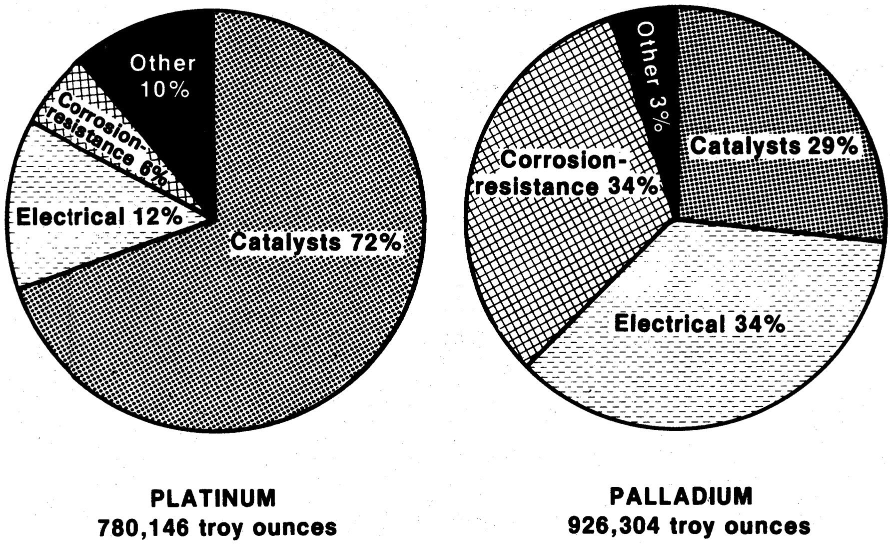

Figure 1.—Uses of platinum and palladium in 1982.

STOCKS

Stocks of platinum increased and stocks of palladium decreased as a result of changes in inventories held by the New York Mercantile Exchange (NYMEX). At least part of the increase in NYMEX platinum stocks was ascribed to the commencement of trading in NYMEX futures contracts by Rustenburg Platinum Holdings Ltd., the Republic of South Africa's largest PGM producer.[4]

Stock data in table 4 are incomplete because the Bureau of Mines does not collect inventory data from end users of PGM, some of whom may hold sizable inventories. In addition to the stocks shown in table 4 were the Government inventories of platinum, palladium, and iridium in the National Defense Stockpile, listed earlier.

Table 4.—Refiner, importer, and dealer stocks of platinum-group metals in the United States, December 31[1]

Year	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
1978	369,823	369,937	16,264	708	51,322	53,357	861,411
1979	305,605	323,865	18,303	1,487	49,678	62,344	761,282
1980	502,185	353,002	15,032	200	46,105	56,737	973,261
1981	r401,389	r398,933	16,819	37	43,355	57,645	r918,178
1982	604,632	384,184	13,348	138	40,562	63,764	1,106,628

rRevised.

[1]Includes metal in depositories of the New York Mercantile Exchange; on Jan. 7, 1983, this comprised 395,800 ounces of platinum and 64,650 ounces of palladium.

PRICES

In general, PGM prices continued to decline in 1982 from 1980 levels, although they did not all follow the same downward path, as may be seen in table 5. In January 1983, Rustenburg began selling more than 60% of its production at market economy prices, retaining its published price list for some long-term customers.[5] The change was expected to increase Rustenburg's market competitiveness.

Table 5.—Monthly average producer and dealer prices[1] of platinum-group metals

(Dollars per troy ounce)

	Platinum		Palladium		Rhodium		Iridium		Ruthenium		Osmium	
	Producer	Dealer	Producer	Dealer	Producer	Dealer	Producer	Dealer	Producer	Dealer	Producer	Dealer
1980: Average	439	677	214	201	766	729	505	666	45	35	150	130
1981:												
January	475	522	200	128	700	609	600	689	45	33	150	130
February	475	480	170	112	700	581	600	670	45	33	150	130
March	475	496	140	119	700	567	600	643	45	33	150	130
April	475	478	140	107	700	547	600	589	45	33	150	130
May	475	462	134	103	687	527	600	530	45	33	150	130
June	475	440	110	92	600	497	600	508	45	32	150	130
July	475	408	110	85	600	472	600	483	45	32	150	130
August	475	423	110	86	600	467	600	463	45	32	150	130
September	475	434	110	87	600	462	600	450	45	32	150	130
October	475	419	110	78	600	436	600	453	45	32	150	130
November	475	393	110	69	600	419	600	444	45	31	150	130
December	475	397	110	70	600	392	600	421	45	31	150	130
Average	475	446	130	95	641	498	600	529	45	32	150	130
1982:												
January	475	368	110	67	600	385	600	400	45	29	150	130
February	475	361	110	67	600	381	600	400	45	29	150	130
March	475	318	110	67	600	357	600	400	45	27	150	130
April	475	337	110	69	600	346	600	395	45	25	150	130
May	475	307	110	68	600	340	600	383	45	25	150	130
June	475	272	110	57	600	329	600	356	45	25	150	130
July	475	285	110	57	600	317	600	349	45	24	150	130
August	475	309	110	59	600	301	600	337	45	24	150	130
September	475	325	110	64	600	291	600	325	45	25	110	130
October	475	342	110	63	600	286	600	320	45	25	110	130
November	475	341	110	74	600	275	600	320	45	25	110	130
December	475	359	110	90	600	272	600	320	45	25	110	130
Average	475	327	110	67	600	323	600	359	45	26	137	130

[1]Average prices calculated at the low end of the ranges of weekly averages rounded to the nearest dollar.

Source: Metals Week.

FOREIGN TRADE

Exports remained about the same, whereas imports decreased in 1982. The principal recipients of exports were the United Kingdom and Japan, and the principal import sources were from the Republic of South Africa, the U.S.S.R., and the United Kingdom.

Table 6.—U.S. exports of platinum-group metals, by year and country

Year and country	Ores and concentrates (troy ounces)	Waste, scrap, and sweepings (troy ounces)	Metal not rolled (troy ounces)			Metal rolled (troy ounces)		Total	
			Platinum	Palladium	Other platinum group	Platinum	Other platinum group	Troy ounces	Value (thousands)
1981:									
Argentina	157	52	474	321	121	--	279	1,404	$263
Australia	--	--	47	--	816	--	50	913	382
Belgium-Luxembourg	--	38,891	--	1,096	3,764	854	848	45,453	13,447
Brazil	217	--	352	--	890	99	93	1,651	326
Canada	190	48,197	5,441	12,066	19,989	484	1,261	87,628	32,327
China	3,215	--	--	--	--	--	--	3,215	107
Finland	--	--	--	--	3,343	--	--	3,343	1,226
France	--	175	730	2,606	1,971	21	410	5,913	1,925
Germany, Federal Republic of	1,100	5,259	30,344	22,437	4,886	243	2,951	67,220	22,031
Greece	--	--	12	3,471	640	--	43	4,166	319
Hong Kong	--	--	2	1,589	372	2,399	1	4,363	1,388
India	222	--	662	32	15	--	--	931	477
Italy	--	--	1,500	559	1,929	164	187	4,339	1,493
Japan	1,655	1,300	178,179	73,299	19,837	56,123	9,589	339,982	130,074
Korea, Republic of	--	--	326	1,471	11	--	2	1,810	214
Mexico	588	--	67	161	1,165	273	168	2,422	769
Netherlands	--	--	628	1,388	257	202	1,819	4,294	916
Norway	--	--	--	6	5,312	--	166	5,484	2,459
South Africa, Republic of	--	--	96	--	2,355	387	4	2,842	1,052
Sweden	--	308	151	--	2,473	1,940	138	5,010	1,641
Switzerland	--	--	96,967	2,819	7,998	380	40	108,204	48,618
United Kingdom	677	109,889	6,089	22,468	1,526	60	8,799	149,508	36,514
Other	225	109	5,261	4,005	2,178	237	1,255	13,270	3,922
Total	8,246	204,180	327,328	149,794	81,848	63,866	28,103	863,365	301,890
1982:									
Argentina	--	8	368	--	394	--	--	770	232
Australia	--	--	--	193	4,286	--	80	4,559	1,676
Belgium-Luxembourg	--	56,119	728	3,737	545	--	2,600	63,729	15,307
Brazil	35	--	131	24	3	--	98	291	68

Canada	148	12,185	6,345	13,069	16,517	1,673	174	50,111	14,428
China	12	1,607	--	--	6,590	116	--	8,325	330
Finland	--	--	--	--	1,963	--	20	1,983	574
France	--	429	80	801	741	145	671	2,867	571
Germany, Federal Republic of	27,900	4,805	8,867	37,179	7,691	587	339	87,368	13,159
Greece	--	--	--	1,324	1,565	--	--	2,889	277
Hong Kong	440	--	17	648	1,611	2,603	878	6,197	958
India	--	--	500	--	39	2	3	544	213
Italy	--	64,999	460	15,361	1,999	--	59	82,878	16,519
Japan	4,944	2,151	97,932	53,736	8,045	40,303	1,215	208,326	55,577
Korea, Republic of	--	--	83	875	25	--	--	983	151
Mexico	435	6	42	203	824	2,036	317	3,863	272
Netherlands	--	3,022	170	6,801	893	--	515	11,401	1,684
Norway	--	--	--	--	5,688	--	66	5,754	1,740
Singapore	--	8	45	--	167	92	--	312	75
South Africa, Republic of	--	--	252	4,202	3,810	--	--	8,264	1,694
Spain	233	49	110	361	110	--	25	888	232
Sweden	--	209	--	77	4,425	2	5	4,718	1,532
Switzerland	24	9	5,244	246	5,840	--	156	11,519	3,141
United Kingdom	968	242,826	3,994	25,717	1,283	2,354	3,009	280,151	51,450
Venezuela	--	--	--	153	12	75	--	240	29
Other	--	5	213	2,690	9,766	236	305	13,215	942
Total	35,139	388,437	125,581	167,397	84,832	50,224	10,535	862,145	[1]182,833

[1]Data do not add to total shown because of independent rounding.

Table 7.—U.S. imports for consumption of platinum-group metals, by year and country

Year and country	Unwrought (troy ounces)										
	Platinum grains and nuggets	Platinum sponge	Palladium	Iridium	Osmium	Osmiridium	Rhodium	Ruthenium	Unspecified combinations	Platinum-group metals from precious metal ores	Sweepings, waste, and scrap
1981	1,891	888,995	1,114,313	11,110	850	9,309	73,738	180,438	32,736	1,442	235,379
1982:											
Australia	--	35	--	--	--	--	--	--	--	--	4,731
Belgium-Luxembourg	--	27,205	51,377	--	--	--	112	--	--	--	26,307
Canada	378	542	7,725	--	--	--	3,215	--	116	--	81,171
Colombia	--	--	--	--	--	--	--	--	--	--	537
Costa Rica	--	--	--	--	--	--	642	--	--	--	2,048
Finland	--	--	--	--	--	--	--	--	--	--	2,969
Germany, Federal Republic of	--	9,039	10,480	2,399	--	--	1,535	3,213	--	--	--
Italy	--	16,199	9,672	--	--	--	--	--	--	--	1,848
Japan	--	3,545	--	--	--	--	--	--	1	--	--
Mexico	--	--	--	--	--	--	--	--	--	--	162,311
Netherlands	--	2,500	19,362	24	--	--	2,919	--	--	--	1,137
Norway	--	10,643	11,693	175	--	--	250	--	--	--	4,113
Peru	--	--	887	--	--	--	--	--	--	--	--
South Africa, Republic of	--	534,742	455,027	13,216	1,000	--	41,699	92,993	7,525	1,073	17,714
Spain	--	790	1,075	--	--	--	--	--	--	--	--
Sweden	--	--	--	--	--	--	--	--	--	--	5,134
Switzerland	--	6,500	14,504	350	--	1,896	200	600	2	--	--
U.S.S.R.	--	10,535	351,615	--	--	--	6,453	1,000	4,456	--	--
United Kingdom	2,920	64,994	103,789	2,650	600	3,680	11,566	35,992	32	--	19,981
Other	--	2,378	2,004	588	--	--	377	--	2,748	300	9,094
Total	3,298	689,647	1,039,210	19,402	1,600	5,576	68,968	133,798	14,880	1,373	339,095

	Semimanufactured (troy ounces)					Platinum-group metals in materials not elsewhere specified (troy ounces)	Total	
	Platinum	Palladium	Iridium	Rhodium	Unspecified combinations		Troy ounces	Value (thousands)
1981	179,321	116,548	248	1,733	3	1,563	2,849,617	$800,256
1982:								
Australia	--	--	--	--	--	--	4,766	1,567
Belgium-Luxembourg	--	2,016	--	--	--	--	107,017	23,121
Canada	2,137	--	--	--	42	--	95,326	18,774
Colombia	--	--	--	--	--	--	537	228
Costa Rica	--	--	--	--	--	--	2,690	1,192
Finland	3,019	--	--	--	--	--	5,988	2,182
Germany, Federal Republic of	--	4,001	--	196	--	--	30,863	6,595
Italy	--	--	--	--	--	--	27,719	6,855
Japan	--	--	--	--	--	--	3,546	1,383
Mexico	--	--	--	--	--	--	162,311	5,645
Netherlands	--	1,394	--	--	--	--	27,336	3,916
Norway	--	--	--	--	--	--	26,874	6,033
Peru	--	--	--	--	--	--	887	315
South Africa, Republic of	28,424	1,001	150	--	--	--	1,194,564	355,356
Spain	--	--	--	--	--	--	1,865	142
Sweden	--	--	--	--	--	--	5,134	1,745
Switzerland	10,290	607	--	--	--	--	34,949	8,442
U.S.S.R.	3,439	25,979	757	809	--	--	405,043	37,733
United Kingdom	66,638	25,720	--	--	--	--	338,562	68,752
Other	81	42	--	--	117	--	17,729	3,961
Total	114,028	60,760	907	1,005	159	--	2,493,706	[1]553,935

[1]Data do not add to total shown because of independent rounding.

Table 8.—Imports of platinum-group metals, by year and country

(Percent of total imports)

Year and country	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total imports
1981:							
South Africa, Republic of	75	42	61	2	67	53	57
U.S.S.R.	2	24	--	--	7	--	13
United Kingdom	10	10	8	98	13	9	10
Other	13	24	31	--	13	38	20
1982:							
South Africa, Republic of	62	35	52	63	56	68	48
U.S.S.R.	2	29	3	--	9	1	16
United Kingdom	16	10	10	37	15	26	13
Other	20	26	35	--	20	5	23

WORLD REVIEW

World production of PGM decreased in 1982, owing to production declines in the Republic of South Africa and Canada. The U.S.S.R. and the Republic of South Africa remained the leading producers.

Lower economic activity in the United States and abroad resulted in less demand for PGM. Demand declined more in the United States than in other countries. In Japan, total demand for platinum, palladium, and rhodium decreased only 1%, to 2.3 million ounces. Figures for other countries are not well documented, but according to one estimate, total demand for platinum and palladium in Western Europe, principally in the Federal Republic of Germany, the United Kingdom, and France, was about 700,000 ounces, each metal accounting for roughly one-half of the total.[6]

Canada.—PGM were produced as byproducts of nickel-copper mining by Inco Ltd. and Falconbridge Nickel Mines Ltd., whose plants were closed during the latter half of 1982, owing to a labor strike at Inco and weak demand for nickel and copper. PGM production was about 120,000 ounces each of platinum and palladium.

Japan.—Japan imported 1.1 million ounces of platinum and 1.0 million ounces of palladium in 1982, primarily from the Republic of South Africa and the U.S.S.R. Estimated consumption of platinum and palladium, in thousand troy ounces, follows:[7]

	Platinum	Palladium
Jewelry	610	61
Automotive	140	90
Chemical	110	320
Electrical	110	420
Dental	--	190
Miscellaneous	103	61
Total[1]	1,074	1,145

[1]Data may not add to totals shown because of independent rounding.

South Africa, Republic of.—The Republic of South Africa continued to be the world's largest producer of platinum and ruthenium. In 1982, about 1,600,000 ounces of platinum and about 700,000 ounces of palladium were produced, which represented about 65% of capacity. Virtually all of the PGM was mined by three companies from the Merensky Reef of the Bushveld Complex in Transvaal. In addition, osmiridium, a naturally occurring alloy of osmium and iridium, was recovered as a byproduct of gold mining.

In June 1982, Impala Platinum Ltd. reduced its annual platinum production rate more than one-fourth, to about 680,000 ounces.[8] Similarly, Rustenburg reduced its annual platinum production rate to about 800,000 ounces, owing to a world decline in industrial consumption of PGM.[9]

U.S.S.R.—The U.S.S.R. produced an estimated 900,000 ounces of platinum and 2,300,000 ounces of palladium in 1982. Production was derived as a byproduct of nickel-copper production, primarily from the Noril'sk-Talnakh area in northwestern Siberia and the Kola Peninsula, near Finland.

Table 9.—Platinum-group metals: World production, by country[1]

(Troy ounces)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Australia, metal recovered domestically from nickel ore:[3]					
Palladium, metal content, from nickel ore	7,395	6,880	10,545	12,892	12,000
Platinum, metal content, from nickel ore	12,958	2,765	2,058	2,090	1,900
Ruthenium[e]	300	200	150	140	130
Canada: Platinum-group metals from nickel ore	346,213	197,943	410,757	382,658	269,800
Colombia: Placer platinum	13,939	12,933	14,345	14,801	12,000
Ethiopia: Placer platinum	123	108	113	[e]125	125
Finland:					
Palladium	NA	932	675	1,993	2,000
Platinum	640	[r]711	225	1,608	1,600
Japan, metal recovered from nickel and copper ores:[4]					
Palladium	24,221	22,495	28,968	25,748	[5]27,862
Platinum	10,176	12,142	12,366	10,521	[5]15,411
South Africa, Republic of: Platinum-group metals from platinum ores[e] [6]	2,860,000	3,017,000	3,100,000	3,110,000	2,600,000
U.S.S.R.: Placer platinum and platinum-group metals recovered from nickel-copper ores[e]	3,150,000	3,200,000	3,250,000	3,350,000	3,500,000
United States: Placer platinum and platinum-group metals from gold and copper ores	8,246	7,300	3,348	7,318	[5]8,033
Yugoslavia:					
Palladium	5,562	5,241	4,501	3,119	3,000
Platinum	417	675	418	482	480
Total	6,440,190	[r]6,487,325	6,838,469	6,923,495	6,454,341

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.

[1]Table includes data available through May 11, 1983. Platinum-group metal production by the Federal Republic of Germany, Norway, and the United Kingdom is not included in this table because the production is derived wholly from imported metallurgical products and to include it would result in double counting.

[2]In addition to the countries listed, China, Indonesia, Papua New Guinea, and the Philippines are believed to produce platinum-group metals, and several other countries may also do so, but output is not reported quantitatively, and there is no reliable basis for the formulation of estimates of output levels. However, a part of this output not specifically reported by country is presumably included in this table credited to Japan. (See footnote 4.)

[3]Partial figure; excludes platinum-group metals recovered in other countries from nickel ore of Australian origin; however, a part of this output may be credited to Japan. (See footnote 4.)

[4]Japanese figures do not refer to Japanese mine production, but rather represent Japanese smelter-refinery recovery from ores originating in a number of countries; this output cannot be credited to the country of origin because of a lack of data. Countries producing and exporting such ores to Japan include (but are not necessarily limited to) Australia, Canada, Indonesia, Papua New Guinea, and the Philippines. Output from ores of Australian, Indonesian, Papua New Guinea, and Philippine origin are not duplicative, but output from Canadian material might duplicate a part of reported Canadian production.

[5]Reported figure.

[6]Includes osmiridium produced in gold mines.

TECHNOLOGY

The Bureau of Mines studied platinum resources in market economy countries.[10] The study concluded that about 110 million ounces of platinum are available at a price of $420 per ounce, nearly all from the Republic of South Africa. Also in the report was an estimate of typical present operating costs for an underground mine in the Republic of South Africa, given as $228 per ounce of refined platinum. Operating costs for placer deposits in Colombia and the United States were about $500 per ounce of refined platinum.

The Bureau of Mines also studied the recovery of PGM from sample concentrates of Stillwater Complex ores.[11] Three methods were researched: two-stage matte leaching, sequential matte leaching, and roasting-leaching. The first step for all methods was matte smelting with lime, fluorspar, and silica flux. All methods resulted in a final residue, containing between 5,500 ounces and 8,500 ounces of PGM per ton, suitable as refinery feed.

Johnson Matthey reported the development of a catalytic filter containing PGM that successfully limited particulate emissions from a diesel engine over a 50,000-mile test run.[12] Emissions were reported to be within the 0.2-gram-per-mile limit set by EPA for 1987 model cars. The new catalytic filter had the ability to store particulates during periods when temperatures were below the 350° C oxidation threshold, and to burn off particulates when the threshold temperature was exceeded. To best use the heat generated by the engine, the catalytic filter was placed as close as possible to the engine and insulated to conserve exhaust heat. In addition to reducing particulate emissions, the catalytic filter also significantly reduced hydrocarbon and carbon monoxide emissions, and objectionable odors.

At the 1982 Society of Automotive Engineers International Congress, four papers were presented on the recycling of automotive catalysts.[13] Papers compared the demand for precious metals and their availability from scrapped vehicles, and current commercial processes and experimental processes for the recovery of precious metals from automotive catalysts.

The Inco Research and Development Center, under contract to the Bureau of Mines, studied the reclamation of several important metals, such as nickel, cobalt, molybdenum, and precious metals, from waste catalysts.[14] For the study, 27 spent automotive catalytic converters were examined to determine precious metals content, substrate type, and construction variety. The report noted that very little PGM are currently being recycled from automotive catalytic converters, partly because of the economic uncertainty caused by volatile PGM prices. Conversely, recovery of catalysts consumed by the chemical and petroleum industries is about 85%. The report recommended that standard procedures for sampling automotive catalysts be adopted, and that automotive dismantlers be given an economic incentive to recycle catalytic converters.

Researchers at Louisiana State University (Baton Rouge) and Michigan State University investigated the possible use of palladium-based drugs, called "cis-palladium," to combat certain types of cancers.[15] They are similar to "cisplatin," platinum-based drugs, used since 1978 in the treatment of cancerous tumors. Cis-palladium is considered to be more effective against cancer and may produce fewer undesirable side effects than cisplatin.

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Potash

By James P. Searls[1]

U.S. potash production (K_2O equivalent) declined 17% and apparent consumption declined 18% in 1982. Production remained essentially the same during both halves of the year owing to temporary closings near the end of the first half and reduced operations in the second half. Sales declined 6%, while yearend stocks were unchanged from those at the beginning of 1982. The United States continued to be a net importer of potash with Canada providing 91% of the imported K_2O.

The world potash supply level appeared to be greater than demand level, as indicated by low international prices. Brazilian consumption of U.S. potash remained depressed, whereas Denmark, India, and Japan increased their consumption of U.S. potash. The decline in potash supply was influenced by the worldwide economic recession; however, some potash producers were slow to reduce production.

In the United States, the average annual price for standard, coarse, and granular muriate of potash (KCl), f.o.b. mine, decreased from $137 per metric ton of K_2O equivalent in 1981 to $109 per ton in 1982. The average annual price of sulfate of potash (K_2SO_4) rose slightly from $349 per ton, f.o.b. mine, in 1981 to $352 per ton in 1982.

On February 3, 1982, the National Potash Co. permanently closed its operations. This facility represented about 9% of U.S. potash production capacity in 1981. Kerr-McGee Chemical Corp. discontinued production of muriate of potash "for sale" in March, then restarted production at a reduced level in May. This event further decreased U.S.

Table 1.—Salient potash statistics[1]

(Thousand metric tons and thousand dollars unless otherwise specified)

	1978	1979	1980	1981	1982
United States:					
Production	4,326	4,271	4,315	4,153	3,366
K_2O equivalent	2,253	2,225	2,239	2,156	1,784
Sales by producers	4,358	4,549	4,265	3,670	3,387
K_2O equivalent	2,307	2,388	2,217	1,908	1,784
Value[2]	$226,500	$279,200	$353,900	$328,900	$265,600
Average value per ton of product dollars	$51.97	$61.38	$82.98	$89.62	$78.42
Average value per ton of K_2O equivalent do	$98.16	$116.92	$159.63	$172.40	$148.87
Exports[3]	1,431	1,119	1,584	887	952
K_2O equivalent	809	635	840	491	519
Value[4]	$88,600	$79,500	$179,830	$107,950	$93,200
Imports for consumption[3 5]	7,762	8,505	8,193	7,903	6,338
K_2O equivalent	4,707	5,165	4,972	4,796	3,858
Customs value	$399,000	$520,800	$648,000	$750,400	$575,400
Apparent consumption[6]	10,689	11,935	10,874	10,686	8,773
K_2O equivalent	6,205	6,918	6,349	6,213	5,123
Yearend producers' stocks, K_2O equivalent	414	251	273	520	520
World: Production, marketable K_2O equivalent	[r]26,122	[r]25,668	27,855	[p]27,046	[e]26,230

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Includes muriate and sulfate of potash, potassium magnesium sulfate, and some parent salts. Excludes other chemical compounds containing potassium.
[2]F.o.b. mine.
[3]Excludes potassium chemicals and mixed fertilizers.
[4]F.a.s. U.S. port.
[5]Includes nitrate of potash.
[6]Measured by sales plus imports minus exports.

capacity approximately 4%. By June, all potash companies were operating either intermittently or on reduced schedules.

Domestic Data Coverage.—Domestic production data for potash are developed by the Bureau of Mines by means of a voluntary domestic semiannual survey of U.S. operations. Of the 11 operations to which a survey request was sent for the first half of the year and 10 operations surveyed for the second half of the year, 100% responded, representing 100% of the total production shown in table 1.

DOMESTIC PRODUCTION

Domestic K_2O production declined 17% from the 1981 level. In 1982, 79% of total production was standard, coarse, or granular muriate of potash and 9% was sulfate of potash. The remaining production comprised manure salts, soluble and chemical grades of muriate of potash, and potassium magnesium sulfate. The New Mexico producers accounted for 85% of the total domestic potash production. New Mexico mine production was 15.7 million tons, averaging 13.0% K_2O crude salts. Production in other States was from natural brines and a solution mine.

At the beginning of the year, seven companies produced potash in New Mexico from underground, bedded deposits east of Carlsbad. The companies were AMAX Chemical Corp. of AMAX Inc.; Duval Corp. of Pennzoil Co., Inc.; International Minerals & Chemical Corp. (IMC); Kerr-McGee Chemical of Kerr-McGee Corp.; Mississippi Chemical Corp.; National Potash, which closed on February 3, of Freeport-McMoRan, Inc.; and Potash Co. of America (PCA) of Ideal Basic Industries, Inc. Sylvinite ore was mined to produce muriate of potash. Langbeinite ore was mined to produce potassium magnesium sulfate. One company reacted muriate of potash and potassium magnesium sulfate to produce sulfate of potash.

Sulfate of potash was also produced at three Texas plants operated by AMAX Chemical, Stauffer Chemical Co., and Permian Chemical Corp. The Stauffer plant was closed after AMAX Chemical discontinued its contract with Stauffer. The AMAX Chemical plant produced sulfate of potash from muriate of potash and sulfur dioxide, whereas the Permian plant used KCl and sulfuric acid. Superfos America Inc. of Superfos A/S of Denmark purchased a minority position in Permian.

Three companies produced potash in Utah in 1982. Great Salt Lake Minerals & Chemicals Corp., a subsidiary of Gulf Resources and Chemical Corp., produced sulfate of potash as a coproduct of salt, magnesium chloride, and sodium sulfate from Great Salt Lake brines. Kaiser Chemicals of Kaiser Aluminum & Chemical Corp. produced muriate of potash from natural near-surface brines at the west end of the Bonneville Salt Flats near Wendover. Texasgulf, Inc., produced muriate of potash from underground solution mines near Moab.

In California, Kerr-McGee Chemical produced both muriate and sulfate of potash along with other products from underground brines at Searles Lake. The production of muriate of potash "for sale" was stopped in March, then restarted in May at a reduced level.

Under the provisions of the Webb-Pomerene Act, Duval and IMC formed the Sulphate of Potash Magnesia Export Association to export potassium magnesium sulfate. These firms were the only two producers in the United States. The association was formed to enlarge international markets for the product.

Table 2.—Production, sales, and inventory of U.S. produced potash, by type and grade

(Thousand metric tons and thousand dollars)

Type and grade	Production				Sold or used						Stocks, end of 6-month period			
	Gross weight		K_2O equivalent		Gross weight		K_2O equivalent		Value[1]		Gross weight		K_2O equivalent	
	1981	1982	1981	1982	1981	1982	1981	1982	1981	1982	1981	1982	1981	1982
January-June:														
Muriate of potash, 60% K_2O minimum:														
Standard	709	628	432	383	683	559	415	341	58,200	39,100	193	465	117	282
Coarse	242	180	148	110	231	213	141	130	20,400	16,400	79	85	48	52
Granular	416	365	252	222	398	368	241	223	34,300	25,900	92	125	56	76
Chemical	29	28	18	18	28	27	18	17	W	W	2	1	1	(2)
Potassium sulfate	205	164	105	84	190	172	97	88	33,600	31,800	62	83	32	43
Other potassium salts[3]	492	317	119	79	469	398	115	100	W	W	284	285	65	64
Total[4]	2,094	1,682	1,073	896	1,998	1,737	1,027	899	181,300	143,600	712	1,044	318	517
July-December:														
Muriate of potash, 60% K_2O minimum:														
Standard	809	527	492	322	605	597	368	363	48,800	35,400	397	396	240	241
Coarse	215	215	131	131	176	197	108	120	14,800	12,700	118	103	72	63
Granular	409	411	248	249	372	372	226	226	29,500	23,300	128	164	78	99
Chemical	26	26	17	16	28	22	18	14	W	W	(2)	5	(2)	3
Potassium sulfate	185	159	95	82	156	173	80	88	28,400	30,100	90	70	46	36
Other potassium salts[3]	415	346	100	88	333	289	81	74	W	W	366	339	84	74
Total[4]	2,059	1,684	1,083	888	1,672	1,650	881	885	147,600	122,000	1,099	1,078	520	520
Grand total	4,153	3,366	2,156	1,784	3,670	3,387	1,908	1,784	328,900	265,600	XX	XX	XX	XX

W Withheld to avoid disclosing company proprietary data; included in "Total." XX Not applicable.
[1]F.o.b. mine.
[2]Less than 1/2 unit.
[3]Includes soluble muriate, manure salts, and potassium magnesium sulfate.
[4]Data may not add to totals shown because of independent rounding.

Table 3.—Production and sales of potash in New Mexico

(Thousand metric tons and thousand dollars)

Period	Crude salts[1] (mine production)		Marketable potassium salts				
			Production		Sold or used		
	Gross weight	K_2O equivalent	Gross weight	K_2O equivalent	Gross weight	K_2O equivalent	Value[2]
1981:							
January-June	9,129	1,186	1,786	904	1,732	881	147,600
July-December	9,361	1,234	1,726	894	1,386	720	113,700
Total[3]	18,490	2,420	3,513	1,798	3,118	1,601	[r]261,200
1982:							
January-June	7,732	1,013	1,434	758	1,471	751	110,600
July-December	7,960	1,026	1,464	766	1,401	745	94,000
Total[3]	15,691	2,039	2,898	1,524	2,872	1,497	204,600

[r]Revised.
[1]Sylvinite and langbeinite.
[2]F.o.b. mine.
[3]Data may not add to totals shown because of independent rounding.

Table 4.—Salient sulfate of potash statistics[1] in the United States

(Thousand metric tons of K_2O equivalent and thousand dollars)

	1978	1979	1980	1981	1982
Production	205	205	203	200	166
Sales by producers	222	204	201	178	176
Value[2]	$45,300	$46,230	$60,080	$61,993	$61,934
Exports[3]	83	81	70	40	71
Value[4]	NA	NA	$23,113	$16,095	$27,648
Imports[5]	29	10	22	18	6
Value[6]	$6,230	$2,710	$7,111	$7,380	$2,409
Apparent consumption[7]	169	133	153	156	111
Yearend producers' stocks	21	22	24	46	36

NA Not available.
[1]Excluding potassium magnesium sulfate.
[2]F.o.b. mine.
[3]Export data supplied by Potash & Phosphate Institute (1978-79) and the U.S. Bureau of the Census (1980-82).
[4]F.a.s. U.S. port.
[5]U.S. Bureau of the Census.
[6]C.i.f. to U.S. port.
[7]Sales plus imports minus exports, independent rounding.

CONSUMPTION AND USES

Apparent domestic consumption of all forms of potash declined nearly 18% from the 1981 level primarily because of weak demand for fertilizers. Surplus grain from the large 1981 harvest reduced farm product prices and thereby profits to levels that caused farmers to decrease their 1982 purchases of fertilizers. Furthermore, the U.S. grain export markets suffered from the strength of the U.S. dollar in international trade, the world recession, and the failure of the U.S.S.R. to purchase more than its minimum contractual requirement for grains. Despite slightly reduced crop planting, the 1982 harvest was sufficient to prevent crop prices and profits from rising in the fall. This circumstance led to fewer potash purchases for the fall plowdown.

According to the Potash & Phosphate Institute, which reports only the sales of U.S. and Canadian producers, the consumption of muriate of potash for agricultural uses declined as follows: Standard grade fell 36% to 563,000 tons; coarse grade fell 15% to 1.7 million tons; granular grade fell 20% to 1.2 million tons; and sulfate of potash and sulfate of potash magnesia (sulfates) fell 14% to 188,000 tons.

The Potash & Phosphate Institute reported that potash sales by U.S. and Canadian producers to the U.S. agricultural industry were, by K_2O content, 43% coarse muriate, 30% granular muriate, 14% standard muriate, 9% soluble muriate, and 4% sulfates.

Except for a gain of 3 percentage points in sales of coarse muriate at the expense of standard muriate, these 1982 percentages were unchanged from those of 1981. Potash sales from U.S. mines represented 12% of the coarse muriate, 26% of the granular muriate, 58% of the standard muriate, 4% of the soluble muriate, and 100% of the sulfates.

In addition, the Potash & Phosphate Institute reported that 319,000 tons of potash was sold for nonagricultural (chemical) uses. Standard muriate was 66% of the total, soluble muriate was 33%, and sulfates were 1%. Nonagricultural use of potash was primarily for producing caustic potash and chlorine. Caustic potash (potassium hydroxide) was used as a caustic chemical and as the major precursor to other potassium chemicals. Compared with caustic soda, caustic potash has slightly different properties, but was competitive in price and availability. In 1982, caustic potash supplies were insufficient because of excess byproduct chlorine on the market. Some muriate of potash was also used by the petroleum well-drilling industry in drilling muds for shale stabilization and in well stimulation by massive fracturing, in which the potassium ion inhibits clay particle expansion.

According to the Potash & Phosphate Institute, the major consumers of agricultural potash (in decreasing order of deliveries) were Illinois, Iowa, Ohio, Minnesota, Indiana, and Wisconsin. These six States consumed 53% of the agricultural potash supplied by U.S. and Canadian producers. The major agricultural consumers of domestically produced potash (in decreasing order of deliveries), Texas, Mississippi, Missouri, Florida, Kentucky, and California, were slightly different than the 1981 list and consumed 57% of the agricultural potash total. The major agricultural consumers of domestically produced sulfates of potash (in decreasing order of deliveries), Florida, Kentucky, California, Georgia, Texas, and North Carolina, consumed 63% of the total.

Table 5.—Sales of North American potash, by State of destination

(Metric tons of K_2O equivalent)

State	Agricultural potash		Nonagricultural potash	
	1981	1982	1981	1982
Alabama	109,345	72,747	52,287	52,973
Alaska	--	544	--	--
Arizona	4,092	1,355	344	55
Arkansas	54,281	39,385	1,381	561
California	55,943	54,415	12,738	10,399
Colorado	30,633	23,082	258	61
Connecticut	4,634	3,322	--	67
Delaware	22,277	20,739	26,988	22,072
Florida	137,473	113,709	1,060	557
Georgia	171,482	116,806	1,559	1,054
Hawaii	14,939	14,663	--	--
Idaho	15,716	15,100	151	656
Illinois	698,789	525,883	29,085	25,267
Indiana	364,045	286,381	4,835	4,050
Iowa	513,411	388,403	1,100	1,835
Kansas	36,091	41,334	4,187	2,688
Kentucky	138,063	136,344	13,990	2,700
Louisiana	55,725	39,186	4,358	3,197
Maine	8,324	4,751	45	94
Maryland	25,113	27,754	1,121	698
Massachusetts	2,325	4,094	583	491
Michigan	158,646	174,684	2,665	2,769
Minnesota	404,039	327,854	171	39
Mississippi	217,987	158,810	9,984	2,561
Missouri	238,920	184,218	5,831	3,947
Montana	10,293	10,675	40	106
Nebraska	53,275	35,316	1,624	1,551
Nevada	54	16	625	220
New Hampshire	455	459	--	74
New Jersey	7,951	6,631	904	668
New Mexico	3,378	4,053	33,957	42,312
New York	86,625	63,463	41,014	47,776
North Carolina	115,707	80,676	1,739	45
North Dakota	21,788	20,345	93	63
Ohio	470,391	363,318	46,495	31,823
Oklahoma	24,345	16,240	14,396	8,836
Oregon	20,801	18,909	1,399	945
Pennsylvania	44,401	42,525	3,674	3,373
Rhode Island	1,643	2,097	132	89
South Carolina	74,387	47,546	450	173
South Dakota	12,531	10,870	--	23

Table 5.—Sales of North American potash, by State of destination —Continued

(Metric tons of K_2O equivalent)

State	Agricultural potash 1981	Agricultural potash 1982	Nonagricultural potash 1981	Nonagricultural potash 1982
Tennessee	133,854	93,014	337	147
Texas	131,356	149,932	53,060	33,580
Utah	913	2,283	2,109	2,219
Vermont	4,462	4,483	--	--
Virginia	52,585	41,221	1,404	833
Washington	35,152	33,081	2,602	2,608
West Virginia	5,217	4,123	28	728
Wisconsin	347,121	265,909	454	434
Wyoming	3,049	1,881	1,469	1,440
Total	5,144,027	4,094,629	382,726	318,857

Source: Potash & Phosphate Institute.

Table 6.—Sales of North American muriate of potash to U.S. customers, by grade

(Thousand metric tons of K_2O equivalent)

Grade	1979	1980	1981	1982
Agricultural:				
Standard	1,067	948	873	563
Coarse	2,459	2,228	2,070	1,750
Granular	1,952	1,687	1,549	1,237
Soluble	522	447	435	357
Total	6,000	5,310	4,927	3,907
Nonagricultural:				
Soluble	118	108	118	106
Other	237	242	260	210
Total	355	350	378	316
Grand total	6,355	5,660	5,305	4,223

Source: Potash & Phosphate Institute.

STOCKS

Yearend 1982 producers' stocks of potash were the same as those of yearend 1981. Because of reduced production in 1982, yearend stocks rose to 29% of production in K_2O content. This was equivalent to 3.5 months of production, based on the calculated monthly average of total 1982 production.

TRANSPORTATION

Domestic rail tariffs were essentially unchanged while ocean rates declined during the year. Potash Corp. of Saskatchewan's (PCS) efforts in 1981 to reduce rail shipping costs by unit train shipping led to the establishment of large company-controlled field warehouses in the U.S. corn belt. This had a side effect of greater local availability for this importer. In 1982, domestic producers commenced parallel operations to meet the competition on terms of both price and availability. PCS opened its fifth warehouse at Fort Dodge, Iowa, in April. AMAX Chemical opened a competing system of six warehouses in Illinois and Missouri. Warehouses were built in Burns Harbor, Ind., and near Toledo, Ohio, to receive freighter shipments on the Great Lakes from Thunder Bay, Ontario, Canada, to points northeast, east, and southeast by rail or truck. More than 0.9 million tons of product passed through Thunder Bay in 1982.

The Mississippi River has also become a focal point for competitive transportation rates since Canadian railroads established a favorable rail tariff to Minneapolis where potash can be loaded onto barges and shipped southward on the river. Potash from Carlsbad, N. Mex., was shipped northward on the Mississippi River on barges loaded in Houston, Tex. One domestic potash producer shipped up the river on barges loaded from railcars near St. Louis, Mo. Approximately 80,000 tons of muriate of potash from the German Democratic Republic and the U.S.S.R. entered Mississippi River traffic in 1982.

The port at Vancouver, British Columbia, Canada, was closed from October 19 to November 4 because of a labor contract dispute.

PRICES

The average 1982 value, f.o.b. mine, of U.S. potash production of all types and grades was $148.87 per ton. The average value, f.o.b. mine, during the first half of the year was $160 per ton and the average value for the second half was $138 per ton. Standard-grade muriate of potash averaged $106 per ton, coarse-grade averaged $116 per ton, and granular averaged $110 per ton for the year. The average value of all three grades of muriate of potash was $109 per ton for the year; $117 per ton in the first half and $101 per ton in the second half. The average value of sulfate of potash for 1982 was $352 per ton.

Table 7.—Prices[1] of U.S. potash, by type and grade

(Dollars per metric ton of K_2O equivalent)

Type and grade	1980		1981		1982	
	January-June	July-December	January-June	July-December	January-June	July-December
Muriate, 60% K_2O minimum:						
Standard	120.30	133.82	140.18	132.45	114.76	97.59
Coarse	134.28	144.69	144.92	137.28	125.76	105.25
Granular	132.48	145.10	142.42	130.94	115.81	103.30
All muriate[2]	126.88	139.27	141.70	132.71	117.16	100.71
Sulfate, 50% K_2O minimum	285.75	313.06	344.84	354.55	362.85	341.91

[1]Average prices, f.o.b. mine, based on sales.
[2]Excluding soluble and chemical muriates.

FOREIGN TRADE

U.S. potash exports in 1982 rose 6% over those of 1981, owing to aggressive marketing and pricing. The average price received per ton of potash, K_2O equivalent, decreased more than 18% and the total value of potash exports declined 14%. On a product tonnage basis, potash exports to Latin America continued to decline, but exports to Africa, Asia, and Europe rose. The United States supplied much less of Brazil's potash requirements in both 1981 and 1982 than in prior years, but increased 1982 exports to India and Japan. Strong but unexplained demand for sulfates of potash in world markets resulted in stable prices and a 40% increase in gross tonnage of exports. Competition from the German Democratic Republic and the U.S.S.R. forced down the price and volume of muriate of potash exports. The strong U.S. dollar continued to cause problems in the export trade.

A 20% decline in total U.S. imports of potash represented declines in imports of all potash products. Imports of muriate of potash from Canada decreased 22% from the 1981 level but remained at 91% of all muriate imports and 91%, by K_2O equivalent, of all potash imports. Israel was the second largest source of imports, with 6% of muriate of potash imports and 6% of total potash imports.

Table 8.—U.S. exports of potash

	Approximate average K_2O content (percent)	1981 Quantity (metric tons) Product	1981 Quantity (metric tons) K_2O equivalent	1981 Value[1] (thousands)	1982 Quantity (metric tons) Product	1982 Quantity (metric tons) K_2O equivalent	1982 Value[1] (thousands)
Potassium chloride, all grades	61	700,420	427,300	$80,680	691,040	421,520	$56,710
Potassium sulfates, all grades[2]	([3])	186,470	63,300	27,270	261,120	97,920	36,490
Total	XX	886,890	490,600	107,950	952,160	519,440	93,200

XX Not applicable.
[1]Export values are f.a.s. U.S. port.
[2]Includes potassium magnesium sulfate.
[3]Varies from year to year according to relative quantities of the two types of sulfates exported.

Source: U.S. Bureau of the Census.

Table 9.—U.S. exports of potash, by country

Country	Metric tons of product: Potassium chloride 1981	Potassium chloride 1982	Potassium sulfates, all grades[1] 1981	Potassium sulfates, all grades[1] 1982	Total 1981	Total 1982	Total value[2] (thousands) 1981	Total value[2] (thousands) 1982
Argentina	720	2,100	5,170	4,310	5,890	6,410	$700	$820
Australia	60,990	--	5,580	5,430	66,570	5,430	8,400	1,150
Bahamas	--	--	--	2,500	--	2,500	--	470
Belgium	--	8,800	--	20	--	8,820	--	740
Brazil	211,210	200,940	16,200	18,410	227,410	219,350	27,330	17,180
Canada	--	2,540	40,880	41,650	40,880	44,190	5,640	4,070
Chile	--	10,490	11,750	3,300	11,750	13,790	2,130	1,470
Colombia	32,340	22,500	--	7,850	32,340	30,350	4,100	2,530
Costa Rica	6,950	13,800	10,180	11,750	17,130	25,550	1,790	2,380
Denmark	16,640	23,700	--	13,000	16,640	36,700	1,730	2,525
Dominican Republic	26,830	18,960	2,100	5,490	28,930	24,450	4,000	2,530
Ecuador	17,350	14,300	1,550	2,230	18,900	16,530	2,090	1,390
Egypt	--	10	--	9,840	--	9,850	--	2,060
French West Indies	4,200	--	3,150	--	7,350	--	950	--
Greece	--	--	--	390	--	390	--	40
Guatemala	8,000	--	--	2,630	8,000	2,630	1,150	330
Haiti	--	640	--	--	--	640	--	70
Honduras	--	--	1,370	2,940	1,370	2,940	390	220
India	44,950	84,970	--	--	44,950	84,970	4,490	6,320
Italy	--	270	--	--	--	270	--	21
Jamaica	4,470	--	--	1,610	4,470	1,610	560	310
Japan	79,690	111,710	22,000	73,220	101,690	184,930	12,820	22,830
Korea, Republic of	--	21,410	60	40	60	21,450	14	1,750
Leeward and Windward Islands	--	6,700	--	--	--	6,700	--	650
Liberia	--	180	--	--	--	180	--	14
Malaysia	--	--	19,100	8,200	19,100	8,200	1,630	660
Mexico	25,610	36,480	21,740	10,090	47,350	46,570	5,820	4,800
New Zealand	98,630	86,960	350	160	98,980	87,120	10,920	7,850
Nicaragua	--	4,450	5,060	--	5,060	4,450	490	350
Panama	5,050	2,800	160	50	5,210	2,850	600	290
Peru	10,500	10	2,900	5,450	13,400	5,460	1,770	860
Philippines	--	90	1,650	830	1,650	920	380	170
Portugal	--	2,670	--	--	--	2,670	--	210
Saudi Arabia	160	280	--	220	160	500	15	50
Sweden	--	--	450	--	450	--	100	--
Taiwan	41,060	80	200	14,520	41,260	14,600	4,310	2,690
Thailand	--	--	5,000	4,800	5,000	4,800	490	410
Turkey	--	--	--	10,000	--	10,000	--	1,930
Uruguay	5,100	2,000	1,500	--	6,600	2,000	790	180
Venezuela	--	11,000	--	30	--	11,030	--	800
Zambia	--	--	7,990	--	7,990	--	2,290	--
Other	--	200	350	157	350	357	40	41
Total[3]	700,420	691,040	186,470	261,120	886,890	952,160	107,950	93,200

[1]Includes potassium magnesium sulfate.
[2]F.a.s. U.S. port.
[3]Data may not add to totals shown because of independent rounding.

Source: U.S. Bureau of the Census.

Table 10.—U.S. imports for consumption of potash

	Approximate average K_2O content (percent)	Quantity (metric tons)		Value (thousands)	
		Product	K_2O equivalent[e]	Customs	C.i.f.
1981					
Potassium chloride	61	7,800,000	4,758,000	$729,540	$811,150
Potassium sulfate	50	36,600	18,300	6,860	7,380
Potassium nitrate	45	32,800	14,760	9,340	10,360
Potassium sodium nitrate mixtures	14	33,900	4,740	4,650	5,180
Total[1]	XX	7,903,300	4,796,000	750,400	834,100
1982					
Potassium chloride	61	6,290,400	3,840,000	564,500	595,050
Potassium sulfate	50	11,800	5,900	2,230	2,410
Potassium nitrate	45	22,800	10,300	6,840	7,630
Potassium sodium nitrate mixtures	14	12,900	1,800	1,790	1,920
Total[1]	XX	6,337,900	3,858,000	575,400	607,000

[e]Estimated. XX Not applicable.
[1]Data may not add to totals shown because of independent rounding.

Source: U.S. Bureau of the Census.

Table 11.—U.S. imports for consumption of potash, by country

Country	Metric tons of product										Total value (thousands)			
	Potassium chloride		Potassium sulfate		Potassium nitrate		Potassium sodium nitrate		Total		Customs		C.i.f.	
	1981	1982	1981	1982	1981	1982	1981	1982	1981	1982	1981	1982	1981	1982
Belgium-Luxembourg	--	--	11,600	7,700	--	--	--	--	11,600	7,700	$2,040	$1,410	$2,290	$1,520
Canada	7,304,600	5,724,000	--	--	--	--	--	--	7,304,600	5,724,000	677,400	514,600	753,770	539,130
Chile	--	--	--	--	--	--	33,900	12,900	33,900	12,900	4,650	1,790	5,180	1,920
German Democratic Republic	62,900	86,100	--	--	--	--	--	--	62,900	86,100	5,200	6,430	6,740	7,900
Germany, Federal Republic of	2,700	3,200	25,100	4,100	--	--	--	--	27,800	7,300	5,100	1,210	5,370	1,380
Israel	407,800	352,800	--	--	32,800	22,800	--	--	440,600	375,600	53,900	40,280	58,500	44,300
Spain	22,000	50,100	--	--	--	--	--	--	22,000	50,100	2,070	4,240	2,260	4,470
U.S.S.R	--	74,200	--	--	--	--	--	--	--	74,200	--	5,400	--	6,350
Total[1]	7,800,000	6,290,400	36,600	11,800	32,800	22,800	33,900	12,900	7,903,300	6,337,900	750,400	575,400	834,100	607,000

[1]Data may not add to totals shown because of independent rounding.

Source: U.S. Bureau of the Census.

WORLD REVIEW

Australia.—Australia has a history of problems with potash production at Lake McLeod. In the early 1970's, Texada Mines Pty. experimented without success with carnallite production from subsurface brines. In 1981, Dampier Salt Pty. Ltd. attempted to produce potassium sulfate as a byproduct of salt, but in 1982, even the salt production was facing losses.

Brazil.—Brazil's efforts to become self-sufficient in fertilizers advanced in 1982. Discovery of a second potash deposit at Fazendinha, southeast of Manaus in the State of Amazonas, was announced, and a 1.5-million-ton-per-year product facility was planned for startup in the early 1990's. Production from this planned new mine and the potash mine in the Sergipe, under development with the help of the French company Mines de Potasse d'Alsace, may enable the Brazilians to supply most of their potash requirements in the 1990's.

Brazil's potash imports, which remained at the reduced 1981 level, were primarily from Kali Bergbau, the German Democratic Republic's potash exporter. Kali Bergbau apparently arranged a clearing account agreement to meet Brazil's need for countertrade due to its lack of foreign cash reserves. Brazil exported coffee and soy flour to the German Democratic Republic.

Canada.—Central Canada Potash of Noranda Mines Ltd. temporarily discontinued operations in September and October, but reapplied to the Provincial Government for permission to expand capacity. PPG Industries Canada Ltd. expanded capacity of its Kalium Chemicals Mine from 1.1 to more than 1.4 million tons of product per year.

PCS, a Government-owned company, was in the midst of withdrawing from its marketing agreement with Canpotex Ltd., the Canadian potash exporter, maintaining production in the face of mounting inventories, and continuing its strong expansion drive. However, after an election and a change in Government policies, PCS decided to remain with Canpotex, and closed down its four plants for 2 months because of the large inventories. The new Government announced its interest in increasing private mineral development. PCS's Rocanville Phase II expansion was completed, adding 540,000 tons of product capacity. A fire in a headframe of the Allan Mine in October led to temporarily lower production levels.

Canpotex, by continuing to handle PCS's exports and adding offshore exports from PCA's Patience Lake plant and the Kalium Chemicals Mine to its list of suppliers, improved its marketing strength. PCA and Kalium have not used Canpotex's services since 1975.

In New Brunswick, Denison-Potacan Potash Co. continued underground exploration to establish the feasibility of its site, and PCA continued its mine development. Exports from PCA's new mine were not expected to be handled by Canpotex. In Manitoba, International Minerals & Chemical Corp. (Canada) Ltd. suspended development plans because of poor market conditions, but professed continued interest in developing the site near McAuley in the southwestern portion of the Province.

Table 12.—Salient Canadian potash statistics

(Thousand metric tons of K_2O equivalent)

	1979	1980	1981	1982
Production[1]	6,715	7,300	7,175	5,208
Domestic sales by domestic producers[1]	379	378	332	273
Exports:				
United States[1]	4,931	4,563	4,182	3,202
Overseas[1]	1,846	2,170	1,823	1,576
Imports for consumption[2]	29	33	11	13
Domestic consumption[3]	408	411	343	286
Yearend producers' stocks[1]	378	564	1,308	1,486

[1]Data supplied by the Potash & Phosphate Institute.
[2]From U.S. Bureau of the Census export data. Sulfate of potash was probably landed on the Canadian east coast from European sources.
[3]Domestic sales by domestic producers plus imports.

China.—The Chinese, who require large quantities of potash for their "green revolution" and burgeoning population, contracted with Jacob's International of Dublin, Ireland, to develop Lake Chaerhan in the Tsaidam Basin of Qinghai Province. A railroad line was constructed from Xining to the lake's edge to provide material transport. Development includes a 200,000-ton-per-year product pilot plant leading to a 1-million-ton-per-year production plant. The lake's recoverable reserves were estimated to be 200 million tons, K_2O equivalent, of muriate of potash. The potash recovery system will combine solar ponding with a processing plant.

Congo.—The Government planned to redevelop the flooded potash mine at Holle. Compagnie des Potasses du Congo was mining the site in 1977 when it was flooded by an aquifer. Estimated reserves of carnallite and sylvinite were about 43 million tons of K_2O equivalent.

Ethiopia.—The Government of Ethiopia planned to develop the potash deposit at the Danakil Depression, south of Mersa Fatma, which is on the Red Sea. Reserves of sylvite were estimated to be over 60 million tons.

France.—France was developing plans to reduce Rhine River pollution from salt tailings of the Alsacian potash mines. Plans included underground reinjection of 700,000 tons per year of salt as brine and transporting an additional 300,000 tons per year of salt to a salt plant.

Enterprise Minière et Chemique, the state-owned potash producer, gained control of the Loos chlorine, inorganic chlorides, and potassium plant as a result of the French chemical industry reorganization.

German Democratic Republic.—Three German Democratic Republic potash mines along the Weser River were encouraged by the Federal Republic of Germany to reduce their pollution of the river. The two nations reached an environmental accord late in the year to reduce salt waste pollution of the river, which is a common boundary. Only the method of cost allocation remained to be solved by the end of the year.

Israel.—Dead Sea Works announced a second expansion program to increase product capacity from 1.0 to 1.3 million tons. The anticipated cost was $71 million, with an additional $17 million investment in infrastructure. The producer was also considering granulating two-thirds of the increase, or 180,000 tons, of this new muriate of potash production. Its 1982 granulation capacity was 175,000 tons.

Plans for hydroelectric power generation, using a canal and the 400-meter drop from the Mediterranean Sea to the Dead Sea, continued in Israel. Electrical generation capacity remained at 800 megawatts-electrical as a peak-power source operating for 45 hours per week on workdays only. There are still concerns about changes in the Dead Sea's chemical composition or disruption of the present Dead Sea stratification for both Israeli and Jordanian potash producers at the south end of the sea. But at this flow rate, the Dead Sea water level will not rise fast enough to force the Jordanian potash producer to build up its dikes before the normal schedule.

Italy.—Italkali S.p.A. was developing a new mine at Milena to provide feed to the extant mill at Campofranco. Italkali, which sells only potassium sulfate, assumed operations from Industria Sali Potassi e Affini in 1981.

Jordan.—Arab Potash Co. produced its first muriate of potash in December. The operation harvested carnallite from solar ponds containing Dead Sea brines. The plant washes the magnesium chloride fraction from the carnallite, then floats the muriate of potash from the salt.

Mexico.—The Mexican effort to produce muriate of potash from Cerro Prieto geothermal brines was apparently successful technically, but was delayed by macroeconomic problems. Mexico claimed 80% recovery of available potash and a 60.6% K_2O equivalent product at an estimated cost of $46 per ton. Production was projected at 60,000 tons per year as a byproduct of electrical generation from a 400-megawatt-electrical geothermal station. Startup was anticipated for 1984 or later.

Spain.—Early in 1982, Unión Explosivos Rio Tinto S.A., owner of Spain's largest potash mine, was granted a 6-month moratorium on payment of its $1 billion in debts.

Tunisia.—The Société de Developpement des Industries Chemiques du Sud asked for tenders to design a facility for potash production from the Sebkhet El Melah, southwest of Zarzis. The Sebkhet El Melah, which appears to be a muriate of potash source, was destined for development before the Chott El Djeria area, which appears to be a sulfate of potash source.

U.S.S.R.—Construction and production efforts in the potash industry were experiencing problems; however, the Beloruskaliy association seemed to be functioning well, providing one-half of total U.S.S.R. production. The Soligorsk combine started a 60,000-ton-per-year sulfate of potash plant, using muriate of potash and sodium sulfate as feed, and a compaction plant of unknown capacity. The combine also claimed a new sylvinite deposit of about 5 billion tons of resource, although no ore grade or recoverable quantity was announced. The last Novosolikamsk section in the Uralkaliy Association did not come on-stream as planned. The problem seemed to be with the construction work force. Generally, the Uralkaliy combine lost an average of 30 operating days per plant because railroad cars for transporting finished product were unavailable. These plants have smaller storage space for finished product than is normal for Western firms and consequently must discontinue operations after about 10 days of stock buildup.

The Kirovabad alumina plant in Azerbaijan started a 60,000-ton-per-year sulfate of potash facility from an alunite operation. A potash discovery in the Irkutsk Oblast was announced in 1982. The U.S.S.R. reported the Nepskoye deposit as 20,000 square kilometers aerial extent and thousands of millions of tons of potassium salt resource. No ore grade or recoverable tonnage estimate was announced. It was not clear if this is the same deposit as the unnamed resource(s) reported in 1980 as 10,000 square kilometers aerial extent, or in 1981 as 70 million tons of reserves, or in 1982 as 10,000 square kilometers aerial extent and 70 million tons of reserves per square kilometer.

Table 13.—Marketable potash: World production, by country[1]

(Thousand metric tons of K_2O equivalent)

Country	1978	1979	1980	1981[p]	1982[e]
Canada (sales)[2]	6,340	7,074	7,532	6,549	5,196
Chile[3]	[r] [e]17	[r]22	23	22	22
China[4]	21	16	12	11	25
France	1,795	[r]1,921	1,894	1,831	[5]1,823
German Democratic Republic	3,323	3,395	3,422	3,490	3,500
Germany, Federal Republic of	2,470	2,616	2,737	2,591	2,600
Jordan	--	--	--	--	10
Israel	744	737	797	839	1,000
Italy[e]	196	182	156	118	120
Spain	613	668	658	[e]705	750
U.S.S.R	8,193	6,635	8,064	8,449	9,000
United Kingdom	[r]157	[r]177	321	285	400
United States	2,253	2,225	2,239	2,156	1,784
Total	[r]26,122	[r]25,668	27,855	27,046	26,230

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through Apr. 20, 1983.
[2]Official Government figures. Potash & Phosphate Institute production data are given in table 12.
[3]Series revised; new data represent officially reported output of potassium nitrate product (gross weight basis) converted assuming 14% K_2O equivalent.
[4]Series revised to reflect officially reported Chinese data on production of potassic fertilizers in terms of nutrient content; small additional quantities may be produced and used by the nonfertilizer chemical industry.
[5]Reported figure.

TECHNOLOGY

The Bureau of Mines Salt Lake City Research Center (Utah) finished studies of potash recovery from low-grade resources with a report on the "Direct Flotation of Potash From Carnallite." The process involves a decomposition leach of the carnallite to wash away the more soluble magnesium chlorine ($MgCl_2$) and direct flotation of the potash using an insoluble slimes flocculation-depression process. The results were 60.5% K_2O equivalent muriate of potash and 81.6% recovery of available potash after loss of 10.5% of the muriate of potash in the $MgCl_2$ leach.[2]

[1]Physical scientist, Division of Industrial Minerals.
[2]Foot, D. G., Jr., C. E. Jordan, and J. L. Huiatt. Direct Flotation of Potash From Carnallite. BuMines RI 8678, 1982, 11 pp.

Pumice and Pumicite

By A. C. Meisinger[1]

Production of pumice and pumicite by domestic producers in 1982 decreased 17% to 416,000 short tons and 13% in value to $3.8 million, compared with that of 1981. Pumice imported for consumption increased 32% over that of 1981, and as a result, apparent domestic consumption declined only 9% to 536,000 tons.

Domestic Data Coverage.—Domestic production data for pumice and pumicite are developed by the Bureau of Mines from one voluntary survey of U.S. operations. Of the 22 operations to which a survey request was sent, 19 or 86% responded, and this represented 96% of the total production shown in table 1. Production for the remaining nonrespondents was estimated using reported prior year production levels adjusted by trends in employment and other guidelines.

Table 1.—Salient pumice and pumicite statistics

(Thousand short tons and thousand dollars unless otherwise specified)

	1978	1979	1980	1981	1982
United States: Sold and used by producers:					
Pumice and pumicite	1,208	1,172	543	499	416
Value (f.o.b. mine and/or mill)	$4,836	$4,864	$4,267	$4,311	$3,750
Average value per ton	$4.00	$4.15	$7.86	$8.64	$9.01
Exports[e]	2	2	1	1	1
Imports for consumption	216	62	194	92	121
Apparent consumption[1]	1,422	1,232	736	590	536
World: Production, pumice and related volcanic materials	[r]16,165	[r]15,284	14,442	[p]13,734	[e]12,871

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Quantity sold or used, plus imports, minus exports.

DOMESTIC PRODUCTION

Production of pumice and pumicite by domestic operators declined 17% in quantity and 13% in value compared with 1981 production. Twenty-one companies operated 22 mines in 8 States to produce 416,000 tons, of which 4 States—California, Idaho, New Mexico, and Oregon—accounted for more than 95% of the U.S. total.

Principal domestic producers were American Pumice Products, Inc., Littlelake, Calif.; Amcor, Inc., Idaho Falls, Idaho; Cascade Pumice Co., Bend, Oreg.; Central Oregon Pumice Co., Bend, Oreg.; Copar Pumice Co., Inc., Espanola, N. Mex.; General Pumice Corp., Santa Fe, N. Mex.; Hess Pumice Products, Malad City, Idaho; Producers Pumice Co., Idaho Falls, Idaho; Tionesta Aggregates Co., Tulelake, Calif.; and Volcanite, Ltd., Kailua Kona, Hawaii. Together, these 10 companies in 1982 accounted for 94% of the tonnage and 61% of the value of total U.S. production of pumice and pumicite.

Table 2.—Pumice and pumicite sold and used by producers in the United States, by State

(Thousand short tons and thousand dollars)

State	1981 Quantity	1981 Value	1982 Quantity	1982 Value
Arizona	1	3	1	7
California	98	1,501	59	1,285
Kansas	W	W	W	W
New Mexico	93	919	97	809
Oklahoma	1	W	1	W
Oregon	W	W	W	W
Other[1]	306	1,888	258	1,649
Total	499	4,311	416	3,750

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Hawaii, Idaho, and States indicated by symbol W.

CONSUMPTION AND USES

U.S. apparent consumption was 536,000 tons in 1982, a decrease of 9% from that of 1981. Domestic use of pumice and pumicite in concrete aggregates for construction purposes, as shown in table 3, decreased 37% to 254,000 tons. Decorative building block accounted for 80% of the 130,000 tons reported in 1982 for other uses.

Table 3.—Pumice and pumicite sold and used by producers in the United States, by use

(Thousand short tons and thousand dollars)

Use	1981 Quantity	1981 Value	1982 Quantity	1982 Value
Abrasives (includes cleaning and scouring compounds)	19	486	19	479
Concrete admixture and concrete aggregate	404	2,469	254	1,199
Landscaping	34	370	13	100
Other[1]	42	986	130	1,972
Total	499	4,311	416	3,750

[1]Includes decorative building block, heat-or-cold insulating medium, pesticide carriers, road construction material, roofing granules, and miscellaneous uses.

PRICES

Prices quoted in Chemical Marketing Reporter for pumice from domestic and foreign sources were unchanged from that of 1981, and were as follows at yearend 1982: domestic grades, bagged in 1-ton lots, $205 per ton for fine; $225 per ton for medium; and $205 per ton for coarse and 2-extra coarse. Yearend quoted prices on imported (Italian) pumice, f.o.b. east coast, bagged in 1-ton lots, were $200 per ton for fine, $285 per ton for medium, and $250 per ton for coarse. Crude or unmanufactured Italian pumice was imported at a customs-declared average value of $135.75 per ton.

The average value, f.o.b. mine and/or mill, for pumice and pumicite sold and used by domestic producers in 1982 increased 4% to $9.01 per ton compared with the 1981 price. The average customs declared price of pumice imported from Greece for use in the manufacture of concrete masonry products decreased 11% to $5.83 per ton.

FOREIGN TRADE

Pumice imported for consumption in 1982 was 121,100 tons, a 32% increase over that imported in 1981; of this, over 99% was from Greece and 98% was for use in the manufacture of concrete masonry products.

[1]Industry economist, Division of Industrial Minerals.

Table 4.—U.S. imports of pumice for consumption, by class and country

Country	Crude or unmanufactured		Wholly or partly manufactured		For use in the manufacture of concrete masonry products		Manu-factured, n.s.p.f.
	Quantity (short tons)	Value (thou-sands)	Quantity (short tons)	Value (thou-sands)	Quantity (short tons)	Value (thou-sands)	Value (thou-sands)
1981:							
Germany, Federal Republic of	1	(1)	--	--	--	--	$23
Greece	2,543	$36	--	--	89,252	$586	--
Italy	343	32	77	$14	--	--	51
Japan	66	1	--	--	--	--	6
Mexico	1	1	--	--	--	--	--
United Kingdom	--	--	(1)	1	--	--	7
Other[2]	--	--	--	--	--	--	39
Total	2,954	70	77	15	89,252	586	126
1982:							
Canada	73	4	--	--	--	--	(1)
Denmark	--	--	--	--	1	1	3
Germany, Federal Republic of	--	--	(1)	(1)	--	--	13
Greece	2,368	34	--	--	118,173	688	--
Italy	442	60	54	7	--	--	24
Japan	--	--	(1)	2	--	--	28
Mexico	4	4	--	--	--	--	2
United Kingdom	--	--	(1)	1	--	--	2
Other[3]	--	--	--	--	--	--	32
Total	2,887	102	54	10	118,174	689	104

[1]Less than 1/2 unit.
[2]Austria, Belgium, Canada, China, Denmark, Hong Kong, India, the Republic of Korea, the Netherlands, and Taiwan.
[3]Austria, France, the Netherlands, and Taiwan.

Table 5.—Pumice and related volcanic materials: World production, by country[1]

(Thousand short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Argentina[3]	24	51	40	56	45
Austria: Pozzolan	10	9	9	9	9
Cape Verde Islands: Pozzolan[e]	17	18	18	18	18
Chile: Pozzolan	201	242	275	306	285
Costa Rica[e]	2	1	1	1	1
Dominica: Pumice and volcanic ash[e]	120	120	120	120	120
France: Pozzolan and lapilli[e]	648	650	660	660	610
Germany, Federal Republic of:					
Pumice (marketable)	2,301	1,579	890	440	385
Pozzolan	192	215	[e]220	[e]220	220
Greece:					
Pumice	[r]1,199	[r]1,041	695	684	690
Pozzolan	[r]1,483	[r]1,368	[e]1,650	1,634	1,650
Guadeloupe:[e] Pozzolan	220	220	[r]275	265	265
Guatemala:					
Pumice	21	20	[e]20	[e]17	17
Volcanic ash	39	41	14	6	7
Iceland	9	27	40	37	38
Italy:					
Pumice and pumiceous lapilli[e]	860	940	990	880	825
Pozzolan[e]	6,400	6,500	6,600	6,600	6,100
Martinique: Pumice	[r]172	[r]183	169	[e]145	145
New Zealand	44	28	15	37	35
Spain[4]	[r]995	[r]859	1,198	1,100	990
United States (sold or used by producers)	1,208	1,172	543	499	416
Total	[r]16,165	[r]15,284	14,442	13,734	12,871

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through Apr. 12, 1983.
[2]Pumice and related volcanic materials are also produced in a number of other countries, including (but not limited to) Iran, Japan, Mexico, Turkey, and the U.S.S.R., but output is not reported quantitatively and available information is inadequate for the formulation of reliable estimates of output levels.
[3]Unspecified volcanic materials produced mainly for use in construction products.
[4]Includes Canary Islands.

Rare-Earth Minerals and Metals

By James B. Hedrick[1]

Domestic mine production of the rare earths increased in 1982. Molycorp, Inc., and Associated Minerals Ltd., Inc. (AMC), were the only domestic mine producers. Molycorp, W. R. Grace & Co., Research Chemicals, a division of NUCOR Corp., and Rhône-Poulenc Inc. were the principal processors of rare earths in the United States. Major end uses were in petroleum cracking catalysis, metallurgical applications, and glass polishing.

Domestic Data Coverage.—Domestic mine production data for rare earths are developed by the Bureau of Mines from two separate, voluntary surveys of U.S. operations. Typical of these surveys is the Rare Earths and Thorium survey. Both of the mines to which a survey request was sent responded, representing 100% of total production. Production data were withheld to avoid disclosing company proprietary data.

Legislation and Government Programs.—Shipments of rare earths that had been sold from the National Defense Stockpile in earlier years by the General Services Administration totaled 364 metric tons[2] of contained rare-earth oxides (REO) in 1982. Government stocks of rare earths at yearend 1982 were 443 (dry) tons of REO contained in sodium sulfate. The Government stocks of yttrium oxide remained unchanged at 108 kilograms.

Lower U.S. import duties for imported rare earths, resulting from the 1979 Tokyo Round of negotiations, continued for nations having most-favored-nation status. The import duties for these countries were scheduled to decline annually through January 1, 1987. The new rare-earth import duty schedule is shown in table 1.

DOMESTIC PRODUCTION

Concentrate.—Domestic mine production of REO contained in bastnasite and monazite concentrates increased 3% in 1982 from the 1981 level. Bastnasite was the major domestic ore of rare earths. The only other rare-earth ore domestically produced was monazite.

Molycorp, the only U.S. producer of bastnasite, produced rare earths from its mine at Mountain Pass, Calif. According to the annual report of the Union Oil Co. of California, the parent company of Molycorp, production of REO contained in bastnasite concentrates was 17,501 tons.

AMC was the only domestic producer of the rare-earth mineral monazite. AMC's placer operations at Green Cove Springs, Fla., recovered monazite as a byproduct of minerals sands mining for titanium and zirconium minerals.

Compounds and Metals.—Molycorp's new $15 million separation plant at Mountain Pass, Calif., began production in the first quarter of 1982. Separation circuits at the plant were to produce, initially, samarium oxide and gadolinium oxide from concentrate. Rare-earth oxides of lanthanum, praseodymium, and neodymium can also be processed in the new circuits to supplement existing facilities.

Table 1.—U.S. import duties for rare earths

TSUS No.	Item	Most favored nation (MFN) Jan. 1, 1982	Most favored nation (MFN) Jan. 1, 1983	Most favored nation (MFN) Jan. 1, 1987	Non-MFN Jan. 1, 1982	Non-MFN Jan. 1, 1983
601.12, 601.45	Ore and concentrate[1]	Free	Free	Free	Free	Free.
418.40, 418.42, 418.44	Cerium chloride, oxide, compounds	12.1% ad valorem	11.1% ad valorem	7.2% ad valorem	35% ad valorem	35% ad valorem.
423.0030	Rare-earth oxides except cerium oxide	4.5% ad valorem	4.4% ad valorem	3.7% ad valorem	25% ad valorem	25% ad valorem.
632.38	Rare-earth metals (including scandium and yttrium).	do	do	do	do	Do.
632.78	Alloys wholly or almost wholly of rare-earth metals (mischmetal).	43 cents per pound.	41 cents per pound.	32 cents per pound.	$2 per pound	$2 per pound.
632.79	Other alloys wholly or almost wholly of rare-earth metals.	38 cents per pound plus 4.7% ad valorem.	35 cents per pound plus 4.2% ad valorem.	20 cents per pound plus 2.4% ad valorem.	$2 per pound plus 25% ad valorem.	$2 per pound plus 25% ad valorem.
755.35	Ferrocerium and other pyrophoric alloys.	39 cents per pound plus 4.7% ad valorem.	36 cents per pound plus 4.3% ad valorem.	22 cents per pound plus 2.6% ad valorem.	do	Do.

[1]Crude or concentrated by crushing, flotation, washing, or by other physical or mechanical processes that do not involve substantial chemical change.

CONSUMPTION AND USES

Domestic rare-earth processors consumed an estimated 18,500 tons of REO in various forms in 1982, a 12% decrease from the 21,000 tons of REO consumed in 1981. Bastnasite consumption was 13% lower in 1982 than in 1981, and consumption of monazite decreased 7%.

Shipments of rare-earth products from domestic producers and refiners of ores, concentrates, and intermediate compounds were 15,200 tons of contained REO, a decrease from the 18,100 tons of contained REO shipped in 1981.

The approximate distribution of rare earths by end use, based on information supplied by primary processors and certain consumers, was as follows: petroleum cracking catalysts, 55%; metallurgical uses (including iron and steel, alloys, and mischmetal), 30%; ceramics and glass (including polishing compounds and additives), 13%; and miscellaneous (including phosphors, electronics, nuclear energy, lighting, and research), 2%.

Consumption of mixed rare-earth compounds during 1982 decreased 50% from the 1981 level, and consumption of purified rare-earth compounds was 31% lower.

The producers of mischmetal, rare-earth silicide, and other rare-earth alloys consumed 51% less contained REO in 1982 than in 1981 as a result of depressed demand for iron and steel products. Shipments of these rare-earth metals and alloys in 1982 were also lower, 48% less than during 1981. Consumption of high-purity rare-earth metal was slightly higher.

The glass industry's principal use of rare earths, mainly cerium concentrate or cerium oxide, was as polishing compounds for lenses, mirrors, cut crystal, television and cathode-ray tube faceplates, gem stones, and plate glass. Purified rare-earth compounds were also used as additives to the glass used in containers, television and cathode-ray tube faceplates, radiation shielding windows, tableware, crystal and leaded stemware, ophthalmic lenses, welder's safety lenses, decorative glass, lasers, incandescent and fluorescent lights, and optical, photochromic, filter, and photographic lenses. These rare-earth additives acted as colorants, color correctors, and decolorizers, as stabilizers against discoloration from ultraviolet light and against browning caused by high-energy radiation, as dopants in laser glass, as modifiers to increase refractive indices and decrease dispersion, and as absorbers of ultraviolet and visible light.

Phosphors containing rare earths were used in color television tubes, radar screens, avionic and data displays, X-ray intensifying screens, low- and high-pressure mercury vapor lights, electronic thermometers, and trichromatic fluorescent lamps.

The ceramic industry used purified rare earths in pigments, heating elements, dielectric and conductive ceramics, thermal and/or flash protective devices, stereo-viewing systems, data printers, welder's electronic safety goggles, image storage devices, and as principal constituents and stabilizers in high-temperature ceramics and glazes.

Purified rare-earth compounds also had applications in petroleum cracking catalysts, noncracking catalysts, oxygen-sensing electrolytes, computer bubble domain memories, substrates for bubble domain memories, electronic components, nuclear control rods, nuclear fuel reprocessing microwave applications, incandescent gas mantles, gas lasers, fiber optics, carbon arc lighting, and synthetic gem stones.

Rare-earth permanent magnets were used in various electric motors, alternators, generators, line printers, computer disk-drive actuators, proton linear accelerators, earring and necklace clasps, medical and dental applications, traveling wave tubes, aerospace applications, and in speakers, headphones, microphones, and tape drives.

Metallurgical applications of rare earths included alloys and additives in high-strength low-alloy steels, gray and ductile iron, stainless and carbon steels, high-temperature and corrosion-resistant metals, hydrogen storage alloys, lighter flints, armaments, permanent magnets, neutron convertor foils, special lead fuses, and in target materials for sealed-tube neutron generators.

STOCKS

Stocks of rare earths in all forms held by 15 producing, processing, and consuming companies increased 46% during 1982.

Bastnasite concentrate stocks held by the principal producer and two other processors increased about 75%. Yearend inventories of monazite and other rare-earth concentrates also increased.

Stocks of mixed rare-earth compounds increased from 2,590 tons of contained REO at yearend 1981 to 4,980 tons at yearend 1982. Inventories of purified rare-earth compounds were 356 tons of contained REO at yearend 1981 compared with an estimated 314 tons at yearend 1982. Yearend stocks of contained REO in mischmetal, rare-earth silicide, and alloys containing rare earths decreased 25%. High-purity rare-earth metal inventories remained about the same.

PRICES

The price of Australian monazite (minimum 60% rare-earth oxide including thoria, f.o.b./f.i.d.),[3] as quoted in Metal Bulletin (London), increased from $A380-$A430 (US$429-US$485)[4] per ton at yearend 1981 to $A400-$A440 (US$392-US$432)[5] per ton by yearend 1982. Although the Australian yearend price quoted for monazite increased in 1982, the foreign exchange rate caused the dollar price to decrease. The yearend price per kilogram for monazite, based on contained REO, was approximately $0.71 to $0.79.

Industrial Minerals quoted yearend prices for yttrium concentrate (60% Y_2O_3, f.o.b. Malaysia) at $46 per kilogram.

Prices quoted from Molycorp for unleached, leached, and calcined bastnasite containing 60%, 70%, and 85% REO increased from $0.92, $0.97, and $1.12 per pound of contained REO at yearend 1981 to $1.00, $1.05, and $1.25 per pound of contained REO, respectively, at yearend 1982.

The price of cerium concentrate quoted by American Metal Market decreased from $1.32 per pound of contained cerium oxide at yearend 1981 to $1.30 per pound of cerium oxide at yearend 1982. Lanthanum concentrate increased from $1.02 per pound REO contained at yearend 1981 to $1.08 per pound REO contained at yearend 1982.

Mischmetal (99.8%, 50-100 lb. lots, f.o.b. Newark, N.J.) prices quoted in American Metal Market, remained at the yearend 1980 level of $5.60 per pound throughout 1981 and 1982.

Rhône-Poulenc quoted rare-earth prices, per kilogram, net 30 days, f.o.b. New Brunswick, N.J., or duty paid at point of entry, effective January 1, 1982, as follows:

Product[1] (oxide)	Percent purity	Quantity (kilograms)	Price per kilogram
Cerium	99.5	20	$17.95
Erbium	96.0	50	170.00
Europium	99.99	20	1,795.00
Gadolinium	99.99	50	136.50
Lanthanum	99.9	50	16.10
Praseodymium	96.0	50	43.40
Samarium	96.0	50	59.50
Terbium	99.9	20	920.00
Yttrium	99.9	50	98.00

[1]Dysprosium, holmium, lutetium, thulium, and ytterbium oxide prices on request.

Rhône-Poulenc also quoted prices for rare earths produced at its Freeport, Tex., plant, net 30 days, f.o.b. Freeport, Tex., effective January 1, 1982:

Product (compound)	Percent purity	Quantity (kilograms)	Price per kilogram
Cerium hydroxide	98	540	[1]$13.10
Cerium nitrate	98	Truckload	[1]12.50
Cerium oxide	95	540	9.74
Lanthanum-neodymium nitrate	98	Truckload bulk	[1]3.85
Neodymium carbonate	95	540	6.30
Neodymium oxide	95	540	[1]8.05

[1]Priced on a contained REO basis.

Molycorp quoted prices for rare-earth oxides, net 30 days, f.o.b. Louviers, Colo., Mountain Pass, Calif., or York, Pa., effective February 15, 1982:

Product (oxide)	Percent[1] purity	Quantity (pounds)	Price per pound
Cerium	99.9	1-199	$8.75
Europium	99.99	1-24	900.00
Gadolinium	99.99	1-69	65.00
Lanthanum	99.99	1-299	7.50
Neodymium	99.99	1-49	60.00
Praseodymium	95.0	1-299	17.50
Samarium	95.0	1-109	30.00
Terbium	99.99	1-49	575.00
Yttrium	99.99	1-49	50.00

[1]Purity expressed as percent of total REO.

Nominal prices for various rare-earth products were quoted by Research Chemicals, net 30 days, f.o.b. Phoenix, Ariz., effective October 1, 1982:

Element	Oxide[1] price per kilogram	Metal[2] price per kilogram
Cerium	$20	$125
Dysprosium	110	300
Erbium	200	650
Europium	1,900	7,500
Gadolinium	140	485
Holmium	650	1,600
Lanthanum	19	125
Lutetium	5,200	14,200
Neodymium	80	260
Praseodymium	130	310
Samarium	130	330
Terbium	1,200	2,800
Thulium	3,400	8,000
Ytterbium	225	875
Yttrium	94	430

[1]Minimum 99.9% purity, 1- to 20-kilogram quantities.
[2]Ingot form, 1 to 5 kilograms, from 99.9% grade oxides.

FOREIGN TRADE

Exports of ferrocerium and other pyrophoric alloys containing rare earths totaled 24,383 kilograms in 1982, a 145% increase from the 1981 level. Major destinations were the Republic of Korea (50%), Japan (30%), and Hong Kong (7%).

Exports of rare-earth metal ores, excluding monazite, decreased 50% from the 1981 total of 9,586,505 kilograms to a total of 4,836,389 kilograms in 1982. Exports in 1982 were valued at $11,347,652. Major destinations were Japan (53%), the Federal Republic of Germany (24%), and the United Kingdom (8%).

Exports of thorium ore, including monazite, decreased 29% in 1982 from the 1981 level. France received all of the reported total of 91,508 kilograms valued at $103,356.

Australia has been the principal import source of monazite for the United States since 1977. Imports of cerium oxide increased substantially in 1982 compared with that of 1981. France remained the largest source of imported rare-earth oxides. Imports of rare-earth alloys, including mischmetal, were significantly lower in 1982 as a result of the depressed state of the domestic steel industry. Brazil continued to be the leading supplier of imported rare-earth alloys.

Table 2.—U.S. imports for consumption of monazite, by country

Country	1978		1979		1980		1981		1982	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Australia	5,018	$1,154	5,686	$1,501	4,933	$1,749	7,469	$3,158	6,600	$2,830
Liberia	53	<1	--	--	--	--	--	--	--	--
Malaysia	1,157	255	561	161	215	101	--	--	603	240
South Africa, Republic of	--	--	3	2	--	--	--	--	--	--
Thailand	767	193	37	13	--	--	--	--	--	--
Total	6,995	1,603	6,287	1,677	5,148	1,850	7,469	3,158	7,203	3,070
REO content[e]	3,847	XX	3,458	XX	2,831	XX	4,108	XX	3,962	XX

[e]Estimated. XX Not applicable.

Table 3.—U.S. imports for consumption of rare earths, by country

Country	1980 Quantity (kilograms)	1980 Value	1981 Quantity (kilograms)	1981 Value	1982 Quantity (kilograms)	1982 Value
Cerium oxide:						
France	2,180	$26,896	7,450	$51,644	26,239	$72,912
Germany, Federal Republic of	4	1,975	--	--	7	1,727
Switzerland	10	1,095	--	--	--	--
United Kingdom	3,636	71,524	127	1,068	--	--
Total	5,830	101,490	7,577	52,712	26,246	74,639
Rare-earth oxide excluding cerium oxide:						
Austria	50	1,372	100	1,339	--	--
Belgium	--	--	4,097	466,781	--	--
Brazil	205,498	3,890,000	NA	299	300	27,235
Canada	34,192	6,123	1	950	--	--
China	2	1,229	--	--	1,300	71,168
France	245,950	11,199,793	147,256	8,169,455	140,020	7,141,420
Germany, Federal Republic of	967	126,314	10,808	1,947,385	17,116	2,258,877
Guyana	--	--	--	--	38	19,543
Italy	715	34,540	--	--	--	--
Japan	168	125,002	14,736	1,154,744	10,292	1,221,724
Netherlands	--	--	--	--	50	26,269
Norway	2,067	166,609	3,984	419,193	4,770	517,124
Switzerland	--	--	--	--	6	3,180
U.S.S.R.	33,465	2,256,545	11,728	895,932	10,746	1,143,593
United Kingdom	1,031	147,480	3,443	121,927	8,316	79,889
Total	524,105	17,955,007	196,153	13,178,005	192,954	12,510,022
Rare-earth metals (alloys):						
Austria	--	--	--	--	17,500	161,506
Brazil	314,034	2,747,765	179,998	1,518,469	40,000	312,758
France	4,000	113,428	37	833	--	--
Germany, Federal Republic of	50	826	950	8,157	4,858	44,531
United Kingdom	230	55,597	555	123,503	769	139,542
Total	318,314	2,917,616	181,540	1,650,962	63,127	658,337
Rare-earth metals, including scandium and yttrium:						
China	--	--	--	--	2,100	52,068
France	--	--	200	11,568	500	14,984
Germany, Federal Republic of	--	--	15	1,415	--	--
Japan	--	--	3	9,329	550	47,483
U.S.S.R.	3,715	252,225	1,000	34,638	--	--
United Kingdom	126	54,459	483	110,940	68	24,394
Total	3,841	306,684	1,701	167,890	3,218	138,929
Other rare-earth metals:						
Brazil	8,000	71,616	--	--	--	--
Germany, Federal Republic of	11	900	168	10,848	6	928
Japan	--	--	--	--	45	2,233
United Kingdom	2	454	25	2,874	--	--
Total	8,013	72,970	193	13,722	51	3,161
Ferrocerium and other pyrophoric alloys:						
Austria	--	--	840	13,314	2,367	33,340
Belgium	208	1,400	--	--	--	--
Brazil	--	--	6,725	102,818	14,954	212,450
France	43,283	633,108	50,443	745,169	47,968	571,079
Germany, Federal Republic of	--	--	100	1,854	462	7,266
Italy	--	--	--	--	6	286
Japan	21,319	255,248	23,741	332,733	19,375	257,589
United Kingdom	507	12,054	1,310	53,287	606	10,163
Total	65,317	901,810	83,159	1,249,175	85,738	1,092,173

NA Not available.

WORLD REVIEW

Bastnasite was the world's principal source of rare earths. It was mined as a primary product in the United States and as a byproduct of iron ore mining in China. A major secondary source of rare earths was monazite, a byproduct of minerals sands mined for titanium and zirconium in several countries and for tin in Malaysia and Thailand. Small quantities of rare earths were also obtained from the yttrium-rich minerals sands byproduct, xenotime. The United States, Australia, India, Brazil, China, and Malaysia were the major rare-earth producing countries.

Australia.—Australia's largest minerals sands production, including monazite, came from the State of Western Australia. The States of Queensland and New South Wales also produced monazite. Production of monazite for the first half of 1982 was 4,991 tons.

Legislation enacted by the Government of New South Wales, because of environmental concerns, curtailed minerals sands mining in newly created parks at yearend. The only exception was the Bridge Hall deposit, which was scheduled to close by mid-1983.[6] The Minerals Sands Producers Association considered the increasing restrictions excessive in view of improved environmental controls and land rehabilitation programs.

Australia's Bureau of Minerals Resources reported that on the basis of known deposits and projected output, 70% of Australia's demonstrated economic resources would be depleted by the turn of the century.[7] Minerals sands reserves may actually be depleted sooner because substantial reserves have been withdrawn from mining for environmental and other considerations.[8] Australia has produced 102,000 tons of monazite since 1950. The latest estimate by the Bureau of Mineral Resources of demonstrated economic resources of Australian monazite was 334,000 tons.

The U.S. Department of State denied assistance to Dillingham Corp., a U.S. company, in its claim for compensation from the Australian Government for halting minerals sands mining on Fraser Island, Queensland, stating that it was a private matter between Dillingham and the Australian Government. Dillingham indicated that it is prepared to take its case to the International Court of Justice if necessary.[9]

The Australian Railways Union banned the handling of monazite, which contains slightly radioactive thorium, because of what the union considered to be insufficient safeguards on its use.[10] Employees at the Transport Workers Union agreed to move the monazite by road after health assurances were given by Allied Eneabba Pty. Ltd., which mines the minerals sands at Yeelirrie, Western Australia. The Australian Waterside Workers Federation also refused to handle monazite. Their ban, however, was lifted, and shipments resumed after safeguards were initiated. Union workers were instructed to wear badges to monitor radiation levels during transport.[11]

Mineral Deposits Ltd. reportedly relinquished prospecting rights over a large area of Moreton Island, Queensland, despite indications of the existence of a minerals sands ore body. More than one-half the total area of the island is available for declaration as a national park.[12]

Renison Goldfields Consolidated Ltd.'s (RGC) subsidiary, AMC, was undergoing a major reorganization, reportedly because of weak markets and escalating costs in minerals sands production. According to RGC's annual report, production was cut back at Capel, Western Australia, and North Stradbroke Island, Queensland. In addition, mining operations at Medowie and Jerusalem Creek, New South Wales, and processing operations at Hexham, New South Wales, and Southport, Queensland, were closed. Capital improvements were planned for facilities at Eneabba in Western Australia, and at Green Cove Springs, Fla., in the United States. AMC's head office was moved to Perth, Western Australia.

Brazil.—Production of various rare-earth materials, in kilograms, was as follows:

Year	Carbonate	Chloride	Oxide
1977	7,210	2,527,455	16,926
1978	7,000	2,799,000	21,000
1979	14,000	2,725,000	16,000
1980	5,750	[r]2,071,456	11,716
1981	5,550	1,910,100	21,605

[r]Revised.

According to Anuário Mineral Brasileiro 1982, measured reserves of monazite were 27,053 tons with a rare-earth oxide content of 16,199 tons. The largest reserves, 20,036 tons of monazite, were located in the São João da Barra region in the State of Rio de Janeiro. Monazite concentrate production in 1981 was 360 tons from the State of Espirito Santo and 2,100 tons from the State of Rio de Janeiro.

Canada.—Iron Ore Co. of Canada announced the discovery of a yttrium-beryllium-zirconium deposit northeast of Schefferville, Quebec, near Strange Lake. The company plans to spend Can$4 million in 1983 for further exploration at the Strange Lake deposit and for a pilot plant.

China.—A new rare-earth processing

plant reportedly began production in the last quarter of 1982 at Baotou, Nei Monggol Autonomous Region.[13] The new rare-earth plant of the Chinese Rare Earth Co., No. 3, was to produce rare-earth compounds and metals. Rare-earth alloys and rare-earth ferroalloys were produced at the No. 1 plant and No. 2 plant, respectively. Total rare-earth reserves for China were reported at 36 million tons of contained REO, with 90% of the reserves located in the Bayan Obo region north of Baotou.

Other plants producing rare-earth products were located throughout China.[14] Plants in Longnan and Xunwu in southern Jiangxi Province produced monazite concentrates. In the central region of Jiangxi Province at Nanchang, the Cemented Carbide Works produced several concentrates and high-purity oxides. High-purity oxides and compounds, separated metals, mischmetal, rare-earth magnets, and magnet alloys were produced by the Yao Long Chemical Plant in the municipality of Shanahai. Rare-earth chloride plants were reported in Gansu Province and at Urumqi, Xinjiang Autonomous Region. Low-purity separated rare earths were produced near Shijiazhuang, Hebei Province, by the Baoding Rare Earth Ceramic factory. Mining of monazite and high-grade xenotime was reported in the coastal Province of Guangdong with lower grade xenotime operations located in Henan Province and Guangxi Province.

India.—Indian Rare Earths Ltd. (IREL) produced monazite from 429,500 tons of raw sand mined in 1981-82.[15] The company also processed 3,704 tons of monazite to produce 3,861 tons of rare-earth chloride. Construction work at IREL's new Orissa Sands complex in Orissa was in an advanced phase. Annual monazite capacity at Orissa will reportedly be 4,000 tons. Problems with the fabrication contractors were cited as the cause for delayed completion of the complex.[16]

Japan.—Japanese consumption of rare earths during 1981 was reported in Roskill's letter from Japan[17] as follows: cerium oxide, 27,000 tons; lanthanum oxide, 500 tons; neodymium oxide, 140 tons (estimated); europium oxide, 3 tons; samarium oxide, 75 tons; yttrium oxide, 120 tons; mischmetal, 550 tons; and rare-earth fluorides, 70 tons.

Japan imported 6,871 tons of rare-earth raw materials in 1981 containing an estimated 4,412 tons of REO.[18] Imports included 2,500 tons of bastnasite, 2,219 tons of rare-earth hydroxides, 2,099 tons of rare-earth chlorides, and 53 tons of crude yttrium oxides.

Japanese imports of rare earths in 1982 were reported in the Japan Metal Journal as follows:

Product	Quantity (kilograms)
Cerium fluoride	261
Cerium oxide	57,843
Lanthanum oxide	82,906
Yttrium oxide	55,874
Crude rare-earth chloride	1,584,120
Ferrocerium and other pyrophoric alloys	15,973
Rare-earth metals including yttrium and scandium	9,084

Leading sources of Japanese imports were China and France.

Santoku Metal Industries began production of neodymium oxide and praseodymium oxide from electrolytic slags and rare-earth separation residues on a pilot scale in 1981. Santoku plans to have full-scale facilities completed by 1983. The plant has planned capacity of 200 to 300 tons of neodymium oxide and 60 to 70 tons of praseodymium oxide[19]

Mitsubishi Chemical Industries reportedly completed a rare-earth separation plant at its Kurosaki factory. The company plans to produce oxides of samarium, gadolinium, europium, terbium, and yttrium.

Nippon Kogyo has reportedly set up an electrolysis plant to refine thulium metal at Mikaichi. The plant has a design capacity to produce 12 tons of thulium metal per year.[20]

Malaysia.—The Malaysia Mining Corp. (MMC) reportedly had the capacity to produce 1,500 tons of byproduct monazite per year from its tin operations in Perak and Selangor States in west Malaysia.[21] At the Berjuntai Tin Dredging Bhd. Mine, one of several mines owned by MMC in Selangor, dredged concentrate averaged 2.0% monazite by weight.[22]

Thailand.—Production of xenotime in Thailand was as follows:[23]

Year	Quantity (tons)
1977	50
1978	--
1979	6
1980	52

United Kingdom.—Steetley Chemicals announced the closing of its 1,500-ton-per-year REO plant at Widnes, England.[24] The principal reasons cited for the closure were the weak rare-earth market during 1982 and built-in overcapacity in the industry. Other causes for the shutdown were delays in bringing the plant into production, highly competitive pricing of products in the industry, and increased foreign production in China, Japan, and France.

Table 4.—Monazite concentrates: World production, by country[1]

(Metric tons)

Country[2]	1978	1979	1980	1981^{p}	1982^{e}
Australia	14,992	16,340	14,079	13,251	13,100
Brazil	^{r}2,541	^{r}1,900	2,532	2,200	2,000
India[3]	3,303	3,254	3,395	3,704	4,000
Malaysia[4]	^{r}1,254	^{r}542	347	320	450
Sri Lanka	213	213	63	^{e}60	60
Thailand	--	32	152	^{e}150	100
United States	W	W	W	W	W
Zaire	77	90	51	50	50
Total	^{r}22,380	^{r}22,371	20,619	19,735	19,760

^{e}Estimated. ^{p}Preliminary. ^{r}Revised. W Withheld to avoid disclosing company proprietary data; not included in "Total."

[1]Table includes data available through Mar. 28, 1983.

[2]In addition to the countries listed, China, Indonesia, North Korea, the Republic of Korea, and Nigeria may produce monazite, but output, if any, is not reported quantitatively, and available general information is inadequate for formulation of reliable estimates of output levels.

[3]Data are for years beginning Apr. 1 of that stated.

[4]Exports.

TECHNOLOGY

It was reported that a new flotation process was developed in China for beneficiating polymetallic ores associated with the rare-earth deposit at Baotou, Inner Mongolia. The flotation process reportedly solved the technical problems of separating rare earths from fluorspar and separating fine-grained iron from iron-containing silicate minerals. Rare-earth recovery rates reportedly were increased as a result of this new process.[25]

Europium oxide-iron cermet was used by the United Kingdom Atomic Energy Authority to build improved reactor control-arm plates. The tips of currently used cadmium-clad plates are "burned up" from high neutron doses, shortening the life of the remainder of the plate. Tests with the neutron-absorbing europium cermet were lower in cost as a result of the extended life of the control-arm plates.[26]

Researchers at Los Alamos National Laboratory developed a new technique for separating and analyzing rare earths. The process selectively ionizes rare-earth atoms using a laser tuned to the characteristic wavelength of a specific element. The technique may be used to produce ultrapure elements, including hard-to-separate rare earths, to measure trace amounts or ratios of elements, and to determine a nuclear weapon's energy yield and performance.[27]

A synthetic analog of the mineral monazite was developed to store and safely dispose of high-level radioactive waste. Researchers at Oak Ridge National Laboratory chose the monazite structure because it can store large amounts of waste per unit volume in a long-term physically and chemically stable form and can be processed at a lower temperature than alternate materials. Naturally occurring monazite, an ore of rare earths, usually contains between 4% and 10% of the actinide thorium. The synthetic monazite has been effective in containing strontium, cesium, and the actinides.[28]

Haber Inc. was developing a new separation process that could be applied to rare earths. The process, called electromolecular propulsion, will reportedly perform separations and purifications that cannot be done by conventional solvent extraction techniques and was expected to speed up separations currently carried out by solvent extraction.[29]

An improved mirror reportedly was developed at Battelle Pacific Northwest Laboratories using a rare-earth solution. Coating the glass substrate with a rare-earth solution before adding the reflective silver coating inhibited corrosion that usually caused the silver backing to separate. The process was developed for solar collecting mirrors but may also be used to improve mirrors for consumers.[30]

An analytical method was developed that utilizes the luminescent properties of europium ions. Europium ions were chelated with tetracycline. By measuring the luminescence of the attached europium, the tetracycline content could be quantified. This simplified method is reportedly capable of detecting tetracycline and its analogs in the nanogram per milliliter range.[31]

Thulium was used in a new portable blood irradiator to suppress early rejection of organ transplants. Developed at Battelle Pacific Northwest Laboratories, the irradiator exposed thulium-169 to a high neutron flux to change it to thulium-170. The thulium-170 emits beta radiation, which irradiates the blood and lowers the level of white blood cells that are responsible for organ transplant rejection.[32]

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[1]Physical scientist, Division of Nonferrous Metals.

[2]All quantities are in metric units unless otherwise specified.

[3]Free on board and/or free into container depot.

[4]Values have been converted from Australian dollars ($A) to U.S. dollars at the rate of $A0.88648=US$1.00 based on yearend 1981 foreign exchange rates from the Wall Street Journal.

[5]Values have been converted from Australian dollars ($A) to U.S. dollars at the rate of $A1.019=US$1.00 based on yearend 1982 foreign exchange rates from the Wall Street Journal.

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[7]Maryborough-Hervey Bay Chronicle. Australian Mineral Sands "Low." Wednesday, May 5, 1982, p. 5.

[8]Ward, J. Mineral Sands—A Dwindling Resource? Pres. at 11th Bureau of Miner. Res. Symp., Aust. Acad. of Sci.

[9]Industrial Minerals (London). Company News and Mineral Notes. No. 175, April 1982, p. 134.

[10]Mining Journal. Labour-Union Ban on Mineral Sands. Jan. 21, 1983, p. 44.

[11]Industrial Minerals (London). Company News Mineral Notes. No. 138, August 1982, p. 65.

[12]Mining Journal. Industry in Action. Mineral Deposits Drops Moreton Authority. Oct. 1, 1982, p. 237.

[13]Brown, G. W. Moving Toward the Year 2000, Baotou Adds Rare Earths Refining Shop. Am. Met. Mark., Tuesday, Nov. 16, 1982, p. 1.

[14]Couch, J. A. Rare Earths From China—Set to Make an Impact. Pres. at Fifth Ind. Miner. Internat. Cong., Madrid, Spain, Apr. 25-29, 1982.

[15]Data for Apr. 1, 1981, to Mar. 31, 1982, 6 pp.

[16]Indian Rare Earths Ltd. 32nd Annual Report 1981-82. P. 17.

[17]Roskill's Letter From Japan. Table 2: Consumption of Rare Earths. No. 74, June 1982, p. 4.

———. Table 1: Rare Earth Manufactures and Principal End-Uses. No. 81, January 1983, p. 3.

[18]———. Table 1: Imports of Rare Earth Raw Materials. No. 74, June 1982, p. 3.

[19]———. Santoku Metal Starts Up Neodymium and Praseodymium Production. No. 81, January 1983, p. 2.

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[23]U.S. Embassy, Bangkok, Thailand. State Department Airgram A-39, May 20, 1982, p. 9. (See Zenotime.)

[24]Industrial Minerals (London). United Kingdom—Steetley Chemicals Closes at Widnes. No. 140, October 1982, p. 15.

[25]Radio broadcast by Xinhua from Beijing, China, in English 12:04 GMT, Dec. 10, 1981.

[26]Moore, D. A., and E. A. Tarrant. Development of Fabrication Techniques for Europia/Iron Cermet Reactor Control-Arm Plates. Am. Ceram. Soc. Bull., v. 62, No. 6, June 1982, pp. 656-660.

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[28]Industrial Research & Development. Special Report 1982 IR 100 Award Winners, Processes and Systems, High-Level Radioactive Waste Stabilization Process. October 1982, p. 132.

[29]Rare-Earth Information Center News. Electro-Molecular Propulsion. V. 17, No. 4, Dec. 1, 1982, p. 4.

Industrial Chemical News. V. 3, May 1982, p. 9.

[30]Rare-Earth Information Center News. RE's in the News, Nice Reflection. V. 17, No. 1, Mar. 1, 1982, p. 2.

[31]Chemical & Engineering News. Lanthanide Chelation Aids Tetracycline Analysis. Sept. 27, 1982, pp. 26-27.

[32]Industrial Research & Development. Special Report 1982 IR 100 Award Winners, Biomedical Tools and Materials, Portable Blood Irradiator ("VCTm"). October 1982, p. 100.

Rhenium

By Ivette E. Torres[1]

Rhenium was produced by three domestic firms in 1982. Two firms recovered rhenium from domestic porphyry copper ores, while the other recovered it on a toll-conversion basis. Consumption of rhenium decreased an estimated 11% from that of 1981, to 5,900 pounds. Imports decreased from 9,669 pounds in 1981 to 5,369 pounds in 1982. The major use continued to be bimetallic platinum-rhenium catalysts to produce low-lead and lead-free gasoline. The price of rhenium decreased throughout the year, reaching $350 per pound for the metal and $300 per pound for the perrhenic acid by yearend.

Domestic Data Coverage.—Domestic consumption data for rhenium are developed by the Bureau of Mines by means of an annual voluntary domestic survey. Of the 37 operations to which a survey request was sent, 70% responded, representing an estimated 86% of the total consumption shown in table 1. The consumption for the remaining 11 nonrespondents was estimated using 1981 consumption levels adjusted for decrease in demand by the oil refineries.

Table 1.—Salient rhenium statistics in the United States

(Pounds of contained rhenium)

	1978	1979	1980	1981	1982
Mine production	W	W	W	W	W
Consumption[e]	12,500	9,500	7,300	6,600	5,900
Imports (metal)	449	927	513	580	176
Imports for consumption of ammonium perrhenate	[1]12,042	8,299	4,991	9,089	5,193
Stocks, Dec. 31	W	W	W	W	W

[e]Estimated. W Withheld to avoid disclosing company proprietary data.
[1]Includes 850 pounds of perrhenic acid.

DOMESTIC PRODUCTION

Kennecott Corp., near Salt Lake City, Utah, and Duval Corp., near Tucson, Ariz., produced rhenium from domestic porphyry copper ores during 1982. Rhenium was recovered as a byproduct of molybdenite (MoS_2) concentrates that are recovered as a byproduct of copper. The rhenium resources owned by Kennecott are located in New Mexico, Utah, and Arizona. Duval's resources are located only in Arizona.

Shattuck Chemical Co., a subsidiary of Phibro Corp., continued to produce rhenium from molybdenite concentrates imported mainly from Canada on a toll-conversion basis for Utah International Inc. Two other producers, M & R Refractory Metals in Winslow, N.J., and Molycorp Inc. in Washington, Pa., remained idle in 1982 owing to lack of demand for rhenium.

CONSUMPTION AND USES

During 1982, the domestic consumption of rhenium decreased an estimated 11% below that of 1981 to 5,900 pounds. The lack of demand for rhenium in platinum-rhenium bimetallic reforming catalysts was the main reason for the decrease in consumption. These catalysts are used by the petroleum industry to produce low-lead and lead-free high-octane gasoline and account for about 80% of all rhenium consumption. These catalysts compete with monometallic platinum catalysts and with other bimetallic catalysts that are used in the reforming process. Although the rhenium content ranges from 0.25% to 0.9%, by weight, the majority of these catalysts contain 0.3% rhenium and 0.3% platinum using alumina (Al_2O_3) as the support. The characteristics that make the platinum-rhenium reforming catalysts so attractive include a lower price when compared with the monometallic platinum catalysts, the ability to tolerate greater carbon accumulation, the resistance toward common poisons like sulfur, and the ability to operate at higher temperatures and lower pressures. The platinum-rhenium catalysts are easily regenerated. The regeneration of these catalysts reduces the annual demand for output of first-generation catalytic feedstock. About 93% of the rhenium and 98% of the platinum can be recovered in this process.

In 1982, the total reforming capacity at domestic refineries decreased by 2.5% to 3,880,630 barrels per stream day. Of this total, 79.5%, or 3,082,500 barrels per stream day, represented bimetallic reforming capacity.[2]

Of the three basic types of bimetallic reforming catalysts, the semiregenerative type accounted for 60.5% of the total reforming capacity. This type of catalyst requires process shutdown for regeneration at specified intervals. Cyclic and other types (nonregenerative, continuous, and moving-bed systems) accounted for 9.8% and 9.2%, respectively, of the total reforming capacity. An estimated 80% of the total reforming capacity employed platinum-rhenium catalysts. Other applications of reforming platinum-rhenium catalysts include the production of benzene, toluene, and xylenes.

About 20% of the total domestic consumption or an estimated 1,200 pounds of rhenium was used in the form of powder or alloys. The major portion of rhenium was contained in tungsten-rhenium and molybdenum-rhenium alloys. When alloyed with other metals, rhenium improves their mechanical and electrical properties, acid and heat resistance, wear and corrosion resistance, and durability. Rhenium was used in the manufacturing of thermocouples, ionization gauges, electron tubes and targets, metallic coatings, semiconductors, heating elements, high-temperature nickel-based alloys, vacuum tubes, mass spectrographs, and electromagnets.

PRICES

In 1982, the price of rhenium and its products continued to decline. This trend began during the second half of 1980 after the price of rhenium reached a record high, which encouraged the recycling of bimetallic platinum-rhenium reforming catalysts by the oil industry. The decline was furthered by a decrease in gasoline demand that still prevails. During the first quarter of 1982, the average price of rhenium metal was about $525 per pound. By the middle of the year, the price decreased to about $425 per pound, dropping to approximately $350 per pound by yearend. The price of perrhenic acid was about $460 per pound during the first quarter and decreased to about $360 per pound by the middle of the year, reaching an average $300 per pound by the end of the year.

FOREIGN TRADE

U.S. imports for consumption of rhenium totaled 5,369 pounds, a decrease of 44.5% from that of 1981. Ammonium perrhenate, with 5,193 pounds of metal content, was the main form of rhenium imported. This represents a 42.9% decrease from that of 1981. The value of these imports was $803,000. All imports of ammonium perrhenate originated from Chile (89%) and the Federal Republic of Germany (11%). Imports of rhenium metal totaled 176 pounds, which represents a 69.7% decrease from that of 1981. The value of these imports totaled almost $88,000 and all but 2 pounds originated from the Federal Republic of Germany.

The import duty on ammonium perrhenate from countries with most-favored-nation status was 3.7% ad valorem; the import duty from countries with non-most-favored-nation status and least developed-developing countries (LDDC) was 25% and 3.1% ad valorem, respectively. The duty on rhenium metal from countries with most-favored-nation status was 4.5% ad valorem for unwrought metal and 7.7% ad valorem for wrought metal. The duty on wrought and unwrought metal from countries with non-most-favored-nation status was 45% and 25% ad valorem, respectively. For the LDDC, the duty on wrought metal was 5.5% ad valorem and 3.7% ad valorem on the unwrought metal. The duty on waste and scrap has been suspended indefinitely.

Table 2.—U.S. imports for consumption of ammonium perrhenate, by country[1]

(Rhenium content)

Country	1978		1979		1980		1981		1982	
	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)
Chile	5,855	$889	4,335	$1,380	2,049	$2,775	5,767	$2,401	4,609	$669
Germany, Federal Republic of	[2]6,187	1,512	3,898	1,854	2,721	4,720	3,322	896	584	134
Poland	--	--	66	25	--	--	--	--	--	--
U.S.S.R	--	--	--	--	135	229	--	--	--	--
Yugoslavia	--	--	--	--	86	165	--	--	--	--
Total	12,042	2,401	8,299	3,259	4,991	7,889	9,089	3,297	5,193	803

[1]Adjusted by the Bureau of Mines.
[2]Includes 850 pounds of perrhenic acid.

Table 3.—U.S. imports for consumption of rhenium metal, by country

Country	1978		1979		1980		1981		1982	
	Gross weight (pounds)	Value	Gross weight (pounds)	Value	Gross weight (pounds)	Value	Gross weight (pounds)	Value	Gross weight (pounds)	Value
Belgium-Luxembourg	15	$6,075	--	--	--	--	--	--	--	--
France	--	--	238	$97,836	100	$43,587	--	--	--	--
Germany, Federal Republic of	434	161,920	468	426,735	390	539,985	578	$573,009	174	$87,413
U.S.S.R	--	--	220	82,594	--	--	--	--	--	--
United Kingdom	--	--	--	--	23	84,135	--	--	2	556
Other[1]	--	--	1	478	--	--	2	1,429	--	--
Total	449	167,995	927	607,643	513	667,707	580	574,438	176	87,969

[1]Includes Austria and Switzerland.

WORLD REVIEW

World production of rhenium in 1982 was estimated to be 29,800 pounds, exclusive of U.S. production. Rhenium was recovered from byproduct MoS_2 from porphyry copper deposits in Canada, Chile, Peru, the U.S.S.R., and the United States. The only exception is in the U.S.S.R. where rhenium was also recovered as a byproduct from the Dzhezkazgan sedimentary copper deposit in Kazakhstan. Rhenium metal and compounds were produced from concentrates in Chile, France, the Federal Republic of Germany, Sweden, the U.S.S.R., the United Kingdom, and the United States.

Canada.—Utah International, the owner of the Copper Island Mine in British Columbia, continued to be the sole producer of rhenium in Canada during 1982. The rhenium was contained in MoS_2 concentrates from copper mining and averaged about 1,000 parts per million. One-half of these concentrates was sent to the Federal Republic of Germany and the other one-half, to the United States for rhenium recovery. About 60% of the total rhenium recovered was returned to Canada to be marketed in the form of perrhenic acid. Rhenium production in Canada for 1982 totaled 4,300 pounds compared with the revised 1981 production figure of 4,045 pounds and was returned to Canada to be marketed.[3]

Chile.—Chilean production of rhenium in 1982 was estimated at 10,000 pounds, the largest amount produced by a market economy country. The Corporación Nacional del Cobre de Chile continued to mine all Chilean rhenium associated with MoS_2 from its copper deposits. Recovery of rhenium in Chile was done by the independent converting facility Molibdenos y Metales S.A. on a toll basis. Chilean MoS_2 was roasted and rhenium produced in the Federal Republic of Germany and the United Kingdom. Other rhenium resources in Chile are associated with MoS_2 in porphyry copper ores at Los Pelambres, Quebrada Blanca, El Abra, and the Disputada de las Condes Mines.

TECHNOLOGY

A method of recovery and refining of rhenium, tungsten, and molybdenum from tungsten-rhenium and molybdenum alloy scrap was developed at the Oak Ridge National Laboratory in Oak Ridge, Tenn.[4] The method consists of oxidizing the scrap with pure oxygen gas in a closed reaction tube to form a volatile rhenium oxide, which is removed as a condensate. The tungsten and molybdenum oxides in the residue can subsequently be separated. The process is reportedly simple and inexpensive, gives a high recovery rate, and generates no environmental pollutants.

The platinum-rhenium, platinum-iridium, and platinum reforming catalysts were compared in a study conducted by Exxon Corp. on the basis of their nature, selectivity, and activity in the reforming process.[5] The study concluded that when both platinum-rhenium and platinum-iridium catalysts were used in the reforming system, because of the difference in their selectiveness, the performance of the system would be improved by increasing the yield of all desirable products.

Different procedures to produce a rhenium coating that would prevent corrosion on the fluorine-hydrazine rocket-engine thrust chambers were tested by the Illinois Institute of Technology Research Institute.[6] The emphasis of this program was directed toward the plasma-arc deposition and exploratory laser melting. Optimum spraying parameters were developed for the plasma-arc deposition that included high-purity powder size, standoff distance, coating thickness, substrate backside, post-spray heat treatment, and linear travel rate. The exploratory laser melting trials resulted in poor wetting of the surface by liquid rhenium. A sodium carbonate-sodium borate mixture was tested to improve wetting but failed the test. Means of improving wetting characteristics would have to be developed before this technique can be used for this application.

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[1]Physical scientist, Division of Ferrous Metals.

[2]Oil and Gas Journal. V. 81, No. 12, Mar. 21, 1983, pp. 126-153.

[3]Hamilton, S. A. Rhenium. (Courtesy of Utah Mines Ltd.) The 1981 Canadian Minerals Yearbook Preprint Series. Chapter 33.1-33.3.

[4]Heshmatpour, B., and R. E. McDonald. Recovery and Refining of Rhenium, Tungsten, and Molybdenum From W-Re, Mo-Re, and Other Alloy Scraps. J. Less-Common Metals, No. 86, 1982, pp. 121-128.

[5]Carter, J. L., G. B. McVicker, W. Weissman, W. S. Kmark, and J. H. Sinfelt. Bimetallic Catalysts; Application in Reforming. Appl. Catalysis, No. 3, 1982, pp. 327-346.

[6]Barton, K. J., R. Yurkewycz, V. Narada, and I. Daniels. Development of Improved Rhenium Coatings for Fluorine Engine Thrust Chambers. Final Report. No. IITRI-N06079-6, 1981, 30 pp.

Salt

By Dennis S. Kostick[1]

Although total domestic production of salt in 1982 was at the lowest level since 1966, apparent domestic consumption was essentially unchanged from the revised 1981 level. As indicated in table 1, salt production and salt sold or used by producers have been decreasing since 1979 because of unusual periods of mild winter weather, reduced demand for chloralkali-based products, and consumer attitudes regarding salt in processed foods.

Domestic Data Coverage.—Domestic production data for salt are developed by the Bureau of Mines from two voluntary surveys of U.S. operations. Typical of these surveys is the salt company survey. Of the 49 companies to which a survey request was sent, 100% responded, representing 100% of the total production shown in table 1. Three producers reported no production of salt in 1982.

Table 1.—Salient salt statistics

(Thousand short tons and thousand dollars)

	1978	1979	1980	1981	1982
United States:					
Production[1]	42,878	46,317	41,483	[r]38,899	37,651
Sold or used by producers[1]	42,869	45,793	40,352	38,907	37,880
Value	$499,345	$538,352	$656,164	[r]$637,568	$671,096
Exports	776	697	831	[r]1,046	1,001
Value	$9,795	$9,025	$12,829	[r]$17,429	$16,647
Imports for consumption	5,380	5,275	5,263	[r]4,319	5,451
Value	$34,247	$40,860	$44,071	[r]$44,523	$56,184
Consumption, apparent	47,473	50,371	44,784	[r]42,180	42,330
World: Production	[r]185,462	[r]191,173	185,626	[p]187,781	[e]186,005

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Excludes Puerto Rico.

Legislation and Government Programs.—The Food and Drug Administration proposed that food manufacturers disclose the salt content in certain processed foods by 1985. The action would also define the conditions under which manufacturers can use the terms "sodium free," "low sodium," "reduced sodium," and "moderately low sodium" on labels.

DOMESTIC PRODUCTION

The total quantity of domestic salt sold or used by producers decreased slightly in 1982 compared with that of 1981. In 1982, 46 companies operated 87 salt-producing plants in 16 States. Eight of the companies sold or used over 1 million short tons each, accounting for 74% of the U.S. total.

The five leading States in quantity of salt sold or used follow:

State	Percent of total	
	1981	1982
Louisiana	32	32
Texas	22	20
New York	14	16
Ohio	9	9
Michigan	6	5
Other States	17	18
Total	100	100

The percentage of salt sold or used by domestic producers, by type, follows:

	Percent	
	1981	1982
Salt in brine	53	48
Mined rock salt	31	36
Vacuum pan salt and grainer or open pan salt	10	10
Solar-evaporated salt	6	6
Total	100	100

Although the weather during the first quarter of 1982 was unseasonably mild compared with previous years, frequent occurrences of freezing rain in the Northeast and the North-central United States necessitated the application of large quantities of rock salt for highway deicing. During the summer, State and municipal governments purchased additional rock salt in anticipation of severe weather at yearend. However, the unexpected mild weather during the last quarter stifled rock salt consumption, left consumers with excessive inventories, and brought production to a standstill. The Detroit Mine of International Salt Co. at Melvindale, Mich., was particularly affected because about 80% of the mine's output was for highway deicing. To obtain additional revenue to minimize worker layoffs and to promote a positive image of salt to the public, the company conducted underground tours for visitors. The tours were an overwhelming success and were scheduled to continue into 1983.[2]

International Salt and its Canadian subsidiary, Iroquois Salt Products Ltd. of Montreal, Quebec, Canada, signed a long-term agreement to purchase and distribute salt from Potash Co. of America (PCA). PCA was scheduled to produce rock salt by yearend at its new potash mine near Sussex, New Brunswick, Canada.[3]

Diamond Crystal Salt Co. signed an agreement to solution mine subterranean salt beds in Michigan to provide cavities for underground storage of gas for Consumers Power Co., a local utility company that owned the salt deposit. In return, Diamond Crystal would use the recovered brine as feedstock for evaporative salt production, thereby reducing brine production costs.[4]

Puerto Rico.—Cabo Rojo Enterprises in Salinas planned to increase solar salt production from 16,000 to 32,000 tons per year by 1983. The company sold solar salt to the following consuming sectors: pharmaceuticals, petrochemicals, tuna packers, feed mills, sugarmills, and leather tanning plants.[5]

Table 2,—Salt sold or used by producers in the United States,[1] by recovery method

(Thousand short tons and thousand dollars)

Recovery method	1981		1982	
	Quantity	Value	Quantity	Value
Evaporated:				
Bulk:				
Open pan or grainer and vacuum pan	3,500	278,878	3,391	293,762
Solar	2,298	42,176	2,441	43,960
Pressed blocks	404	26,099	430	28,466
Total[2]	6,201	r347,153	6,262	366,187
Rock:				
Bulk	11,809	162,457	13,460	187,077
Pressed blocks	62	r4,723	72	5,592
Total[2]	11,871	r167,179	13,532	192,670
Salt in brine (sold or used as such)	20,835	r123,235	18,086	112,239
Grand total[2]	38,907	r637,568	37,880	671,096

rRevised.
[1]Excludes Puerto Rico.
[2]Data may not add to totals shown because of independent rounding.

Table 3.—Salt sold or used by producers in the United States, by State

(Thousand short tons and thousand dollars)

State	1981 Quantity	1981 Value	1982 Quantity	1982 Value
Kansas[1]	r1,410	r60,148	1,588	71,826
Louisiana	12,565	r114,476	12,172	117,569
Michigan	2,321	103,293	2,002	106,303
New York	5,597	103,668	6,205	117,718
Ohio	3,608	90,254	3,514	90,572
Texas	8,397	84,240	7,421	82,805
Utah	1,072	21,775	1,227	23,210
West Virginia	963	W	941	W
Other[2]	2,974	r59,713	2,810	61,093
Total	38,907	r 3637,568	37,880	671,096
Puerto Rico[e]	8	144	16	290

[e]Estimated. [r]Revised. W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Quantity and value of brine included with "Other."
[2]Includes Alabama, Arizona, California, Colorado, Kansas (brine only), Nevada, New Mexico, North Dakota, Oklahoma, and items indicated by symbol W.
[3]Data do not add to total shown because of independent rounding.

Table 4.—Evaporated salt sold or used by producers in the United States, by State

(Thousand short tons and thousand dollars)

State	1981 Quantity	1981 Value	1982 Quantity	1982 Value
Kansas	901	r54,247	914	64,863
Louisiana	232	21,870	289	22,990
Michigan	1,148	89,442	1,112	93,796
New York	649	r51,394	616	52,588
Utah	1,034	21,478	1,181	22,847
Other[1]	2,238	r108,723	2,152	109,103
Total[2]	6,201	r347,153	6,262	366,187
Puerto Rico[e]	8	144	16	290

[e]Estimated. [r]Revised.
[1]Includes Arizona, California, Hawaii, New Mexico, North Dakota, Ohio, Oklahoma, and Texas.
[2]Data may not add to totals shown because of independent rounding.

Table 5.—Rock salt sold by producers in the United States

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1978	14,688	150,794
1979	14,891	152,192
1980	11,806	176,541
1981	11,871	r167,179
1982	13,532	192,670

[r]Revised.

Table 6.—Pressed-salt blocks sold by original producers of salt in the United States

(Thousand short tons and thousand dollars)

Year	From evaporated salt Quantity	From evaporated salt Value	From rock salt Quantity	From rock salt Value	Total Quantity	Total Value
1978	381	20,625	58	3,041	439	23,666
1979	391	19,727	64	3,987	455	23,714
1980	393	24,412	65	4,502	458	28,914
1981	404	26,099	62	r4,723	466	r30,822
1982	430	28,466	72	5,592	1501	34,058

[r]Revised.
[1]Data do not add to total shown because of independent rounding.

Table 7.—Distribution of salt sold or used by producers in the United States, by consumer or use

(Thousand short tons)

Consumer or use	Evaporated: Vacuum pans and open pans	Evaporated: Solar	Rock	Brine	Total[1]
1981:					
Chlorine, caustic soda, soda ash	r100	r646	r1,978	r19,517	r22,241
All other chemicals	214	207	568	r739	r1,728
Textile and dyeing	r106	r23	51	--	r180
Meatpackers, tanners, casing manufacturers	r157	r77	256	--	r491
Dairy	r76	r4	8	--	r88
Canning	r121	r40	70	--	230
Baking	r79	r23	7	--	109
Flour processors (including cereal)	r43	r23	17	--	82
Other food processing	r175	r22	25	--	r222
Feed dealers	r369	r371	r407	--	r1,147
Feed mixers	r227	r108	312	--	r646
Metals	r49	W	228	W	r299
Rubber	r50	W	3	W	r113
Oil	r102	r336	98	r283	r820
Paper and pulp	W	57	130	W	r246
Water softener manufacturers and service companies	r273	rW	218	rW	r700
Grocery stores	r731	r111	179	--	r1,021
Highway use	r76	r113	r6,537	--	r6,725
U.S. Government	r16	r49	62	(2)	r126
Distributors (brokers, wholesalers, etc.)	r500	W	574	W	r1,428
Miscellaneous and undistributed[3]	r214	r744	r760	r677	r1,695
Total[1]	r 4 3,678	r 4 2,954	r 4 12,488	r 4 21,216	r 5 40,336
1982:					
Chlorine, caustic soda, soda ash	111	290	1,296	16,881	18,578
All other chemicals	255	119	349	142	865
Textile and dyeing	100	11	54	--	165
Meatpackers, tanners, casing manufacturers	173	89	287	--	550
Dairy	75	4	7	--	86
Canning	105	19	80	--	204
Baking	101	2	6	--	109
Flour processors (including cereal)	64	1	18	--	83
Other food processing	193	44	30	--	267
Feed dealers	393	205	374	--	972
Feed mixers	225	134	340	--	699
Metals	W	45	212	W	294
Rubber	6	W	5	W	51
Oil	126	323	77	509	1,035
Paper and pulp	W	25	150	W	209
Water softener manufacturers and service companies	276	225	205	12	718
Grocery stores	745	102	206	--	1,053
Highway use	W	392	8,656	W	9,057
U.S. Government	20	W	123	W	152
Distributors (brokers, wholesalers, etc.)	605	W	806	W	1,720
Miscellaneous and undistributed[3]	160	540	644	545	1,443
Total[1]	4 3,734	4 2,570	4 13,926	4 18,088	5 38,310

r Revised. W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous and undistributed."
[1]Data may not add to totals shown because of independent rounding.
[2]Less than 1/2 unit; included with "Miscellaneous and undistributed."
[3]Includes withheld figures and some exports and consumption in overseas areas administered by the United States.
[4]Differs from totals shown in tables 2, 4, and 5 because of changes in inventory.
[5]Differs from totals shown in tables 1, 2, and 3 because of changes in inventory.

NOTE: Additional imported salt distributed by end use shown in table 14.

Table 8.—Distribution (shipments) of evaporated and rock salt[1] in the United States, by destination

(Thousand short tons)

Destination	1981			1982		
	Evaporated			Evaporated		
	Vacuum pans and open pans	Solar	Rock	Vacuum pans and open pans	Solar	Rock
Alabama	r36	W	541	50	W	513
Alaska	5	6	--	W	10	--
Arizona	r25	r41	W	11	60	3
Arkansas	r23	W	37	34	W	59
California	r228	r843	W	142	702	W
Colorado	r48	r105	36	25	122	33
Connecticut	r16	r13	138	12	18	210
Delaware	r3	19	270	3	120	38
District of Columbia	W	W	W	1	W	W
Florida	r75	r70	52	74	50	43
Georgia	r55	r35	71	62	W	79
Hawaii	W	--	--	2	W	--
Idaho	16	r61	W	5	72	W
Illinois	r256	r96	1,042	369	42	1,380
Indiana	r163	W	551	168	12	673
Iowa	r138	r47	231	146	29	321
Kansas	r87	r9	193	100	10	239
Kentucky	r38	W	r560	44	1	394
Louisiana	r49	W	455	58	W	370
Maine	r7	1	110	7	W	156
Maryland	r42	r140	96	44	237	92
Massachusetts	r30	r45	360	36	88	414
Michigan	r139	r37	1,203	215	W	1,348
Minnesota	r130	r74	r338	141	79	354
Mississippi	21	--	139	20	--	93
Missouri	r80	r31	278	105	14	515
Montana	r27	r53	W	4	70	5
Nebraska	r64	r57	96	99	60	121
Nevada	W	r190	W	W	W	W
New Hampshire	r3	W	W	2	W	W
New Jersey	r130	r202	277	119	141	377
New Mexico	10	r116	26	8	W	30
New York	r199	r119	r1,831	271	63	2,125
North Carolina	r112	50	110	146	102	100
North Dakota	r98	r67	r3	39	60	7
Ohio	r280	7	r1,431	326	21	1,609
Oklahoma	r52	18	77	51	18	74
Oregon	23	223	W	11	228	W
Pennsylvania	r188	r114	979	157	162	972
Rhode Island	r7	78	9	5	85	3
South Carolina	r47	W	19	34	10	17
South Dakota	r53	r31	32	42	26	34
Tennessee	r86	--	332	62	--	397
Texas	r164	69	231	154	64	226
Utah	r29	r233	W	5	275	W
Vermont	6	89	115	6	1	183
Virginia	r86	57	168	65	172	146
Washington	r43	r669	W	15	258	W
West Virginia	r17	4	r224	15	W	112
Wisconsin	r200	18	r648	203	12	832
Wyoming	W	27	W	W	37	2
Other[2]	r57	r355	r657	32	651	853
Total	r3,691	r4,519	r13,966	3,745	4,182	15,552

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Other."

[1]Each salt type includes domestic and imported quantities.

[2]Includes shipments to overseas areas administered by the United States, Puerto Rico, exports, some shipments to unspecified destinations, and shipments to States indicated by symbol W.

CONSUMPTION AND USES

Although domestic production declined in 1982, apparent consumption remained at the 1981 level because of increased salt imports. Salt consumption in the chloralkali industry decreased 16% because of the reduced demand for certain chloralkali-based products such as polyvinyl chloride and glass. Production of chlorine gas, caustic soda, and metallic sodium, in thousand tons, in 1982, as reported by the U.S. Department of Commerce, Bureau of the Census, was as follows:

	1981[r]	1982
Chlorine gas (100%)	10,767	9,120
Sodium hydroxide, liquid (100%)	10,414	9,141
Metallic sodium	109	103

[r]Revised.

Domestic and imported salt distributed by producers for highway use, as shown in tables 7 and 14, respectively, increased 45% from 1981 to 1982 despite the relatively mild winter weather. The frequency but not the magnitude of snow and freezing rain storms in certain regions, as well as sizable State and municipal government inventories of salt, contributed to the apparent increase in consumption of deicing salt. An estimated 40% to 50% of the salt sold for highway use in 1982 was still in inventory by 1983.

The 1981 data in tables 7 and 8 were revised because some companies had previously reported inaccurate data.

STOCKS

Total yearend salt stocks of producers increased slightly to 3.4 million tons in 1982 compared with 3.2 million tons reported in 1981. Most stocks were in the form of rock and solar salt.

PRICES

The average values of different classes of salt, f.o.b. works, as reported by producers follow:

	Per ton	
	1981	1982
Evaporated:		
Open pan or grainer and vacuum pan	$79.68	$86.63
Solar	18.35	18.01
Pressed blocks, all sources	66.14	67.84
Rock salt, bulk	13.76	13.90
Salt in brine	[r]5.91	6.21

[r]Revised.

The following yearend 1982 salt prices, which were unchanged from those of 1981, were quoted in Chemical Marketing Reporter:[6]

Salt, evaporated, common, 80-pound bags, carlots or truckloads, North, works, 80 pounds	$3.00
Salt, chemical-grade, same basis, 80 pounds	3.20
Salt, rock, medium coarse, same basis, 80 pounds	2.05
Bulk, same basis, per ton	50.00

FOREIGN TRADE

Exports of salt from the United States decreased slightly in 1982, as shown in tables 1 and 10. Approximately 96% of the salt was shipped to Canada, with minor amounts exported to Mexico, Saudi Arabia, Australia, and Iraq.

U.S. imports of salt increased 26% in 1982, as shown in tables 1 and 11 through 13. Imports from Canada of mainly rock salt and imports from the Bahamas and Mexico of solar salt represented about 80% of the total.

Table 9.—Salt shipped to the Commonwealth of Puerto Rico and overseas areas administered by the United States

Area	1981 Quantity (short tons)	1981 Value (thousands)	1982 Quantity (short tons)	1982 Value (thousands)
Puerto Rico	70,572	$9,144	65,000	$8,450
Virgin Islands	3	1	2	1

Table 10.—U.S. exports of salt, by country

(Thousand short tons and thousand dollars)

Country	1981 Quantity	1981 Value	1982 Quantity	1982 Value
Angola	1	57	(1)	53
Australia	(1)	9	4	69
Bahamas	1	193	1	183
Canada	1,011	11,818	957	11,550
Costa Rica	1	78	(1)	24
Denmark	(1)	38	1	55
Germany, Federal Republic of	(1)	7	(1)	6
Honduras	(1)	23	1	32
Hong Kong	(1)	26	(1)	20
Iraq	r9	r1,604	2	790
Malaysia	--	--	1	10
Mexico	3	399	14	456
Netherlands Antilles	(1)	161	(1)	129
Saudi Arabia	12	2,314	10	2,449
South Africa, Republic of	1	14	1	5
Trinidad and Tobago	(1)	32	(1)	33
United Arab Emirates	1	73	(1)	97
United Kingdom	(1)	55	1	67
Venezuela	1	10	(1)	3
Other	r5	r518	8	616
Total	r1,046	r17,429	1,001	16,647

rRevised.
1Less than 1/2 unit.

Source: U.S. Bureau of the Census.

Table 11.—U.S. imports for consumption of salt

(Thousand short tons and thousand dollars)

Year	In bags, sacks, barrels, or other packages (dutiable) Quantity	In bags, sacks, barrels, or other packages (dutiable) Value	Bulk (dutiable) Quantity	Bulk (dutiable) Value
1979	1	1,760	[1]5,275	[1]39,099
1980	1	1,478	[2]5,263	[2]42,593
1981	27	1,483	r [3]4,292	r [3]43,040
1982	47	1,613	[4]5,404	[4]54,571

rRevised.

1Includes salt brine from Canada through Detroit customs district, 239 short tons ($5,370); from the United Kingdom through Washington, D.C., customs district, less than 1 short ton ($344); from Denmark through Cleveland customs district, 6 short tons ($43,410); from Finland through New York customs district, less than 1 short ton ($949); from Sweden through New York customs district, less than 1 short ton ($637).

2Includes salt brine from Canada through Ogdensburg, N.Y., customs district, 20 short tons ($1,406), and Detroit district, 11,490 short tons ($39,205); from Sweden through New York customs district, 36 short tons ($727); from Denmark through Cleveland customs district, 2 short tons ($20,498); from the Federal Republic of Germany through Boston customs district, 2 short tons ($1,774); from Austria through New York customs district, 50 short tons ($500); from Poland through Cleveland customs district, less than 1 short ton ($300).

3Includes salt brine from Canada through Portland, Maine, and Detroit customs districts, 25 short tons ($372) and 710 short tons ($11,452), respectively; from Denmark through Cleveland customs district, 72 short tons ($1,437); from the United Kingdom through Boston customs district, 500 pounds ($791); from France through Los Angeles customs district, 2,012 short tons ($40,234).

4Includes salt brine from Canada through Portland, Maine, and St. Albans, Vt., customs districts, 26 short tons ($377), and 55 short tons ($2,698), respectively; from Chile through Wilmington, N.C., customs district, 100 pounds ($350); and from the United Kingdom through Washington, D.C., customs district, 200 pounds ($2,152).

Source: U.S. Bureau of the Census.

Table 12.—U.S. imports for consumption of salt, by country

(Thousand short tons and thousand dollars)

Country	1981		1982	
	Quantity	Value	Quantity	Value
Bahamas	753	6,501	843	7,566
Brazil	28	175	147	1,287
Canada[1]	1,685	16,248	2,155	20,847
Chile	77	554	[2]383	[2]3,350
France	2	68	85	674
Germany, Federal Republic of	([3])	38	2	54
Italy	[4]30	[4]669	17	132
Mexico	1,328	[r]15,519	1,350	16,522
Netherlands	[r 5]91	[5]1,588	72	1,731
Netherlands Antilles	149	1,565	112	1,184
Spain	[6]90	[6]753	250	2,326
Tunisia	61	459	31	222
Other	[r 7]25	[r 7]386	[8]4	[8]289
Total	[r]4,319	[r]44,523	5,451	56,184

[r]Revised.
[1]In 1981, includes salt brine through Portland, Maine, customs district, 25 short tons ($372), and Detroit customs district, 710 short tons ($11,452); salt in bags, sacks, and barrels through nine different customs districts amounted to 204 short tons ($1,079,143). In 1982, includes salt brine through Portland, Maine, customs district, 26 short tons ($377), and St. Albans, Vt., customs district, 55 short tons ($2,698).
[2]Includes salt brine through Wilmington, N.C., customs district, 100 pounds ($350).
[3]Less than 1/2 unit.
[4]Includes salt in bags, sacks, and barrels through Boston and New York customs districts, 24 pounds ($3,351).
[5]Includes salt in bags, sacks, and barrels through Philadelphia customs district, 87 pounds ($15,775).
[6]Includes salt in bags, sacks, and barrels through Portland, Maine, Boston, and Chicago customs districts, 3 short tons ($21,947).
[7]Includes salt brine through Cleveland customs district, 72 short tons ($92,309), and Boston customs district, 500 pounds ($791).
[8]Includes salt brine from Denmark through Cleveland customs district, 300 pounds ($5,956); from United Kingdom through Washington, D.C., customs district, 200 pounds ($2,152).

Source: U.S. Bureau of the Census.

Table 13.—U.S. imports for consumption of salt, by customs district

(Thousand short tons and thousand dollars)

Customs district	1981		1982	
	Quantity	Value	Quantity	Value
Anchorage, Alaska	2	252	1	154
Baltimore, Md	135	1,284	255	2,694
Boston, Mass	28	254	([1])	13
Buffalo, N.Y	136	1,155	110	946
Charleston, S.C	--	--	297	2,659
Chicago, Ill	307	2,489	614	5,300
Cleveland, Ohio	35	434	22	189
Detroit, Mich	512	4,527	813	7,749
Duluth, Minn	100	1,358	101	1,097
Los Angeles, Calif	243	2,970	148	2,018
Milwaukee, Wis	334	2,774	354	3,292
Mobile, Ala	--	--	12	56
New Orleans, La	[r]89	752	163	1,251
New York, N.Y	155	2,347	317	3,195
Norfolk, Va	44	371	103	850
Ogdensburg, N.Y	63	714	20	408
Philadelphia, Pa	45	369	146	1,797
Portland, Maine	370	3,583	449	3,968
Portland, Oreg	400	4,280	409	4,344
Providence, R.I	83	805	185	1,489
St. Albans, Vt	65	1,148	67	1,020
San Juan, P.R	7	104	13	200
Savannah, Ga	344	2,388	6	54
Seattle, Wash	568	[r]6,886	602	8,031
Tampa, Fla	88	678	84	914
Wilmington, N.C	166	2,569	160	2,449
Other	1	31	1	46
Total[2]	[r]4,319	[r]44,523	5,451	56,184

[r]Revised.
[1]Less than 1/2 unit.
[2]Data may not add to totals shown because of independent rounding.

Source: U.S. Bureau of the Census.

Table 14.—U.S. imports for consumption of salt, by use as reported by salt producers

(Thousand short tons)

Use	1981	1982
Government (highway use)	1,581	1,786
Chemical industry	r780	760
Water-conditioning service companies	303	117
Other	r392	587
Total[1]	r3,056	[2]3,249

rRevised.
[1]Disagreement with totals in tables 1, 11, 12, and 13 is because of incomplete data on the uses of imported salt.
[2]Data do not add to total shown because of independent rounding.

WORLD REVIEW

Canada.—Les Mines Seleine, owned by Société Québécoise d'Exploration Minière (SOQUEM), the Quebec Government-funded company, commenced production in September at its 1.38-million-ton-per-year salt mine on the Isles de la Madeleine in the Gulf of St. Lawrence. The $80 million project was delayed for 6 months because of flooding during construction. The bulk of mine production was to be used for deicing Quebec highways.[7]

Germany, Federal Republic of.—Physikolisch-Technische Bundesanstalt, a Government agency, presented plans for a 10-year mining project to excavate a salt dome at Gorleben for storage of nuclear waste material. Because West German nuclear reactor operators will be required to have adequate waste storage facilities after 1990, surface preparation of the site was scheduled for 1983, pending license approval, and shaft sinking to a level of 2,950 feet was scheduled from 1985-89. Approximately 1.3 million tons of salt will be recovered and stored near the mine for refilling once the nuclear waste is in place.[8]

Mozambique.—A solar evaporation complex was built using Korean technology at Nova Mambone on the coast of the southern Province of Inhambane. As the third largest solar operation in the country, it was expected to produce 7,500 tons per year by 1985. Output from the operation was planned for domestic uses.[9]

Table 15.—Salt: World production, by country[1]

(Thousand short tons)

Country[2]	1978	1979	1980	1981p	1982e
Afghanistan	89	22	e6	7	10
Albania e	55	70	75	75	75
Algeria	189	r [3]162	[3]154	187	170
Angola e	55	55	55	55	55
Argentina:					
Rock salt	1	1	1	1	[4]1
Other salt	771	682	1,106	1,033	1,000
Australia (marine salt and brine salt)	6,356	5,701	5,859	5,842	6,200
Austria:					
Rock salt	1	1	1	1	1
Evaporated salt	354	419	452	509	500
Salt in brine	172	229	243	248	250
Bahamas	1,800	485	754	1,069	[4]899
Bangladesh[5]	866	743	510	304	300
Benin	([6])	([6])	([6])	([6])	([6])
Brazil:					
Rock salt	631	759	877	925	900
Marine salt	3,006	3,159	3,353	3,049	3,000
Bulgaria	96	95	96	96	95
Burma	336	284	89	93	60
Canada	7,112	7,585	7,748	7,981	8,900
Chile	434	650	486	320	300
China	21,528	16,281	19,048	20,194	17,600
Colombia:					
Rock salt	416	422	383	348	350
Other salt	507	407	541	440	440
Costa Rica	38	51	e44	e43	45
Cuba	144	134	144	177	[4]218

See footnotes at end of table.

Table 15.—Salt: World production, by country[1] —Continued

(Thousand short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Cyprus	[r]3	[r]7	7	10	10
Czechoslovakia	284	299	305	343	330
Denmark[3]	358	419	[e]420	419	440
Dominican Republic	42	[e]42	62	[e]70	70
El Salvador[e]	30	30	30	22	25
Egypt	832	679	701	717	[4]914
Ethiopia:[5]					
Rock salt[e]	11	17	17	17	20
Marine salt	55	[r]102	110	121	120
France:					
Rock salt	505	631	331	328	330
Brine salt	1,215	1,310	1,227	1,204	1,100
Marine salt	952	1,986	[e]1,405	1,517	1,500
Salt in solution	4,254	4,955	4,867	4,266	4,400
German Democratic Republic:					
Rock salt	2,963	3,304	3,391	3,369	3,300
Marine salt	58	60	57	62	60
Germany, Federal Republic of:					
Marketable:					
Rock salt	7,546	9,876	7,450	9,223	7,700
Marine salt and other salt	6,407	6,757	5,111	4,601	5,000
Ghana[e]	55	55	55	55	55
Greece	147	149	133	132	130
Guatemala	12	[r]15	11	15	15
Honduras[e]	35	35	35	35	35
Iceland	--	--	([6])	([6])	([6])
India:					
Rock salt	4	4	6	[e]4	4
Marine salt	7,381	7,751	8,823	9,832	11,000
Indonesia	259	779	761	772	770
Iran[7]	770	770	660	660	770
Iraq[e]	90	100	100	90	90
Israel	134	118	130	146	143
Italy:					
Rock salt and brine salt	4,102	4,949	4,406	3,968	3,900
Marine salt	1,334	[e]1,300	[e]1,400	1,063	1,100
Japan[8]	1,183	[r]1,189	1,226	1,133	1,200
Jordan	33	33	33	33	45
Kampuchea[e]	13	29	33	26	[4]42
Kenya:					
Crude	22	24	30	[e]30	30
Refined	[e]13	[e]13	22	[e]23	25
Korea, North[e]	600	600	630	630	630
Korea, Republic of	717	551	502	496	500
Kuwait	21	21	22	21	20
Laos[e]	17	20	22	22	20
Leeward and Windward Islands[e]	55	55	55	55	55
Lebanon[e]	13	11	13	17	11
Libya[e]	17	11	11	11	11
Madagascar	33	[e]33	[e]33	[e]33	35
Mali[e]	5	5	5	5	5
Malta	1	1	1	1	1
Mauritania[e]	1	1	1	--	--
Mauritius	7	7	7	[e]7	10
Mexico	6,212	6,800	7,248	8,767	8,800
Mongolia[e]	17	17	17	17	20
Morocco	38	112	74	52	55
Mozambique[e]	[r]30	[r]30	30	30	30
Namibia (marine salt)[e]	250	250	250	250	250
Netherlands	3,240	4,355	3,818	3,944	4,000
Netherlands Antilles[e]	440	440	440	440	440
New Zealand	72	61	[9]7	62	60
Nicaragua[e]	[r]20	20	22	20	20
Niger[e]	1	3	3	3	3
Pakistan:[5]					
Rock salt	455	564	546	567	600
Other salt	250	212	220	241	250
Panama	17	[r]19	21	15	14
Peru	384	440	504	551	550
Philippines	249	355	381	391	400
Poland:					
Rock salt	1,582	1,607	1,615	1,447	1,500
Other salt	3,261	3,275	3,383	3,261	3,200
Portugal:					
Rock salt	360	450	442	[e]440	440
Marine salt	165	[e]155	[e]140	[e]130	140

See footnotes at end of table.

Table 15.—Salt: World production, by country[1] —Continued

(Thousand short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Romania:					
Rock salt	1,827	1,819	1,950	1,874	1,900
Other salt	3,397	3,384	3,622	3,638	3,600
Senegal	154	154	154	154	150
Sierra Leone[e]	200	[r]220	220	200	200
Somalia	2	33	[e]30	[e]30	30
South Africa, Republic of	540	594	625	580	[4]646
Spain:					
Rock salt	2,306	2,411	2,622	2,535	2,500
Marine salt and other evaporated salt	1,408	[r]1,390	1,245	1,555	1,500
Sri Lanka	165	134	126	115	110
Sudan	79	90	88	71	80
Switzerland	431	[r]424	417	475	500
Syria	[e]120	83	106	99	100
Taiwan	375	404	796	387	[4]289
Tanzania	32	41	40	41	40
Thailand:					
Rock salt	13	12	19	12	15
Other salt[e]	180	180	180	180	180
Togo	1	1	1	1	1
Tunisia	469	440	482	515	[4]464
Turkey	[r]1,035	[r]1,172	1,289	1,455	1,500
Uganda[e]	1	1	1	20	45
U.S.S.R	[r]15,983	[r]15,763	16,094	16,755	17,000
United Kingdom:					
Rock salt	1,445	1,752	1,925	1,488	1,800
Brine salt[10]	1,940	2,111	1,773	1,603	1,500
Other salt[10]	4,673	4,756	4,189	4,317	4,300
United States, including Puerto Rico:					
Rock salt	14,688	14,891	11,806	11,871	[4]13,532
Other salt:					
United States	28,181	30,902	28,545	27,036	[4]24,348
Puerto Rico[e]	27	27	27	8	16
Venezuela	174	[e]170	268	276	275
Vietnam[e]	585	580	570	660	660
Yemen Arab Republic[e]	30	100	70	60	60
Yemen, People's Democratic Republic of[e]	83	83	90	80	80
Yugoslavia:					
Rock salt	94	151	186	212	[4]472 (all Yugoslavia)
Marine salt	23	23	22	40	
Salt from brine	212	212	205	209	
Total	[r]185,462	[r]191,173	185,626	187,781	186,005

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through June 15, 1983.
[2]Salt is produced in many other countries, but quantities are relatively insignificant and reliable production data are not available.
[3]Data represents sales.
[4]Reported figure.
[5]Year ending June 30 of that stated.
[6]Less than 1/2 unit.
[7]Year beginning Mar. 21 of that stated.
[8]Fiscal year ending Mar. 31 of that stated.
[9]Production of 5,500 tons (312,123 New Zealand dollars), as per Department of State Airgram A-46, Dec. 4, 1981.
[10]Data captioned "Brine salt" for the United Kingdom are the quantities of salt obtained from the evaporation of brines; that captioned "Other salt" are the salt content of brines used for purposes other than production of salt by evaporation.

TECHNOLOGY

Sodium, produced by the electrolysis of molten salt, was used as a heat transfer medium in an advanced liquid sodium solar receiver designed to generate 2.5 million watts of electricity or industrial process heat. The unit achieved a 90% energy conversion efficiency in a 4-month test. Liquid sodium receivers have a greater steam conversion efficiency, lower working pressures, and higher overall heat-transfer rates than conventional water-steam generators.[10]

Researchers at West Virginia University received a grant from the West Virginia Department of Highways to determine whether salt brine was as effective as rock salt as a deicing agent. The researchers planned to experimentally spray salt brine from a gas well field on a section of highway from a truck equipped with a pressurized spraying system and a truck with a gravity-fed system. They also planned to compare the effects of rock salt and salt brine on road surfaces and adjacent vegetation.[11]

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[1]Physical scientist, Division of Industrial Minerals.
[2]Detroit Free Press. Buried Treasure? July 15, 1982, sec. A, p. 3.
[3]Chemical Week. Wrap-Up Rock Salt. V. 130, No. 12, Mar. 24, 1982, p. 21.
[4]Industrial Minerals (London). Diamond and Power in Salt Pact. No. 185, February 1983, pp. 19-20.
[5]Caribbean Business. Local Salt Producer Hopes to Expand Production by 50%. V. 10, No. 20, May 19, 1982, p. 43.
[6]Chemical Marketing Reporter. Current Prices of Chemicals and Related Materials. V. 222, No. 26, Dec. 27, 1982, p. 30.
[7]Engineering and Mining Journal. Salt Production Begins at Canada's Les Mines Seleine. V. 183, No. 11, November 1982, p. 49.
[8]———. West German Salt Dome May Be Used for Nuclear Waste. V. 183, No. 6, June 1982, pp. 45, 49.
[9]Mining Magazine (London). World Highlights. V. 147, No. 1, July 1982, p. 16.
[10]Renewable Energy News (Ottawa, Canada). Liquid-Sodium Receiver 2.5 MW at 90% Efficiency. V. 5, No. 7, October 1982, p. 1.
[11]Gazette (Charleston, W. Va.). Road Salt May Come From Wells. Sec. B, Mar. 25, 1982, p. 4.

Sand and Gravel

By Valentin V. Tepordei[1]

A total of 626 million tons of sand and gravel valued at $2.0 billion, f.o.b. plant, was reported produced in the United States in 1982. This tonnage is the lowest production reported since 1955, 21% lower than that of 1980, when the last full survey was conducted, and 37% below the record high production of 1978, reflecting mainly the impact of the recession on the construction industry. Of this total, about 95% was construction sand and gravel, and 5% was industrial sand and gravel.

Production of construction sand and gravel decreased 22% from that of 1980 and 13% from the estimated production of 1981. Production of industrial sand and gravel de-

Table 1.—Salient sand and gravel statistics in the United States[1]

(Thousand short tons and thousand dollars)

	1978	1979	1980	1981	1982
Sold or used:					
Construction:					
Sand:					
Quantity	489,800	455,000	373,400	NA	217,900
Value	$989,200	$974,100	$925,400	NA	$622,900
Gravel:					
Quantity	473,500	490,500	389,700	NA	278,400
Value	$1,064,000	$1,170,000	$1,071,000	NA	$882,200
Sand and gravel, unprocessed:					
Quantity	NA	NA	NA	NA	100,900
Value	NA	NA	NA	NA	$178,100
Total construction:[2]					
Quantity	963,300	945,500	763,100	[e]690,000	597,200
Value	$2,053,000	$2,144,000	$1,996,000	[e]$1,928,000	$1,683,000
Industrial:					
Sand:					
Quantity	31,810	32,120	28,711	29,250	27,300
Value	$243,200	$275,200	$286,500	$326,300	$332,900
Gravel:					
Quantity	1,041	1,391	865	728	1,000
Value	$5,554	$8,574	$6,458	$5,997	$6,800
Total industrial:[2]					
Quantity	32,850	33,510	29,600	29,980	28,400
Value	$248,800	$283,800	$293,100	$332,300	$339,700
Exports:					
Quantity	4,260	2,076	2,451	2,397	1,946
Value	$29,270	$32,440	$40,660	$36,736	$34,397
Imports for consumption:					
Quantity	625	423	541	337	274
Value	$2,084	$2,321	$2,718	$2,608	$4,002

[e]Estimated. NA Not available.
[1]Puerto Rico excluded from all sand and gravel statistics.
[2]Data may not add to totals shown because of independent rounding.

creased 5% from that of 1981. Industrial sand and gravel is fully surveyed every year; however, a full survey of construction sand and gravel is conducted only for even-numbered years.

Exports of construction sand and gravel decreased 11% to 1.1 million tons valued at $8.1 million, primarily because of decreased gravel shipments to Canada. Imports of construction sand and gravel decreased 44% to 185,000 tons valued at $1.5 million. Domestic apparent consumption of construction sand and gravel in 1982 was 596 million tons.

Exports of industrial sand decreased 28% in 1982 to 818,000 tons valued at $26.3 million, and imports increased 18 times to 89,000 short tons valued at $2.5 million. Domestic apparent consumption of industrial sand and gravel was 28 million tons.

Domestic Data Coverage.—Domestic production data for sand and gravel are developed by the Bureau of Mines from voluntary surveys of U.S. producers. Of the 5,030 active construction sand and gravel operations surveyed in 1982, 3,803, or 76%, reported to the Bureau of Mines. Their combined production represented 64% of the U.S. total shown in the tables. Of the 194 active industrial sand and gravel operations surveyed, 187, or 96%, reported. Their total production represented 97% of the U.S. total shown in the tables. The nonrespondents' production was estimated using preliminary production reports, adjusted prior years production levels, and employment data.

Legislation and Government Programs.—On January 1, 1982, a temporary restraint of the Mine Safety and Health Administration's (MSHA) enforcement of safety rules in surface mining of sand and gravel and stone operations went into effect, as a result of limitations in funding imposed by the U.S. Congress. This temporary restraint was lifted on July 15, 1982, and MSHA's inspectors resumed enforcing the safety rules, this time under new guidelines that reduced the number of significant and substantial violations.

On January 6, 1983, the Surface Transportation Assistance Act of 1982 became Public Law 97-424. This law extended the Federal Highway Trust Fund to September 30, 1988, increased the Federal fuel tax from 4 to 9 cents per gallon, effective April 1, 1983, and increased other fees paid by highway users. The levels of funding established in the act are the highest ever for highways and mass transportation and the highest in constant dollars since the early seventies. The additional funding was expected to increase sand and gravel demand significantly during 1983-86.

CONSTRUCTION SAND AND GRAVEL

DOMESTIC PRODUCTION

Total U.S. production of construction sand and gravel decreased 22% in 1982 compared with that of 1980. At the regional level, the Pacific again led the Nation in the production of construction sand and gravel with 147 million tons or 25% of the U.S. total. Next was the East North Central region with 96 million tons or 16% of the total, followed by the West South Central region with 77 million tons or 13% of the total.

If the four major geographic regions are compared, the West again led the Nation in the production of construction sand and gravel with 36% of the total. North Central was next with 27%, and the South was third with 25%. Production in the North Central and the West decreased approximately 25% and 26%, respectively, while production in the Northeast and South decreased 13% and 16%, respectively.

Based on 1980 census data on population, 1982 U.S. per capita sand and gravel production was 2.6 tons. On a regional basis, per capita production was 5.0 tons in the West, followed by North Central with 2.7 tons, the South with 2 tons, and the Northeast with 1.4 tons.

Construction sand and gravel was produced in every State, and the 10 leading States in 1982 were, in descending order of volume, California, Texas, Alaska, Illinois, Michigan, Minnesota, Colorado, Arizona, and New York. Their combined production represented 52% of the national total.

Compared with that of 1980, 1982 production of construction sand and gravel decreased significantly in most States, including all but one of the top 10. Decreases were 37% in Michigan; 26% to 29% in Ohio, California, and Colorado; 19% to 21% in Minnesota, New York, Illinois, and Arizona; and 9% in Alaska. Texas was the only large producing State that showed an increase, 2% over its 1980 production. The largest percentage decreases in production of sand and gravel over the 2-year interval were recorded in smaller producing States: West

Virginia, 73%; Rhode Island, North Dakota, and Idaho, 54% to 56%; and Tennessee and Arkansas, 42% to 44%.

A total of 3,589 producers of construction sand and gravel with 5,030 operations was canvassed by the Bureau of Mines for the year 1982. Most of the construction sand and gravel produced came from operations larger than 200,000 tons per year; these operations, representing 15% of the total, produced 64% of the total tonnage. The trend toward larger operations with a higher degree of mechanization and automation continued in 1982, and the number of small operations and their share of the market continued to decrease.

The top 10 producers of construction sand and gravel were, in descending order of tonnage, Lone Star Industries Inc.; Koppers Co. Inc.; Conrock Co. Inc.; American Aggregates Corp.; Dravo Corp.; Texas Industries Inc.; Tanner Co.; Gifford-Hill & Co. Inc.; General Development Corp.; and Fordyce Co. Combined production of the 147 operations owned by the top 10 producers represented 13% of the national total.

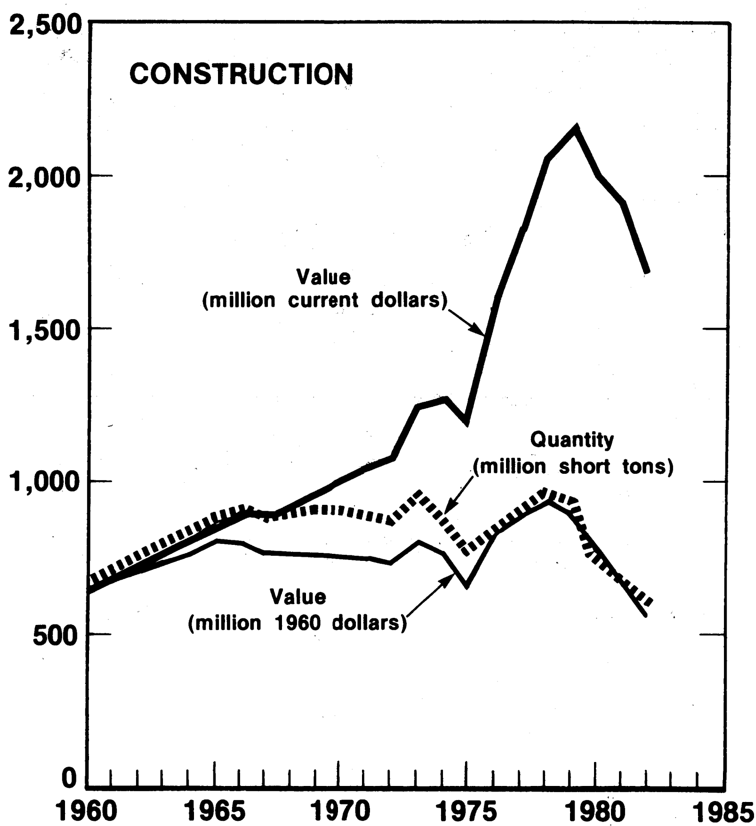

Figure 1.—Production and value of construction sand and gravel in the United States for 1960-82 (includes estimates for 1981).

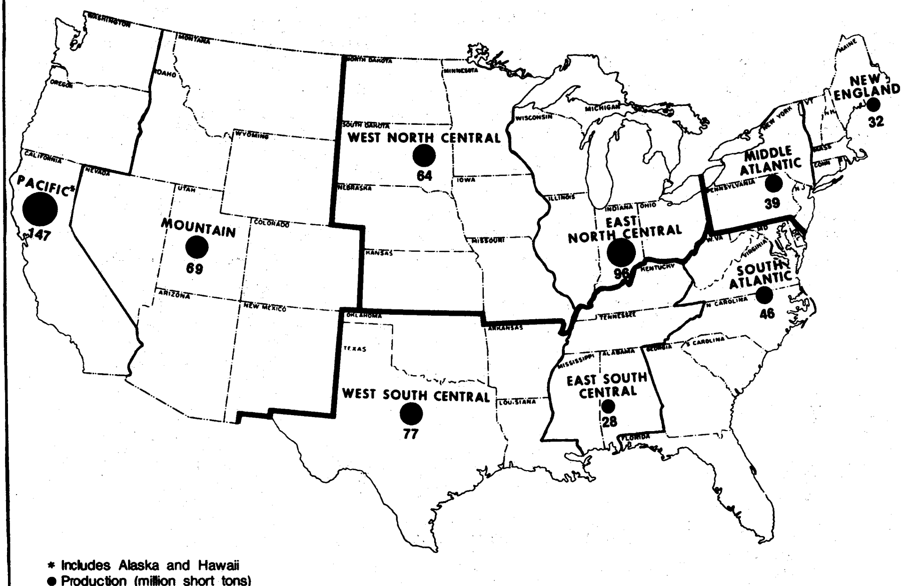

Figure 2.—Production of construction sand and gravel in the United States in 1982, by geographic region.

CONSUMPTION AND USES

Sand and gravel production reported by producers to the Bureau of Mines is actually material that is "sold or used" by the companies and is defined as such. Stockpiled production is not reported until it is sold or consumed. Therefore, the sold or used tonnage represents the amount produced for domestic consumption and export.

Compared with that of 1980, 1982 domestic consumption of construction sand and gravel decreased 22% to 597 million tons valued at $1.7 billion. About 38% of this tonnage was used as concrete aggregates for buildings, highways, dams, and airports; 22%, in road base and coverings; 17%, as construction fill; 14%, as asphaltic concrete aggregates and other bituminous mixtures; 6%, in concrete products such as blocks, bricks, pipes, and, as sand, in plaster and gunite; and the remainder, for railroad ballast, snow and ice control, and other uses.

Most of the sand and gravel for concrete aggregates and concrete products was used in the South, 37%, and West, 29%, regions with high levels of construction activity. Most of the sand and gravel for asphaltic concrete aggregates and road base and road surfacing was used in the West, 38%, and North Central, 35%.

PRICES

Prices in this chapter are f.o.b. plant, which usually is the first point of sale or captive use. This value does not include transportation from the plant or yard to the consumer. It does, however, include all costs of mining, processing, and in-plant transportation.

Compared with that of 1980, the 1982 average unit price of construction sand and gravel increased 8% to $2.82 per ton. Increases were higher than average for some end uses including concrete products, 17%, and railroad ballast, 21%, and lower than average for concrete aggregates, 8%; asphaltic concrete aggregates, 6%; road base and coverings, 8%; and fill, 2%.

TRANSPORTATION

Of the total construction sand and gravel produced in 1982, 87% was transported by truck from the plant to the first point of sale or use, 9% was used at the plantsite, and the remainder was transported by rail or waterway. Because most of the producers had not kept records nor reported the distance that the construction sand and gravel was shipped nor the cost per ton per mile, no transportation cost data were available.

FOREIGN TRADE

Exports.—Exports of construction sand increased 3% to 631,000 tons, but decreased 14% in value to $5.4 million; 91% of these went to Canada. Exports of construction gravel decreased 24% to 497,000 tons, but increased 9% in value to $2.7 million; 49% of these went to Canada.

Imports.—Imports of construction sand and gravel decreased 44% to 185,000 tons and 26% in value to $1.5 million; 84% of these came from Canada.

TECHNOLOGY

The 66th annual convention of the National Sand and Gravel Association was held in February 1982 in Las Vegas, Nev., in conjunction with the biennial International Concrete & Aggregate Show. Topics covered included plant automation through the use of computerized controls, improvements in pit production, new trends in the marketing of sand and gravel, and the effects of current and proposed legislation and regulation on the sand and gravel industry, including the Highway Trust Fund.[2]

In April 1982, the 18th Annual Forum on Geology of Industrial Minerals, sponsored by the Indiana Geological Survey and Indiana University's Department of Geology, was held in Bloomington, Ind.[3] Most of the papers dealt with construction materials, the theme of the conference.

A feasibility study regarding mining and marketing of sand and gravel from offshore deposits in southern California was published by California Geology magazine in December 1982. The study proposed a prototype mining and processing vessel that could produce 1.1 million tons per year. Analysis had shown that the proposed operation is economically feasible. Also, the geology of the offshore deposits was reviewed.[4]

Table 2.—Construction sand and gravel sold or used in the United States, by geographic region

Geographic region	1981				1982			
	Quantity[e] (thousand short tons)	Percent of total	Value[e] (thousands)	Percent of total	Quantity (thousand short tons)	Percent of total	Value (thousands)	Percent of total
Northeast:								
New England	35,600	5	$90,300	5	32,321	5	$89,062	5
Middle Atlantic	42,000	6	132,700	7	38,545	6	129,049	8
North Central:								
East North Central	119,600	17	308,400	16	96,047	16	254,355	15
West North Central	71,300	10	160,800	8	63,864	11	146,533	9
South:								
South Atlantic	48,200	7	132,300	7	45,589	8	134,904	8
East South Central	35,800	5	92,800	5	28,025	5	76,195	5
West South Central	81,400	12	247,600	13	76,651	13	242,270	14
West:								
Mountain	78,600	12	257,100	13	68,996	12	192,799	11
Pacific	177,500	26	506,100	26	147,132	25	418,034	25
Total[1]	690,000	100	1,928,000	100	597,200	100	1,683,000	100

[e]Estimated.
[1]Data may not add to totals shown because of independent rounding.

Table 3.—Construction sand and gravel sold or used in the United States, by State

(Thousand short tons and thousand dollars)

State	1981[e]		1982	
	Quantity	Value	Quantity	Value
Alabama	9,503	23,340	7,019	17,226
Alaska	41,000	75,600	40,832	74,895
Arizona	20,990	63,340	19,124	58,375
Arkansas	9,146	22,400	7,076	19,056
California	107,200	352,100	81,147	270,995
Colorado	23,500	73,300	19,591	60,780
Connecticut	6,500	15,400	4,920	16,388
Delaware	1,205	2,959	1,300	3,197
Florida	14,910	30,600	13,749	30,481
Georgia	3,364	8,308	3,166	8,361
Hawaii	459	1,198	449	1,221
Idaho	3,063	7,329	2,340	6,258
Illinois	25,150	68,970	21,557	59,149
Indiana	15,870	41,330	13,097	34,579
Iowa	10,330	29,080	10,064	25,618
Kansas	10,500	21,000	9,720	20,612
Kentucky	6,939	16,070	6,499	15,936
Louisiana	17,240	53,550	16,558	50,966
Maine	7,500	19,400	6,701	15,118
Maryland	9,500	31,800	9,720	32,386
Massachusetts	12,500	31,300	12,003	34,438
Michigan	28,100	68,050	20,567	47,726
Minnesota	23,950	49,770	20,276	44,222
Mississippi	10,480	29,260	9,455	27,115
Missouri	7,500	16,900	6,359	14,477
Montana	5,640	12,910	5,338	12,794
Nebraska	11,770	28,310	11,282	28,128
Nevada	7,065	15,770	6,027	11,724
New Hampshire	4,528	12,990	4,332	12,593
New Jersey	9,756	26,050	7,940	25,722
New Mexico	6,496	19,780	5,616	17,670
New York	18,280	45,560	17,524	47,799
North Carolina	6,294	18,330	5,198	15,395
North Dakota	3,000	6,500	2,347	4,873
Ohio	32,240	95,570	26,311	83,684
Oklahoma	9,000	21,700	7,490	17,733
Oregon	12,000	35,100	9,513	30,629
Pennsylvania	14,000	61,100	13,081	55,527
Rhode Island	1,332	3,985	1,146	3,671
South Carolina	5,131	13,240	4,727	13,170
South Dakota	4,285	9,224	3,816	8,604
Tennessee	8,830	24,130	5,051	15,917
Texas	46,000	150,000	45,527	154,515
Utah	8,212	54,550	7,579	14,920
Vermont	3,196	7,254	3,218	6,854
Virginia	7,109	24,470	6,978	28,522
Washington	16,870	42,130	15,190	40,295
West Virginia	651	2,601	751	3,392
Wisconsin	18,210	34,522	14,515	29,218
Wyoming	3,680	10,120	3,382	10,279
Total[1]	690,000	1,928,000	597,200	1,683,000

[e]Estimated.

[1]Data may not add to totals shown because of independent rounding.

Table 4.—Construction sand and gravel production in the United States in 1982, by size of operation

Size range	Number of operations	Percent of total	Thousand short tons	Percent of total
Less than 25,000	1,681	34.3	17,241	2.9
25,000 to 49,999	829	16.9	30,571	5.1
50,000 to 99,999	897	18.3	65,536	11.0
100,000 to 199,999	737	15.0	106,177	17.8
200,000 to 299,999	294	6.0	72,922	12.2
300,000 to 399,999	178	3.6	61,725	10.3
400,000 to 499,999	78	1.6	33,734	5.6
500,000 to 599,999	61	1.2	32,772	5.5
600,000 to 699,999	43	.9	27,212	4.6
700,000 to 799,999	28	.6	20,946	3.5
800,000 to 899,999	23	.5	19,593	3.3
900,000 to 999,999	11	.2	10,408	1.7
1,000,000 to 1,499,999	24	.5	28,422	4.8
1,500,000 to 1,999,999	9	.2	16,026	2.7
2,000,000 to 2,499,999	4	.1	8,895	1.5
2,500,000 and over	4	.1	44,991	7.5
Total	4,901	100.0	[1]597,200	100.0

[1]Data do not add to total shown because of independent rounding.

Table 5.—Number of construction sand and gravel active operations[1] and processing plants in the United States in 1982, by geographic region

Geographic region	Number of active operations		Active operations with processing plants: Associated with extraction areas on land			Associated with dredging operations		Total number of active operations without plants[2]
	Total	With plants[2]	Plants at site: Stationary	Plants at site: Portable	Plants not at site (stationary or portable)	Plants on board	Plants on land	
Northeast:								
New England	429	345	162	144	26	2	11	52
Middle Atlantic	530	452	197	206	6	9	34	76
North Central:								
East North Central	955	827	414	308	13	19	73	78
West North Central	927	789	229	387	10	31	132	70
South:								
South Atlantic	327	221	113	34	9	14	51	86
East South Central	216	162	69	35	9	17	32	29
West South Central	417	309	161	62	9	18	59	88
West:								
Mountain	605	551	211	269	24	9	38	47
Pacific	495	450	273	141	10	4	22	53
Total	4,901	4,106	1,829	1,586	116	123	452	579

[1]An undetermined number of operations leased from the Bureau of Land Management in Alaska are counted as one operation.
[2]Based on reports submitted by individual companies.

Table 6.—Number of construction sand and gravel active operations[1] and processing plants in the United States in 1982, by State

State	Number of active operations		Active operations with processing plants					Total number of active operations without plants[2]
			Associated with extraction areas on land			Associated with dredging operations		
	Total	With plants[2]	Plants at site: Stationary	Plants at site: Portable	Plants not at site (stationary or portable)	Plants on board	Plants on land	
Alabama	66	49	19	12	3	4	11	10
Alaska	26	23	11	10	--	1	1	5
Arizona	104	98	55	34	5	1	3	7
Arkansas	110	50	23	12	4	6	5	57
California	260	256	166	73	4	3	10	14
Colorado	166	151	39	82	6	5	19	13
Connecticut	79	72	34	29	7	1	1	8
Delaware	8	7	3	2	--	--	2	1
Florida	40	31	10	2	--	2	17	6
Georgia	32	28	16	--	--	1	11	2
Hawaii	4	2	1	1	--	--	--	1
Idaho	51	45	26	13	2	--	4	8
Illinois	156	141	64	54	--	7	16	17
Indiana	140	127	63	36	1	3	24	13
Iowa	157	163	52	88	2	--	21	6
Kansas	154	106	23	39	1	3	40	22
Kentucky	27	25	11	1	3	7	3	1
Louisiana	80	63	10	13	1	5	34	4
Maine	125	84	16	56	6	--	6	21
Maryland	45	27	12	5	2	--	8	7
Massachusetts	115	90	53	26	7	1	3	13
Michigan	250	177	49	101	8	7	12	20
Minnesota	241	178	60	107	3	--	8	19
Mississippi	69	42	13	14	--	1	14	11
Missouri	79	73	15	24	3	14	17	5
Montana	68	62	22	35	3	--	2	4
Nebraska	160	146	38	51	--	12	45	14
Nevada	51	44	15	21	4	--	4	6
New Hampshire	39	39	24	13	2	--	--	--
New Jersey	57	49	27	8	--	1	13	8
New Mexico	62	60	18	35	3	1	3	3
New York	354	296	107	172	5	1	11	56
North Carolina	100	55	30	15	3	2	5	43
North Dakota	46	44	14	29	--	--	1	1
Ohio	219	206	142	43	2	1	18	17
Oklahoma	76	63	20	22	2	3	16	12
Oregon	80	72	42	20	5	--	5	7
Pennsylvania	119	107	63	26	1	7	10	12
Rhode Island	14	13	7	5	--	--	1	1
South Carolina	41	28	12	5	2	3	6	12
South Dakota	90	79	27	49	1	2	--	3
Tennessee	54	46	26	8	3	5	4	7
Texas	151	133	108	15	2	4	4	15
Utah	62	53	22	31	--	--	--	3
Vermont	57	47	28	15	4	--	--	9
Virginia	57	40	27	5	2	5	1	15
Washington	125	97	53	37	1	--	6	26
West Virginia	4	5	3	--	--	1	1	--
Wisconsin	190	176	96	74	2	1	3	11
Wyoming	41	38	14	18	1	2	3	3
Total	4,901	4,106	1,829	1,586	116	123	452	579

[1]An undetermined number of operations leased from the Bureau of Land Management in Alaska are counted as one operation.

[2]Based on reports submitted by individual companies.

Table 7.—Construction sand and gravel sold or used in the United States in 1982, by major use

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	228,060	$728,359	$3.19
Plaster and gunite sands	8,087	28,585	3.53
Concrete products (blocks, bricks, pipe, decorative, etc.)	26,543	87,180	3.28
Asphaltic concrete aggregates and other bituminous mixtures	86,116	263,622	3.06
Road base and coverings	130,948	342,312	2.61
Road stabilization (cement)	1,126	2,658	2.36
Road stabilization (lime)	342	609	1.78
Fill	98,344	178,551	1.82
Snow and ice control	6,923	15,983	2.31
Railroad ballast	1,058	3,383	3.20
Other	9,622	31,958	3.32
Total[1]	597,200	1,683,000	2.82

[1]Data may not add to totals shown because of independent rounding.

Table 8.—Construction sand and gravel sold or used in the

(Thousand short tons

Geographic region	Concrete aggregate (including concrete sand)		Plaster and gunite sands		Concrete products (blocks, bricks, pipe, decorative, etc.)		Asphaltic concrete aggregates and other bituminous mixtures	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Northeast:								
New England	10,086	34,459	178	734	1,619	5,235	4,647	14,141
Middle Atlantic	11,520	45,711	1,282	4,907	2,378	9,449	6,351	25,437
North Central:								
East North Central	33,073	92,463	744	2,578	4,770	13,869	17,838	50,475
West North Central	20,439	54,814	530	1,597	2,769	7,025	9,829	20,668
South:								
South Atlantic	23,604	74,760	1,159	3,666	3,431	13,798	5,009	17,458
East South Central	12,836	35,101	159	735	1,243	2,970	6,813	21,009
West South Central	50,628	172,763	706	2,007	3,717	12,055	4,603	17,829
West:								
Mountain	21,537	68,899	1,076	3,519	1,935	7,144	10,347	28,923
Pacific	44,338	149,389	2,254	8,841	4,682	15,633	20,678	67,683
Total[2]	228,062	728,359	8,087	28,585	26,543	87,180	86,116	263,622

W Withheld to avoid disclosing company proprietary data; included in "Total."
[1]Includes road and other stabilization (cement and lime).
[2]Data may not add to totals shown because of independent rounding.

United States in 1982, by geographic region and major use

and thousand dollars)

Road base and coverings[1]		Fill		Snow and ice control		Railroad ballast		Other uses		Total[2]	
Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
7,583	17,418	4,682	8,597	2,206	4,458	90	214	1,230	3,805	32,321	89,062
9,340	25,749	5,091	10,503	1,784	4,429	70	237	728	2,626	38,545	129,049
25,143	65,114	11,548	21,261	1,218	2,539	48	164	1,664	5,892	96,047	254,355
22,503	47,595	5,800	9,501	553	1,342	328	677	1,113	3,316	63,864	146,533
3,344	9,877	8,075	11,814	W	W	W	W	859	3,264	45,589	134,904
4,795	12,026	1,784	3,032	93	283	8	18	294	1,020	28,025	76,195
7,037	19,748	9,360	15,827	W	W	W	W	495	1,776	76,651	242,270
25,880	65,905	6,602	13,595	454	1,128	219	1,075	946	2,611	68,996	192,799
26,790	82,148	45,402	84,422	449	1,381	247	887	2,292	7,648	147,132	418,034
132,415	345,579	98,344	178,551	6,923	15,983	1,058	3,383	9,622	31,958	597,200	1,683,000

Table 9.—Construction sand and gravel sold or used in the

(Thousand short tons

State	Concrete aggregates (including concrete sand)		Plaster and gunite sands		Concrete products (blocks, bricks, pipe, decorative, etc.)		Asphaltic concrete aggregates and other bituminous mixtures	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Alabama	3,985	10,655	W	W	372	1,100	1,026	2,657
Alaska	1,367	5,934	W	W	W	W	1,938	2,358
Arizona	6,021	20,708	572	1,815	796	2,960	3,319	10,981
Arkansas	3,834	12,295	208	508	308	747	682	2,070
California	36,551	125,672	2,074	8,347	3,822	12,421	14,869	53,312
Colorado	5,236	19,436	217	725	594	2,724	2,591	6,947
Connecticut	1,678	6,455	13	75	238	846	613	2,260
Delaware	340	927	37	135	W	W	W	W
Florida	7,198	18,026	757	2,519	382	968	639	3,452
Georgia	2,446	6,628	W	W	126	349	W	W
Hawaii	W	W	--	--	--	--	--	--
Idaho	929	3,202	W	W	28	81	167	624
Illinois	8,615	23,986	141	518	890	2,660	4,068	11,270
Indiana	4,801	13,322	W	W	726	2,127	2,836	8,812
Iowa	4,382	12,799	96	374	56	191	2,330	4,564
Kansas	3,493	8,105	W	W	323	843	1,393	3,066
Kentucky	3,812	9,270	30	79	380	723	1,712	4,669
Louisiana	10,027	30,759	13	53	1,042	3,375	1,740	8,513
Maine	1,007	3,107	--	--	102	298	1,694	4,553
Maryland	4,766	17,204	--	--	1,018	3,266	1,730	5,200
Massachusetts	5,046	17,663	W	W	781	2,108	1,028	3,284
Michigan	5,540	15,254	157	578	821	2,285	3,068	6,499
Minnesota	5,587	14,881	142	503	1,447	3,394	3,005	5,775
Mississippi	3,324	9,358	W	W	267	579	2,939	9,741
Missouri	3,241	8,513	8	27	145	428	747	1,870
Montana	883	2,826	W	W	60	253	712	2,021
Nebraska	2,453	5,930	W	W	713	1,928	1,392	3,458
Nevada	2,325	5,192	26	109	103	215	1,411	2,747
New Hampshire	1,416	4,658	28	84	122	377	902	2,849
New Jersey	2,767	10,205	762	2,618	471	1,591	1,242	3,554
New Mexico	2,049	7,534	99	423	245	609	427	1,734
New York	4,193	14,829	157	595	800	2,377	2,696	9,334
North Carolina	2,861	9,101	205	632	131	393	993	3,094
North Dakota	475	1,433	W	W	W	W	323	601
Ohio	9,448	29,558	253	851	1,872	5,813	5,776	19,010
Oklahoma	4,175	11,757	174	301	241	790	532	1,073
Oregon	1,678	5,343	8	W	223	1,154	1,941	6,483
Pennsylvania	4,559	20,676	363	1,694	1,107	5,482	2,413	12,550
Rhode Island	W	W	W	W	W	W	115	295
South Carolina	2,353	6,915	30	W	362	1,280	928	3,478
South Dakota	808	3,153	6	29	W	10	640	1,334
Tennessee	1,716	5,818	W	W	224	568	1,136	3,942
Texas	32,591	117,952	310	1,145	2,125	7,143	1,649	6,172
Utah	3,040	5,911	95	185	W	W	1,261	2,387
Vermont	794	2,157	W	W	51	144	295	900
Virginia	3,114	13,622	W	W	1,351	7,270	410	1,279
Washington	4,736	12,408	153	302	618	1,979	1,931	5,530
West Virginia	525	2,336	--	--	W	W	W	W
Wisconsin	4,669	10,343	W	W	461	985	2,090	4,884
Wyoming	1,054	4,090	21	118	W	W	459	1,482
Total[2]	227,908	727,906	7,155	25,342	25,944	84,834	85,808	262,668
Undistributed	150	450	933	3,244	596	2,349	308	955
U.S. total[2]	228,062	728,359	8,087	28,585	26,543	87,180	86,116	263,622

W Withheld to avoid disclosing company proprietary data; included by State in "Other and undistributed uses" column, and by use in "Undistributed" line. XX Not applicable.

[1]Includes road and other stabilization (cement and lime).

[2]Data may not add to totals shown because of independent rounding.

[3]Less than 1/2 unit.

United States in 1982, by State and major use

and thousand dollars)

Road base and coverings[1]		Fill		Snow and ice control		Railroad ballast		Other and undistributed uses		Total[2]	
Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
947	1,830	650	892	W	W	--	--	41	93	7,019	17,226
1,498	3,442	35,956	62,758	37	176	--	--	37	226	40,832	74,895
5,778	15,251	2,511	6,198	75	209	3	9	50	246	19,124	58,375
1,656	2,729	311	500	--	--	--	--	78	207	7,076	19,056
17,328	54,725	4,781	10,630	192	575	153	517	1,377	4,796	81,147	270,995
9,164	26,635	1,116	2,001	209	620	137	803	327	888	19,591	60,780
1,189	3,215	631	1,480	310	977	--	--	248	1,081	4,920	16,388
751	1,652	63	135	--	--	--	--	110	346	1,300	3,197
74	119	4,699	5,397	--	--	--	--	--	--	13,749	30,481
257	712	113	180	--	--	--	--	223	491	3,166	8,361
W	W	405	1,066	--	--	--	--	44	155	449	1,221
774	1,539	322	483	5	7	W	W	112	323	2,340	6,258
4,827	13,794	2,510	5,062	W	W	W	W	507	1,858	21,557	59,149
2,187	4,959	1,896	3,581	209	440	W	W	443	1,339	13,097	34,579
1,927	4,610	997	1,933	78	208	--	--	199	940	10,064	25,618
2,223	4,527	1,666	2,668	125	412	W	W	498	991	9,720	20,612
280	607	253	499	W	W	8	18	25	69	6,499	15,936
1,997	5,264	1,668	2,835	70	167	--	--	--	--	16,558	50,966
1,825	3,318	1,017	1,967	732	966	22	93	303	818	6,701	15,118
881	2,530	841	2,232	2	6	--	--	481	1,948	9,720	32,386
2,094	5,006	1,796	3,144	738	1,619	W	W	520	1,613	12,003	34,438
7,949	18,448	2,302	3,136	420	641	16	47	293	839	20,567	47,726
7,683	15,721	1,684	2,424	191	349	30	97	506	1,078	20,276	44,222
2,293	6,332	512	787	W	W	--	--	119	320	9,455	27,115
1,712	2,459	343	659	68	170	--	--	95	350	6,359	14,477
2,636	5,998	750	1,164	98	172	W	W	200	361	5,338	12,794
5,720	14,676	661	1,124	25	49	W	W	318	964	11,282	28,128
1,651	2,432	461	903	24	53	--	--	26	72	6,027	11,724
1,114	3,123	327	616	239	384	10	22	175	477	4,332	12,593
949	2,798	1,399	3,577	242	897	--	--	107	483	7,940	25,722
2,204	5,839	481	1,135	--	--	4	14	107	382	5,616	17,670
5,044	11,688	2,801	4,731	1,373	2,886	46	153	413	1,206	17,524	47,799
474	1,252	482	750	9	35	--	--	45	136	5,198	15,395
1,256	2,118	183	354	([3])	1	--	--	110	367	2,347	4,873
5,241	18,666	2,879	6,596	324	977	2	6	516	2,206	26,311	83,684
280	593	2,023	2,845	5	14	--	--	61	360	7,490	17,733
4,230	13,718	813	1,829	56	202	8	W	557	1,901	9,513	30,629
3,346	11,263	891	2,195	168	645	24	84	208	938	13,081	55,527
229	688	277	609	W	W	--	--	525	2,079	1,146	3,671
113	136	843	1,130	--	--	W	W	98	231	4,727	13,170
1,982	3,483	266	338	65	155	W	78	47	24	3,816	8,604
1,275	3,257	370	855	W	W	--	--	332	1,476	5,051	15,917
3,105	11,162	5,358	9,646	W	W	W	W	387	1,295	45,527	154,515
2,308	4,978	651	955	W	W	--	--	224	503	7,579	14,920
1,133	2,068	634	780	162	416	W	W	150	390	3,218	6,854
724	3,088	1,030	1,979	W	W	--	--	350	1,285	6,978	28,522
3,706	10,184	3,447	8,138	164	429	86	349	348	976	15,190	40,295
W	W	5	11	--	--	--	--	221	1,045	751	3,392
4,940	9,246	1,961	2,886	193	334	W	W	200	539	14,515	29,218
1,365	3,233	310	757	--	--	W	W	173	598	3,382	10,279
132,319	345,111	98,346	178,551	6,608	15,191	549	2,290	12,534	41,309	597,200	1,683,000
99	467	--	--	314	794	510	1,093	XX	XX	XX	XX
132,415	345,579	98,344	178,551	6,923	15,983	1,058	3,383	XX	XX	597,200	1,683,000

Table 10.—Transportation of construction sand and gravel in the United States in 1982 to site of first sale or use

Method of shipment	Thousand short tons	Percent of total
Truck	519,059	86.9
Rail	6,828	1.1
Waterway	13,535	2.3
Not shipped, used at site	55,561	9.3
Unspecified	2,187	.4
Total	[1]597,200	100.0

[1]Data do not add to total shown because of independent rounding.

Table 11.—U.S. exports of construction sand and gravel, by country

(Thousand short tons and thousand dollars)

Country	Construction sand		Gravel	
	Quantity	F.a.s. value[1]	Quantity	F.a.s. value[1]
1981				
Bahamas	(2)	10	23	104
Canada	574	2,632	609	1,977
Germany, Federal Republic of	3	157	--	--
Mexico	13	366	11	87
Saudi Arabia	4	392	1	40
United Kingdom	1	124	--	--
Venezuela	1	206	(2)	2
Other	17	2,411	8	244
Total	613	6,298	652	2,454
1982				
Bahamas	(2)	12	29	150
Canada	573	1,943	434	1,307
Mexico	37	657	2	49
Panama	4	85	2	66
Peru	6	569	(2)	11
Saudi Arabia	2	161	(2)	103
Republic of South Africa	(2)	3	5	401
Other	9	1,967	25	593
Total	631	5,397	497	2,680

[1]Value of material at U.S. port of export; based on transaction price, including all charges incurred in placing material alongside ship.
[2]Less than 1/2 unit.

Table 12.—U.S. imports for consumption of construction sand and gravel, by country

(Thousand short tons and thousand dollars)

Country	1981		1982	
	Quantity	C.i.f. value[1]	Quantity	C.i.f. value[1]
Antigua and Barbuda	56	812	17	210
Australia	(2)	2	4	476
Bahamas	--	--	9	32
Canada	275	1,112	155	659
Other	2	61	(2)	102
Total	333	1,987	185	1,479

[1]Value of material at U.S. port of entry; based on purchase price and includes all charges (except U.S. import duties) in bringing material from foreign country to alongside carrier.
[2]Less than 1/2 unit.

INDUSTRIAL SAND AND GRAVEL

DOMESTIC PRODUCTION

In 1982, the total output of industrial sand and gravel decreased 5% compared with that of 1981, to 28.4 million tons. At the regional level, North Central continued to lead the Nation with 10.9 million tons or 38% of the U.S. total, followed closely by the South with 10.2 million tons or 36% of the total. Next were the West with 3.9 million tons or 14% of the total and the Northeast with 3.4 million tons or 12%. Approximately 74% of total U.S. industrial sand and gravel was produced in two major geographic regions, North Central and South.

Based on the 1980 census data on population, U.S. per capita industrial sand and gravel production was 0.13 ton. Per capita production by regions was 0.19 ton in the North Central, followed by the South with 0.13 ton, the West with 0.09 ton, and the Northeast with 0.07 ton.

A comparison of 1981 and 1982 production by major geographic regions indicates that the output of industrial sand and gravel in the North Central decreased 18%, more than three times the national average of 5%, and decreased 3% in the Northeast. At the same time, production of industrial sand increased 2% in the South and 16% in the West, a region with a much smaller output.

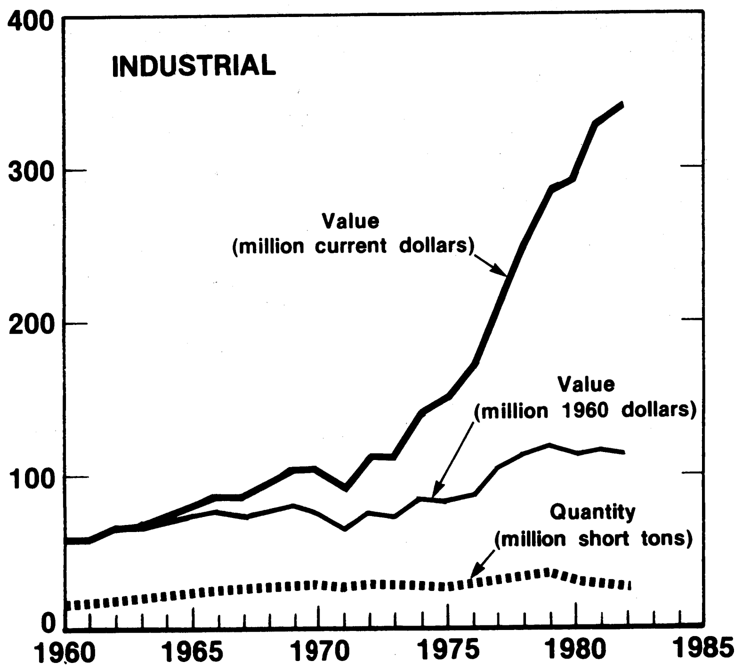

Figure 3.—Production and value of industrial sand and gravel in the United States for 1960-82.

The five leading States in the production of industrial sand and gravel were, in descending order of volume, Illinois, Michigan, Texas, California, and New Jersey. Their combined production represented 49% of the national total. Production decreased significantly in several major producing States including Michigan, 34%; and Illinois, Ohio, and Oklahoma, 14% to 19%; but increased in Texas, 17%; and California, 8%.

In 1982, 117 producers of industrial sand and gravel with 194 operations were canvassed by the Bureau of Mines. About 73% of the industrial sand produced came from 50 operations with an annual production larger than 200,000 tons.

The 10 leading producers of industrial sand and gravel in 1982 were, in descending order of tonnage, Pennsylvania Glass Sand Corp.; Martin Marietta Aggregates; Unimin Corp.; Ottawa Silica Co.; Jessie S. Morie & Son Inc.; Oglebay Norton Co.; Owens-Illinois Inc.; Manley Bros. of Indiana Inc.; Sargent Sand Co.; and Alabama Silica Co. Inc. Their combined production, from 55 operations, represented 64% of the U.S. total.

Vulcan Materials Co. began construction in early 1982 of an $18.5 million, 500,000-ton-per-year facility in Voca, Tex., for production of hydraulic fracturing sand. According to Vulcan, the company has the option to purchase land containing reserves in excess of the economic life of the planned facility. The new operation was to start producing in 1983.[5]

Texas Mining Co. of Brady, Tex., a subsidiary of Oglebay Norton of Cleveland, Ohio, brought online a new hydraulic fracturing sand processing plant at its Voca, Tex., operation, and added a new dryer at its Brady, Tex., plant.[6]

Walter C. Best Inc. of Chardon, Ohio, began a modernization program of its industrial sand operation designed to increase production capacity and improve the quality of its products. Emphasis was placed on improving quality and expanding the company's markets through diversification. Hydraulic fracturing sand, foundry sand, and blasting sand were some of the new items being produced, with glass sand to be available in the near future.[7]

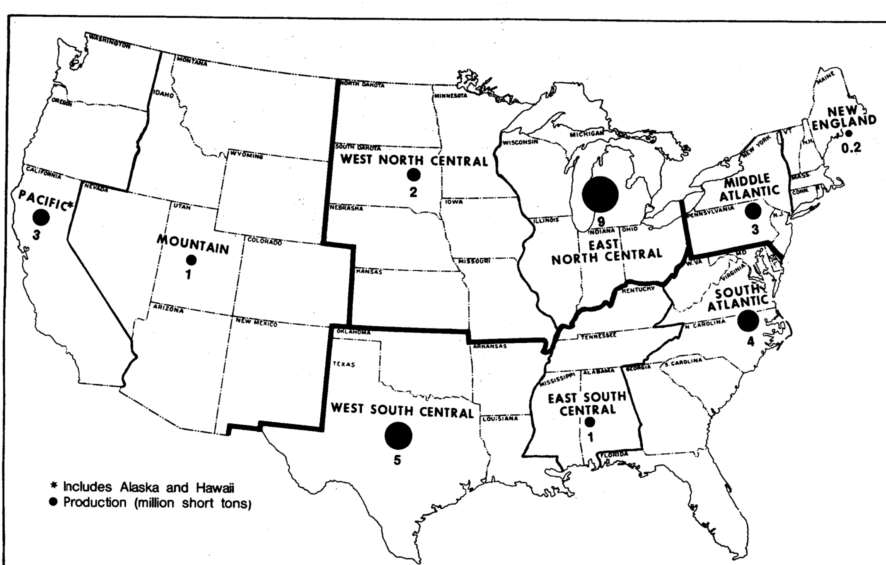

Figure 4.—Production of industrial sand and gravel in the United States in 1982, by geographic region.

CONSUMPTION AND USES

The sand and gravel production reported by producers to the Bureau of Mines is actually material that is sold or used by the companies and is defined as such. Stockpiled production is not reported until it is consumed. Therefore, the sold or used tonnage represents the amount produced for consumption or export in a given year.

In 1982, U.S. consumption of industrial sand and gravel was about 28 million tons valued at $340 million. About 43% of this tonnage was used as glassmaking sand, and 25%, as foundry sand. Other important uses were abrasive sand, about 10% of the total, and hydraulic fracturing sand, about 6%. On a regional level, most of the glass sand was consumed in the South, 33%, and North Central, 32%, while most of the foundry sand was used in the North Central, 69%, and a significant but smaller amount in the South, 22%. Of the smaller, but important, end uses, most of the abrasive sand was used in the South, 77%, and most of the hydraulic fracturing sand was used in the South, 53%, and North Central, 41%.

Compared with that of 1981, 1982 consumption increased for abrasive sand, 39%; hydraulic fracturing sand, 26%; and glassmaking sand, 1%; while foundry sand use decreased 28%.

PRICES

For purposes of this chapter, prices are f.o.b. plant, which usually is the first point of sale or self-use. This value does not include transportation from the plant or yard to the consumer. It does, however, include all the costs related to mining, processing, and transportation of sand and gravel to the first point of sale or self-use.

The average 1982 value, f.o.b. plant, of U.S. industrial sand and gravel increased 8% to $11.98 per ton. Average unit values for industrial sand and industrial gravel were $12.18 and $6.69 per ton, respectively. Nationally, industrial sand used as fillers had the highest value per ton, at $26.47, followed by fiberglass sand, $23.31, and hydraulic fracturing sand, $22.21.

TRANSPORTATION

Of the total industrial sand and gravel produced in 1982, 68% was transported by truck from the plant or pit to the site of first point of sale or use, 29% was transported by rail, and the remainder, by waterway. Because most of the producers had no records of and did not report shipping distances or cost per ton per mile, no transportation cost data were available.

FOREIGN TRADE

Exports.—Exports of industrial sand decreased 28% to 818,000 tons valued at $26.3 million. Of this, 71% went to Canada, and 20% went to Mexico.

Imports.—Imports of industrial sand increased 18 times to 89,000 tons valued at $2.5 million. Of this, 88% came from Australia, and the remainder, from Canada.

TECHNOLOGY

A new and promising application of thermal infrared imagery was demonstrated by A. B. Kahle of the Jet Propulsion Laboratory and L. C. Rowan of the U.S. Geological Survey. By analyzing multiwavelength thermal data acquired by aircraft flown over the Tintic area of Utah, it was shown that occurrences of free silica can be mapped using this new technology. These results led to the development of a six-channel thermal scanner that the National Aeronautics and Space Administration began flying in a jet aircraft in the summer of 1982 as part of its geological remote-sensing research program.[8]

In 1982, the American Telephone & Telegraph Co. completed installation of a long-distance, optical fibre telephone line between New York and Washington, D.C. This 372-mile link is a major step in the development of optical fibre technology. Although replacement of existing U.S. lines was expected to be slow, the market could become significant, with substantial growth rates.[9]

A review of several major U.S. industrial sand operations and a comparison between U.S. and British extraction and processing methods were published by the manager of a large British producer following a 2-week study tour of the United States.[10]

Several articles reviewing industrial sand operations,[11] new processing methods,[12] and transportation of industrial minerals[13] were published during 1982.

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[1]Physical scientist, Division of Industrial Minerals.

[2]Levine, S. NSGA Covers Environmental, Economic, and Engineering Subjects at Annual Convention. Pit & Quarry, v. 74, No. 10, April 1982, pp. 72-73.

[3]Ault, C. H., and G. S. Woodward (ed.). Proceedings of the 18th Forum on Geology of Industrial Minerals (cosponsored by Indiana Geological Survey and the University of Indiana, Bloomington, Ind., Apr. 14-16, 1982). Indiana Geol. Surv. Occasional Paper 37, 1983, 251 pp.

[4]California Geology. Offshore Sand and Gravel Mining. V. 35, No. 12, December 1982, pp. 259-279.
[5]Rock Products. Industry News. Frac Sand Market Capacity Burgeons. V. 85, No. 1, January 1982, p. 41.
[6]Work cited in footnote 5.
[7]Industrial Minerals. Sand Investment for Best. No. 182, November 1982, pp. 17-18.
[8]Mining Congress Journal. Possibility of Mapping Free Silica Exciting. V. 68, No. 7, July 1982, p. 23.
[9]Industrial Minerals. Optical Fibres Advance. No. 188, May 1983, p. 17.
[10]Littler, A. Glass Sand Production: Practice in the USA and Britain Compared. Quarry Management and Prod., v. 10, No. 1, January 1983, pp. 9-15.
[11]Robertson, J. L. Underwater Mining Extends Life of Silica Sand Deposit. Rock Prod., v. 85, No. 2, February 1982, pp. 37-39.
McLucas, G. Unique Quartz Sand Quarry Leads a Triple Life. Pit & Quarry, v. 75, No. 4, October 1982, pp. 46-48.
[12]Pit & Quarry. Pan-type Dewatering Filter Raises Silica Sand Quality. V. 74, No. 13, July 1982, pp. 130-131.
[13]Blair, R. E. Minerals Transportation. Min. Eng., v. 34, No. 10, October 1982, pp. 1429-1432.
Thurlow, E. E. Rail Transportation of Mineral Commodities. Min. Eng., v. 34, No. 10, October 1982, pp. 1448-1450, 1456.

Table 13.—Industrial sand and gravel sold or used in the United States, by geographic region

Geographic region	1981				1982			
	Quantity (thousand short tons)	Percent of total	Value (thousands)	Percent of total	Quantity (thousand short tons)	Percent of total	Value (thousands)	Percent of total
Northeast:								
New England	141	(1)	$2,677	1	225	1	$3,413	1
Middle Atlantic	3,326	11	39,790	12	3,154	11	42,252	12
North Central:								
East North Central	11,880	40	114,200	34	9,059	32	96,385	28
West North Central	1,346	4	13,870	4	1,837	6	19,209	6
South:								
South Atlantic	3,965	13	47,300	14	3,574	13	45,980	14
East South Central	1,357	5	6,891	2	1,474	5	13,554	4
West South Central	4,678	16	63,570	19	5,104	18	74,081	22
West:								
Mountain	830	3	12,380	4	1,368	5	13,338	4
Pacific	2,454	8	31,630	10	2,559	9	31,512	9
Total[2]	29,980	100	332,300	100	28,400	100	339,700	100

[1]Less than 1/2 unit.
[2]Data may not add to totals shown because of independent rounding.

Table 14.—Industrial sand and gravel sold or used in the United States, by State

(Thousand short tons and thousand dollars)

State	1981		1982	
	Quantity	Value	Quantity	Value
Alabama	182	864	960	8,096
Arizona	179	2,455	107	1,617
Arkansas	642	8,236	881	11,370
California	2,150	28,269	2,317	28,703
Colorado	W	W	222	3,266
Connecticut	W	W	80	1,746
Florida	349	4,419	341	4,257
Georgia	W	W	541	6,793
Idaho	W	W	W	W
Illinois	4,646	49,186	3,989	45,665
Indiana	257	1,179	W	W
Iowa	W	W	W	W
Kansas	W	W	331	3,635
Kentucky	W	247	7	116
Louisiana	293	4,026	378	4,590
Massachusetts	87	W	140	1,615
Michigan	4,393	29,787	2,920	21,934
Minnesota	W	W	694	5,903
Mississippi	W	W	W	W
Missouri	778	8,602	750	8,997
Montana	W	W	W	W
Nebraska	19	144	14	105
Nevada	W	W	W	W
New Jersey	2,305	26,438	2,140	28,151
New Mexico	--	--	W	W
New York	55	W	45	512
North Carolina	1,236	10,440	716	4,878

See footnotes at end of table.

Table 14.—Industrial sand and gravel sold or used in the United States, by State —Continued

(Thousand short tons and thousand dollars)

State	1981 Quantity	1981 Value	1982 Quantity	1982 Value
Ohio	1,487	20,893	1,223	17,816
Oklahoma	1,500	14,317	1,222	13,114
Pennsylvania	W	W	969	13,589
Rhode Island	W	W	5	52
South Carolina	803	10,531	720	10,902
Tennessee	1,142	5,610	468	4,826
Texas	2,242	36,992	2,623	45,007
Utah	22	286	W	W
Virginia	W	W	W	W
Washington	304	3,358	242	2,809
West Virginia	W	W	W	W
Wisconsin	1,100	13,180	788	9,662
Other	3,805	52,871	2,521	30,000
Total[1]	29,980	332,300	28,400	339,700

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Data may not add to totals shown because of independent rounding.

Table 15.—Industrial sand and gravel production in the United States in 1982, by size of operation

Size range	Number of operations	Percent of total	Thousand short tons	Percent of total
Less than 25,000	55	28.4	407	1.4
25,000 to 49,999	27	13.9	930	3.3
50,000 to 99,999	32	16.5	2,248	7.9
100,000 to 199,999	30	15.5	4,147	14.6
200,000 to 299,999	19	9.8	4,651	16.4
300,000 to 399,999	8	4.1	2,808	9.9
400,000 to 499,999	10	5.1	4,448	15.7
500,000 to 599,999	4	2.1	2,142	7.6
600,000 to 699,999	2	1.0	1,227	4.3
700,000 and over	7	3.6	5,347	18.9
Total	194	100.0	[1]28,400	100.0

[1]Data do not add to total shown because of independent rounding.

Table 16.—Number of industrial sand and gravel active operations and processing plants in the United States in 1982, by geographic region

Geographic region	Number of active operations		Active operations with processing plants					Total number of active operations without plants[1]
			Associated with extraction areas on land			Associated with dredging operations		
	Total	With plants[1]	Plants at site		Plants not at site (stationary or portable)	Plants on board	Plants on land	
			Stationary	Portable				
Northeast:								
New England	7	6	5	--	--	--	1	--
Middle Atlantic	17	15	12	1	--	--	2	2
North Central:								
East North Central	43	42	35	3	1	2	1	1
West North Central	18	17	10	--	--	1	6	--
South:								
South Atlantic	27	27	19	--	--	3	5	--
East South Central	18	16	5	--	4	2	5	--
West South Central	31	31	22	1	1	2	5	--
West:								
Mountain	18	18	15	--	3	--	--	--
Pacific	15	14	10	4	--	--	--	1
Total	194	186	133	9	9	10	25	4

[1]Based on reports submitted by individual companies.

Table 17.—Industrial sand and gravel sold or used by U.S. producers, by major use

Major use	North East			North Central			South			West			United States		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
1981															
Sand:															
Glassmaking:															
Containers	1,635	$19,046	$11.65	2,225	$17,095	$7.68	2,848	$27,307	$9.59	1,588	$20,645	$13.00	8,296	$84,093	$10.14
Flat (plate and window)	W	W	12.03	619	5,058	8.17	854	7,841	9.18	W	W	9.71	1,690	15,188	8.99
Specialty	W	W	12.30	227	2,691	11.85	424	4,346	10.25	W	W	12.74	937	10,628	11.34
Fiberglass (unground)	W	W	10.44	564	4,633	8.21	--	--	--	W	W	11.64	722	6,434	8.91
Fiberglass (ground)	W	W	10.32	79	1,871	23.68	293	6,551	22.36	W	W	21.00	433	9,094	21.00
Foundry:															
Molding and core	733	8,550	11.66	6,597	49,969	7.57	1,886	12,587	6.67	227	3,492	15.38	9,442	74,598	7.90
Molding and core facing (ground)	W	W	16.30	83	1,534	18.48	W	W	10.19	W	W	21.00	120	1,984	16.53
Refractory	72	1,302	18.08	278	2,539	9.13	36	470	13.06	(1)	W	W	386	4,317	11.18
Metallurgical:															
Silicon carbide	W	W	18.25	453	3,104	6.85	W	W	W	W	W	13.50	463	3,259	7.04
Flux for metal smelting	--	--	--	W	W	7.40	--	--	--	W	W	10.52	246	2,556	10.39
Abrasives:															
Blasting	114	1,943	17.04	155	2,939	18.96	1,230	19,199	15.61	106	1,455	13.73	1,605	25,536	15.91
Scouring cleansers (ground)	W	W	W	W	W	20.05	W	W	19.86	--	--	--	173	3,464	20.02
Sawing and sanding	W	W	7.69	W	W	6.84	113	970	8.58	W	W	19.50	180	1,467	8.15
Chemicals (ground and unground)	W	W	11.93	197	2,205	11.19	152	2,113	13.90	W	W	9.75	426	5,178	12.15
Fillers (ground):															
Rubber, paints, putty, etc	W	W	43.41	80	2,957	36.96	78	3,012	38.62	W	W	7.05	284	8,095	28.50
Ceramic (ground):															
Pottery, brick, tile, etc	W	W	26.07	95	2,929	30.83	64	1,369	21.39	W	W	12.60	179	4,751	26.54
Filtration	54	1,067	19.76	83	981	11.82	110	998	9.07	2	42	21.00	249	3,088	12.40
Traction (engine)	18	212	11.78	180	1,496	8.31	134	882	6.58	65	661	10.17	398	3,252	8.17
Coal washing	W	W	13.00	W	W	12.80	W	W	9.07	--	--	--	40	395	9.88
Roofing granules and fillers	W	W	17.33	W	W	14.92	114	1,743	15.29	14	146	10.43	162	2,448	15.11
Hydraulic fracturing	W	W	19.00	532	11,669	21.93	775	18,696	24.12	W	W	21.53	1,407	32,513	23.11
Other	841	10,342	12.30	716	13,928	19.45	289	4,814	16.66	1,220	16,934	13.88	1,413	23,996	16.98
Total[2]	3,467	42,462	12.25	13,163	127,598	9.69	9,400	112,898	12.01	3,222	43,375	13.46	29,252	326,333	11.16
Gravel:															
Metallurgical:															
Silicon, ferrosilicon	--	--	--	W	W	7.91	505	4,402	8.72	W	W	10.23	622	5,467	8.79
Filtration	--	--	--	W	W	3.00	W	W	8.67	W	W	8.50	6	46	7.67
Other	--	--	--	W	W	6.29	W	W	4.78	--	--	--	99	484	4.89
Total	--	--	--	66	498	7.55	600	4,868	8.11	62	631	10.18	728	5,997	8.24
Grand total[2]	3,467	42,462	12.25	13,229	128,096	9.68	10,000	117,766	11.78	3,284	44,006	13.40	29,980	332,300	11.08

1982															
Sand:															
Glassmaking:															
Containers	1,968	25,340	12.88	2,323	20,882	8.99	2,859	32,421	11.34	1,716	21,195	12.35	8,865	99,839	11.26
Flat (plate and window)	W	W	12.95	420	5,523	13.15	642	6,099	9.50	W	W	9.97	1,294	14,101	10.90
Specialty	W	W	13.18	173	2,570	14.86	236	2,456	10.41	W	W	13.75	637	8,095	12.71
Fiberglass (unground)	W	W	13.97	884	7,291	8.25	--	--	--	W	W	12.27	1,069	9,659	9.04
Fiberglass (ground)	W	W	12.94	108	2,398	22.20	243	6,116	25.17	W	W	21.50	388	9,044	23.31
Foundry:															
Molding and core	452	5,588	12.36	4,658	37,807	8.12	1,511	14,599	9.66	145	2,055	14.17	6,766	60,049	8.88
Molding and core facing (ground)	W	W	10.73	60	1,520	25.33	W	W	17.80	W	W	19.00	141	2,433	17.26
Refractory	W	W	22.33	181	2,668	14.74	W	W	14.50	--	--	--	214	3,264	15.25
Metallurgical:															
Silicon carbide	W	W	18.33	99	1,088	10.99	--	--	--	W	W	9.82	140	1,516	10.83
Flux for metal smelting	--	--	--	W	W	7.27	--	--	--	W	W	7.66	205	1,566	7.64
Abrasives:															
Blasting	144	2,084	14.47	141	2,364	16.77	1,785	25,970	14.55	219	1,534	7.00	2,288	31,952	13.97
Scouring cleansers (ground)	W	W	W	94	2,021	21.50	W	W	22.09	--	--	--	160	3,461	21.63
Sawing and sanding	W	W	13.33	W	W	16.36	231	1,792	7.76	W	W	17.50	270	2,408	8.92
Chemicals (ground and unground)	W	W	12.65	W	W	14.00	156	2,157	13.83	--	--	--	335	4,610	13.76
Fillers (ground):															
Rubber, paints, putty, etc	W	W	47.31	80	2,003	25.04	W	W	41.88	91	994	10.92	260	6,882	26.47
Ceramic (ground):															
Pottery, brick, tile, etc	W	W	27.94	81	2,740	33.83	127	1,411	11.11	W	W	14.00	226	4,627	20.47
Filtration	71	980	13.80	84	827	9.85	132	1,237	9.37	13	158	12.15	299	3,202	10.71
Traction (engine)	18	218	12.11	204	1,938	9.50	187	1,179	6.30	50	497	9.94	459	3,831	8.35
Coal washing	W	W	10.00	W	W	11.50	W	W	9.48	--	--	--	40	396	9.90
Roofing granules and fillers	55	655	11.91	49	668	13.63	404	3,486	8.63	9	77	8.56	517	4,886	9.45
Hydraulic fracturing	W	W	15.00	728	12,281	16.87	936	24,503	26.18	W	W	23.77	1,770	39,319	22.21
Other	565	9,264	16.40	476	8,599	18.07	373	7,111	19.06	1,154	16,513	14.31	989	17,739	17.94
Total[2]	3,272	44,126	13.49	10,843	115,189	10.62	9,822	130,539	13.29	3,394	43,024	12.68	27,331	332,879	12.18
Gravel:															
Metallurgical:															
Silicon, ferrosilicon	W	W	W	W	W	7.98	230	2,251	9.79	W	W	11.12	326	3,169	9.72
Filtration	--	--	--	6	19	3.17	W	W	4.17	W	W	8.43	19	103	5.42
Grinding	W	W	W	--	--	--	W	W	8.87	--	--	--	146	1,885	12.91
Other	107	1,539	14.38	47	386	8.21	100	825	8.25	533	1,826	3.43	533	1,689	3.17
Total	107	1,539	14.38	53	405	7.64	331	3,076	9.29	533	1,826	3.43	1,024	6,846	6.69
Grand total[2]	3,379	45,665	13.51	10,896	115,595	10.61	10,153	133,615	13.16	3,927	44,850	11.42	28,400	339,700	11.96

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Less than 1/2 unit.
[2]Data may not add to totals shown because of independent rounding.

Table 18.—Transportation of industrial sand and gravel in the United States in 1982 to site of first sale or use

Method of shipment	Thousand short tons	Percent of total
Truck	19,194	68
Rail	8,291	29
Waterway	689	02
Not shipped, used at site	181	01
Total	[1] 28,400	100

[1]Data do not add to total shown because of independent rounding.

Table 19.—U.S. exports of industrial sand, by country

(Thousand short tons and thousand dollars)

Country	1981		1982	
	Quantity	F.a.s. value[1]	Quantity	F.a.s. value[1]
Australia	1	322	2	432
Bahamas	6	106	13	152
Canada	814	14,851	584	10,890
Costa Rica	10	157	9	134
Germany, Federal Republic of	6	1,251	3	1,566
Japan	14	1,322	3	1,241
Mexico	224	3,380	165	3,756
Netherlands	1	344	3	1,735
Panama	10	293	4	129
Peru	11	1,007	4	436
Saudi Arabia	2	387	1	184
United Kingdom	3	559	4	1,088
Venezuela	4	396	2	240
Other	26	3,609	21	4,337
Total	1,132	27,984	818	26,320

[1]Value of material at U.S. port of export; based on transaction price, including all charges incurred in placing material alongside ship.

Table 20.—U.S. imports for consumption of industrial sand, by country

(Thousand short tons and thousand dollars)

Country	1981		1982	
	Quantity	C.i.f. value[1]	Quantity	C.i.f. value[1]
Antigua and Barbuda	3	36	--	--
Australia	--	--	78	2,199
Canada	1	57	11	124
Germany, Federal Republic of	(2)	279	(2)	161
Other	(2)	249	(2)	39
Total	4	621	89	2,523

[1]Value of material at U.S. port of entry; based on purchase price and includes all charges (except U.S. import duties) in bringing material from foreign country to alongside carrier.
[2]Less than 1/2 unit.

Silicon

By Gerald F. Murphy[1]

Demand for silicon metal and silicon alloys declined substantially in 1982, a consequence of the world recession. Accordingly, production and shipments of silicon materials also decreased dramatically. Imports of ferrosilicon materials were about one-half that of 1981, with the regular 75% grade making up 66% of the total. Attempts by domestic producers to maintain their October 1, 1981, price increases failed because of the poor domestic market and the availability of low-cost imports.

Domestic Data Coverage.—Domestic production data for the silicon commodity are developed by the Bureau of Mines by means of monthly and annual voluntary, domestic surveys. Typical of these surveys is the monthly Silicon Alloys survey. Of the 20 canvassed operations to which a survey collection request was made, 100% responded, representing 100% of the total production shown in table 1.

Table 1.—Production, shipments, and stocks of silvery pig iron, ferrosilicon, and silicon metal in the United States in 1982

(Short tons, gross weight, unless otherwise specified)

Alloy	Silicon content (percent)		Producers' stocks as of Dec. 31, 1981	Production	Shipments	Producers' stocks as of Dec. 31, 1982
	Range	Typical				
Silvery pig iron	5-24	18	W	W	W	W
Ferrosilicon (includes briquets)	25-55	48	110,331	232,670	212,516	92,600
Do	56-95	76	23,115	75,654	76,879	28,004
Silicon metal (excluding semiconductor grades)	96-99	98	17,312	77,639	80,767	12,935
Miscellaneous silicon alloys (excluding silicomanganese)	32-65	--	13,614	50,430	44,913	16,384

W Withheld to avoid disclosing company proprietary data.

Legislation and Government Programs.—In August 1981, in response to a petition by The Ferroalloys Association, the U.S. Department of Commerce began a Section 232 investigation of the U.S. ferroalloy industry as it relates to national security. As a result of the investigation, the Government, in December 1982, announced programs to upgrade manganese and chromium ores stockpiles and to ensure minimum production capacity during a national emergency. No programs specific to ferrosilicon were announced.

DOMESTIC PRODUCTION

Production and shipments of silicon metal and silicon alloys decreased dramatically in 1982, mainly the result of the world recession. Because of the state of the economy, domestic ferroalloy producers were faced with an abnormally low demand for silicon alloys by the ferrous foundry and steel industries and reduced demand for silicon metal by the aluminum industry, as well as producers of chemicals and electronic products. Shipments for all four classes of silicon alloys and silicon metal ranged from slightly more than 10% to about 40% less than those in 1981, while production ranged from about 18% to a little more than 50% less than 1981 totals. The most pronounced decline occurred for 50% ferrosilicon (25% to 55% range) with shipments declining by about two-fifths and production declining by approximately one-half. Magnesium ferrosilicon constituted about four-fifths of production classified as miscellaneous silicon alloys, the remainder in this class being calcium silicon, silicon-manganese-zirconium, and proprietary inoculants.

A number of plant closures and production cutbacks occurred in 1982, a further consequence of the worldwide recession. Interlake, Inc., Globe Metallurgical Div., temporarily halted ferrosilicon production at its Beverly, Ohio, plant beginning mid-November. International Minerals & Chemical Corp. ceased production of ferrosilicon at its Kimball, Tenn., and Bridgeport, Ala., plants November 1. The Hanna Mining Co. closed its Wenatchee, Wash., silicon and ferrosilicon plant October 1. Northwest Alloys, Inc., ceased production of ferrosilicon at its Addy, Wash., plant November 28, and SKW Alloys, Inc., temporarily suspended ferrosilicon production at its Niagara Falls, N.Y., plant October 1. Toward yearend 1982, only 6 of a total 51 furnaces that produced ferrosilicon and silicon metal were operating, representing less than 20% capacity utilization on a gross-weight basis.

Table 2.—Producers of silicon alloys and/or silicon metal in the United States in 1982

Producer	Plant location	Product
Alabama Alloy Co., Inc	Bessemer, Ala	FeSi.
Aluminum Co. of America, Northwest Alloys, Inc	Addy, Wash	FeSi and Si.
Dow Corning Corp	Springfield, Oreg	Si.
Elkem Metals Co	Alloy, W. Va	FeSi and Si.
Do	Ashtabula, Ohio	FeSi.
Foote Mineral Co., Ferroalloys Div	Graham, W. Va	FeSi.
Do	Keokuk, Iowa	Silvery pig iron.
Hanna Mining Co.:		
Hanna Nickel Smelting Co	Riddle, Oreg	FeSi.
Silicon Div	Wenatchee, Wash	FeSi and Si.
Interlake, Inc., Globe Metallurgical Div	Beverly, Ohio	FeSi and Si.
Do	Selma, Ala	Si.
International Minerals & Chemical Corp., Industry Group, TAC Alloys Div.	Bridgeport, Ala	FeSi.
Do	Kimball, Tenn	FeSi.
Ohio Ferro-Alloys Corp	Montgomery, Ala	FeSi and Si.
Do	Philo, Ohio	FeSi and Si
Do	Powhatan Point, Ohio	Si.
Reynolds Metals Co	Sheffield, Ala	Si.
SKW Alloys, Inc	Calvert City, Ky	FeSi.
Do	Niagara Falls, N.Y	FeSi.
South African Manganese Amcor, Ltd., Roane Alloys Div	Rockwood, Tenn	Si.

CONSUMPTION AND USES

Reported consumption of silicon metal and silicon alloys declined substantially in 1982 to a total of 272,000 short tons contained silicon, a decline of slightly more than one-third compared with the 1981 total of 412,000 tons. This drop in demand was largely due to weak demand by ferrous foundries, steel plants, and aluminum plants. Iron foundries were especially hard hit by low production rates in the automotive industry. Cast iron shipments exclusive of ingot molds, as reported by the Bureau of the Census, fell 31% from 12.3 million net tons in 1981 to 8.5 million net tons in 1982. A lesser decline was observed for silvery pig iron, while more pronounced decreases occurred for 85% ferrosilicon and especially 65% ferrosilicon. The greatest demand in 1982 was for the 50% ferrosilicon grade and silicon metal, followed, on the basis of silicon content, by the 75% ferrosilicon grade, silicon carbide, miscellaneous silicon alloys, and silvery pig iron. The end uses for silicon materials were, in decreasing order, steel, cast iron, silicones and silanes, and nonferrous alloys, with about 70% of consumption accounted for by ferrous applications. Cast iron production consumed the greatest amounts of silvery pig iron and miscellaneous silicon alloys, while steelmaking was the biggest user of 75% ferrosilicon. Steel plants and iron foundries together accounted for 96% of 50% ferrosilicon usage; 87% of silicon metal went into nonferrous alloys, silicones, and silanes.

SKW planned to expand capacity for silicon-based ferroalloys at its Niagara Falls, N.Y., plant by about one-third with an addition of a 20- to 25-megawatt furnace. The furnace was to produce 50% ferrosilicon, 75% ferrosilicon, or silicon metal. The expansion was made possible by an agreement with Niagara Mohawk Power Co. and the Power Authority of the State of New York in which SKW was to be provided additional hydroelectric power. The expansion was to be completed by 1986. Toth Aluminum Corp., New Orleans, La., announced plans for construction of an $8.9 million commercial metal chlorides plant at Vacherie, La. The plant was to produce silicon chloride and other metal chlorides using Toth's carbo-chlorination technology. The facility was tentatively scheduled to go on-line in November 1983. PQ Corp., Valley Forge, Pa., and Degussa AG, Frankfurt am Main, Federal Republic of Germany, agreed to form a joint venture to produce and market precipitated silicas in the United States. The 50-million-pound-per-year plant was to be located at one of PQ's present plantsites. Production was to begin before the end of 1983.

Although consumption of silicon alloys is mainly determined by the health of the ferrous foundries, steel plants, and aluminum plants, which experienced production drops of about 30%, 40%, and 20%, respectively, silicon metal consumption also depends on the aluminum and chemical industries. The aluminum industry, which uses silicon metal to make both wrought and cast products, cut back production because of lack of demand and high inventories. The reduction was in large part caused by the depressed housing and transportation markets. Consumption of silicon metal for silicones and silanes suffered a decline of one-fourth, compared with that of 1981.

Silicon metal produced by tonnage methods is used as raw material for the manufacture of the relatively small quantity of hyperpure polycrystalline silicon for electronics, solar cells, and other highly special applications. The Bureau of Mines does not collect data on these specialty grades of silicon, which have a high unit value. Domestic production of polysilicon was estimated at 1,600 tons. Union Carbide Corp. broke ground for its new $85 million polycrystalline silicon plant at Moses Lake, Wash. Capacity was to be about 1,300 tons per year, making it one of the largest polysilicon facilities in the world. Union Carbide's advanced technology was to be used for silane feedstock production, and proprietary technology obtained from Komatsu Electronics Co. Ltd., Tokyo, Japan, was to be used for the decomposition of silane into polycrystalline silicon. Arco Solar, Inc., a subsidiary of Atlantic Richfield Co., built and put into operation a $15 million, 1-megawatt solar photovoltaic electricity plant at Hesperia, Calif. The facility's solar cell modules are mounted on computer-controlled trackers that follow the sun. The unit was to be three times the size of the world's largest photovoltaic solar plant near Riyadh, Saudi Arabia. Electrical output was to be fed into Southern California Edison's grid. Solarex Corp., Rockville, Md., dedicated its new solar cell facility near Frederick, Md., October 29. The A-shaped plant's southern roof consists of an array of 224,640 crystalline-silicon solar cells, which convert sunlight directly into electricity to produce all of the power needed for the plant's operation. A bank of special lead batteries stores power generated by the roof array and provides power for rainy days. The factory is totally independent of a utility and is a model for future plants in remote areas where power is not readily available. SEH America, Inc., a wholly owned subsidiary of Shin-Etsu Handotai Co. Ltd., of Japan, announced plans to build a $30 million single-crystal silicon plant at Vancouver, Wash. The new facility was scheduled for completion early in 1984. Plant output was expected to be 10 tons of single-crystal silicon and 500,000 semiconductor wafers per month.

Consumer stocks for all classes of silicon material declined substantially from those at the end of 1981. Stocks of 25% to 55% ferrosilicon dropped the most, while stocks of 81% to 95% ferrosilicon and silicon carbide showed the smallest declines.

Table 3.—Consumption, by major end use, and stocks of silicon alloys and metal in the United States in 1982

(Short tons, gross weight, unless otherwise specified)

End use	Silicon content (percent)	Silvery pig iron	Ferrosilicon[1]				Silicon metal	Miscellaneous silicon alloys[2]	Silicon carbide[3]
	Range	5-24	25-55	56-70	71-80	81-95	96-99	--	63-70
	Typical	18	48	65	76	85	98	48	64
Steel:									
Carbon		35	43,507	(4)	17,364	(4)	229	783	70
Stainless and heat-resisting		--	16,152	(4)	16,918	63	177	(4)	--
Full alloy		(4)	19,214	--	7,192	(4)	743	779	(4)
High-strength low-alloy		(4)	4,416	--	1,030	(4)	--	(4)	(4)
Electric		--	(4)	(4)	(4)	--	--	--	--
Tool		--	703	--	571	--	24	(4)	--
Unspecified		43	8,738	2,576	18,224	439	--	554	156
Total		78	92,730	2,576	61,299	502	1,173	2,116	226
Cast irons		30,339	107,991	979	17,050	203	58	21,270	17,725
Superalloys		6	79	--	21	36	35	--	--
Alloys (excluding alloy steels and superalloys)		117	4,086	--	44	26	32,493	72	2
Silicones and silanes		--	--	--	--	--	39,012	--	--
Miscellaneous and unspecified		--	4,620	--	75	--	[5]9,218	127	--
Total		30,540	209,506	3,555	78,489	767	81,989	23,585	17,953
Percent of 1981		76	65	40	67	56	67	73	69
Total silicon content[6]		5,497	100,563	2,310	59,651	652	80,349	11,321	11,490
Consumers' stocks, Dec. 31, 1982		1,392	14,850	189	8,225	170	3,607	1,687	1,190

[1]Includes briquets.
[2]Primarily magnesium-ferrosilicon but also includes other silicon alloys. Average silicon content estimated as 48%, based on 1982 production survey.
[3]Does not include silicon carbide for abrasive or refractory uses.
[4]Included with "Steel: Unspecified."
[5]Includes an estimated 9,000 tons consumed for unspecified chemicals.
[6]Estimated based on typical percent content.

PRICES

Prices for both domestic and imported metallurgical-grade silicon metal and regular-grade 75% ferrosilicon decreased in January. The price of domestic 50% ferrosilicon also decreased in January. Attempts by domestic producers to maintain their October 1, 1981, price increases failed because of weak demand by the iron and steel, aluminum, and chemical industries, along with the availability of low-cost imports. Although little 50% ferrosilicon is imported into the United States because of shipping difficulties, the ability of steel mills to switch between 50% and 75% grades puts both domestic 50% and 75% ferrosilicon under pressure from low-cost imported 75% ferrosilicon.

The price of domestic, lump silicon metal with 1% maximum iron and 0.07% maximum calcium decreased at the beginning of 1982 from 67.5 to 62 cents per pound of contained silicon, and then remained steady through December. In January, the price of imported silicon metal decreased from 62-63 cents to 61-62 cents per pound. However, the price of this material continued to decline over the year to a yearend price of 47 to 49 cents per pound.

The price of domestic regular-grade 75% ferrosilicon decreased from 53.25 cents per pound of contained silicon to 47 cents per pound in January, with no further change through the remainder of the year. The f.o.b. warehouse price of imported 75% ferrosilicon, as quoted in Metals Week, began the year in the range of 39 to 41 cents per pound. However, the price of this material showed a downward trend throughout the year, ending in the range of 34.5 to 36 cents per pound. The price of domestic 50% ferrosilicon also decreased in January from 49.25 to 45 cents per pound, with no further change in 1982. In August, one domestic producer reduced its price of calcium silicon from 82 to 66 cents per pound.

FOREIGN TRADE

Ferrosilicon exports, in both terms of quantity and value, declined to their lowest level since 1978 but were only slightly less than those for 1981. Principal 1982 recipients were Canada, 6,771 tons, and Australia, 2,796 tons, together accounting for about 64% of total quantity and about 68% of total value. Exports went to 31 countries. Silicon metal exports declined substantially in 1982 to a total of 2,411 tons, the lowest level since 1978. The largest quantities of the metal were exported to Japan and Mexico, 1,221 and 630 tons, respectively, together accounting for about 77% of total quantity and about 22% of total value. Exports of silicon metal went to 34 countries.

Compared with those of 1981, imports in 1982 decreased by about one-half in both quantity and value for ferrosilicon overall and about one-tenth in both quantity and value for silicon metal. Imports of 75% ferrosilicon were the most significant on a quantity basis, amounting to 68% of reported consumption. Brazil shipped one-third of the total in this range, while Norway and Venezuela, each with nearly one-fifth of the total, were the next largest sources. Imports in this class decreased dramatically, about 57%, compared with those of 1981. The next largest import class was 50% ferrosilicon (30% to 60% silicon), which amounted to about 16% of ferrosilicon imports. The main sources of this material were Brazil, Canada, and France, together accounting for nearly 93% of the total. Average silicon content of all ferrosilicon in 1982 declined to 68% from 71% in 1981. Imports of silicon metal in the 96% to 99% range decreased by one-fourth in terms of gross weight. Canada, Yugoslavia, and Sweden were the dominant sources, together accounting for about 75% of the total. However, imports of silicon metal in the 99% to 99.7% range increased by approximately 12%, with Canada, Brazil, Argentina, and China the principal shippers.

Although there was a marked decrease in imports of ferrosilicon, a corresponding decrease in exports left the United States a net importer of ferrosilicon material. Net imports amounted to slightly less than 70,000 tons and a trade deficit of about $28 million. Despite the large decrease in ferrosilicon imports compared with those of 1981, foreign suppliers maintained their penetration of the U.S. domestic market, slightly more than 20%.

Table 4.—U.S. exports of ferrosilicon and silicon metal

Year	Quantity (short tons)	Value (thousands)
FERROSILICON		
1978	11,900	$7,871
1979	22,357	14,740
1980	27,488	18,572
1981	15,768	12,136
1982	14,932	11,996
SILICON METAL		
1978	2,404	21,974
1979	4,987	45,752
1980	14,372	65,478
1981	8,673	57,001
1982	2,411	34,335

Table 5.—U.S. imports for consumption of ferrosilicon and silicon metal, by grade and country

Grade and country	1981 Quantity (short tons) Gross weight	1981 Quantity (short tons) Silicon content	1981 Value (thousands)	1982 Quantity (short tons) Gross weight	1982 Quantity (short tons) Silicon content	1982 Value (thousands)
Ferrosilicon:						
Over 8% but not over 30% silicon:						
Brazil	--	--	--	100	15	$145
Canada	2,783	393	$177	541	147	60
Germany, Federal Republic of	(1)	(1)	(1)	--	--	--
Total[2]	2,783	393	177	641	162	204
Over 30% but not over 60% silicon, with over 2% magnesium:						
Brazil	2,244	1,042	1,849	4,705	2,131	3,649
Canada	1,287	580	1,079	341	163	314

See footnotes at end of table.

Table 5.—U.S. imports for consumption of ferrosilicon and silicon metal, by grade and country —Continued

Grade and country	1981 Quantity (short tons) Gross weight	1981 Quantity (short tons) Silicon content	1981 Value (thousands)	1982 Quantity (short tons) Gross weight	1982 Quantity (short tons) Silicon content	1982 Value (thousands)
Ferrosilicon —Continued						
Over 30% but not over 60% silicon, with over 2% magnesium —Continued						
France	326	162	$333	561	270	$517
Germany, Federal Republic of	2	1	2	13	6	18
Italy	192	88	166	--	--	--
Japan	1	(1)	1	5	2	8
Mexico	33	16	17	--	--	--
Norway	275	122	223	180	80	152
Total[2]	4,360	2,011	3,671	5,805	2,653	4,657
Over 30% but not over 60% silicon, not elsewhere classified:						
Brazil	311	167	285	5,404	2,662	1,738
Canada	7,128	3,360	2,221	3,425	1,657	1,116
France	3,772	2,184	5,279	2,223	1,285	3,002
Germany, Federal Republic of	826	452	1,181	833	353	856
Japan	--	--	--	2	1	3
Mexico	--	--	--	55	27	18
Norway	2,205	1,288	556	--	--	--
Total[2]	14,242	7,451	9,522	11,940	5,984	6,733
Over 60% but not over 80% silicon, with over 3% calcium:						
Brazil	1,487	932	1,929	3,591	2,573	2,490
Canada	1,483	1,076	973	60	45	35
China	--	--	--	2	2	1
France	6,234	4,504	4,663	935	568	1,297
Germany, Federal Republic of	911	571	1,502	629	388	967
Italy	206	131	248	100	64	128
Norway	4,277	2,825	1,322	--	--	--
Spain	76	47	90	209	132	237
Yugoslavia	1,543	1,003	616	--	--	--
Total[2]	16,217	11,089	11,343	5,526	3,771	5,155
Over 60% but not over 80% silicon, not elsewhere classified:						
Argentina	679	511	324	2,303	1,742	993
Brazil	41,018	31,138	19,679	16,995	12,686	7,887
Canada	7,885	5,848	4,509	6,013	4,432	3,294
Chile	920	691	506	--	--	--
China	1	1	1	2	2	1
France	1,728	1,322	1,118	3,044	2,338	1,573
Germany, Federal Republic of	383	289	1,034	532	397	1,018
Iceland	12,176	9,153	6,309	--	--	--
Italy	--	--	--	112	71	143
Mexico	--	--	--	114	87	62
Norway	23,736	17,754	10,411	8,764	6,586	3,468
South Africa, Republic of	1,869	1,452	969	4,131	3,039	1,747
Spain	--	--	--	133	83	161
Venezuela	23,783	17,852	8,719	8,489	6,352	2,503
Yugoslavia	2,599	1,953	1,340	--	--	--
Total[2]	116,778	87,963	54,918	50,632	37,816	22,850
Over 80% but not over 90% silicon:						
Argentina	1,100	936	534	--	--	--
Canada	53	44	34	--	--	--
Norway	--	--	--	698	601	208
Total	1,153	980	568	698	601	208
Over 90% but not over 96% silicon:						
Belgium-Luxembourg	39	38	36	156	150	133
France	37	35	48	--	--	--
Germany, Federal Republic of	39	38	34	40	37	33
Norway	--	--	--	1,294	1,174	371
Total[2]	115	111	118	1,490	1,361	536
Total ferrosilicon	155,648	109,998	80,317	76,732	52,348	40,343

See footnotes at end of table.

Table 5.—U.S. imports for consumption of ferrosilicon and silicon metal, by grade and country —Continued

Grade and country	1981 Quantity (short tons) Gross weight	1981 Quantity (short tons) Silicon content	1981 Value (thousands)	1982 Quantity (short tons) Gross weight	1982 Quantity (short tons) Silicon content	1982 Value (thousands)
Silicon metal:						
Over 96% but not over 99% silicon:						
Argentina	741		$687	1,400		$1,191
Belgium-Luxembourg	168		567	7		96
Brazil	331		352	110		121
Canada	8,303		8,953	6,012		6,183
China	--		--	40		81
France	226		244	99		126
Germany, Federal Republic of	(1)	NA	2	--	NA	--
Japan	4		83	20		113
Norway	1,606		1,503	1,312		1,394
South Africa, Republic of	1,419		1,504	394		412
Sweden	1,074		1,121	1,649		1,578
Yugoslavia	3,903		3,470	2,324		2,199
Total[2]	17,776	NA	18,485	13,366	NA	13,494
Over 99% but not over 99.7% silicon:						
Argentina	385	382	361	1,438	1,426	1,420
Brazil	1	1	1	1,991	1,972	1,968
Canada	4,856	4,812	5,674	5,514	5,463	6,251
China	116	115	118	1,035	1,026	1,018
France	269	267	270	987	981	1,119
Germany, Federal Republic of	(1)	(1)	1	--	--	--
India	(1)	(1)	(1)	--	--	--
Japan	2	2	9	5	5	28
Norway	28	28	65	827	819	867
Portugal	2,205	2,185	2,160	--	--	--
South Africa, Republic of	3,109	3,080	3,461	528	520	574
Switzerland	55	55	68	--	--	--
United Kingdom	(1)	(1)	(1)	(1)	(1)	(1)
Total[2]	11,026	10,926	12,188	12,326	12,214	13,246
Over 99.7% silicon:						
Austria	--		--	(1)		(1)
Belgium-Luxembourg	(1)		2	(1)		(1)
Bulgaria	--		--	2		8
Canada	48		52	19		22
China	9		316	29		1,045
Denmark	15		854	16		356
France	1		366	2		495
German Democratic Republic	(1)		11	--		--
Germany, Federal Republic of	418		19,704	441		17,679
India	(1)	NA	1	--	NA	--
Italy	89		4,073	60		2,757
Japan	39		1,307	44		1,793
Korea, Republic of	--		--	(1)		6
Netherlands	--		--	(1)		6
South Africa, Republic of	94		100	--		--
Sweden	8		77	4		52
Switzerland	1		396	(1)		10
Taiwan	--		--	1		24
United Kingdom	(1)		5	31		1,202
Yugoslavia	110		97	--		--
Total[2]	834	NA	27,361	649	NA	25,455
Total silicon metal	29,636	XX	58,034	26,338	XX	52,195

NA Not available. XX Not applicable.
[1]Less than 1/2 unit.
[2]Data may not add to totals shown because of independent rounding.

WORLD REVIEW

Although the world recession worsened in 1982, foreign producers of ferrosilicon and other ferroalloys were apparently less affected than the U.S. ferroalloy industry. However, a number of developing countries' economies were in such a poor state that there was imminent danger that these countries would default on foreign loans. Faced with overcapacity owing to weak demand and a need for cash flow, producing countries turned to the world market to dispose of their surplus production. Because of the recession, many countries devised protective trade measures to protect their domestic industries. The European Economic Community (EEC) began antidumping actions, in June, against Yugoslavia and Venezuela for exports of ferrosilicon to the EEC. The investigation was opened in response to complaints from nine ferrosilicon producers from France, the Federal Republic of Germany, and Italy. Those producers claimed that the two countries sold their material at 26% below cost.[2] Later in the year, the EEC Commission added Iceland, Norway, and Sweden to its investigation. Complaints against these countries were initiated by French and Italian producer associations, who claimed these countries exported ferrosilicon into the EEC considerably below normal market prices.[3]

Brazil.—Brazil exported 16,995 short tons of regular 75% ferrosilicon to the United States in 1982, down from the 41,018 short tons in 1981. However, Brazil's share of total U.S. imports of this material remained unchanged from that in 1981, at about 35%. Shipments of 75% ferrosilicon to Japan were approximately 39,700 tons compared with about 16,900 short tons in 1981.[4] Cia. Brazileira Carbureta de Càlcio, (CBCC) the largest Brazilian producer of ferrosilicon, which had brought onstream a 22,000-ton-per-year furnace in 1980, planned to add a second new 22,000-ton-per-year furnace in 1984. Two more furnaces were planned in the following decade.[5]

Canada.—Union Carbide Canada Ltd. closed its ferrosilicon and silicon metal plant at Beauharnois, Quebec, early in the year. The plant had two ferrosilicon furnaces, each with a capacity of 25,000 tons per year, and one silicon metal furnace with a capacity of 7,000 tons per year. Weak demand for silicon materials was cited as the reason for the shutdown. Reopening of the facility was not expected before 1983.[6]

China.—China supplied Japan with approximately 37,000 tons of ferrosilicon and about 15,000 tons of silicon metal in calendar year 1982 compared with about 55,000 tons of ferrosilicon and approximately 10,700 tons of silicon metal in calendar year 1981.[7] However, Chinese exports to Japan dropped abruptly beginning with the second quarter, apparently the result of a severe drought in Sichuan Province that curtailed hydroelectric power supplies to ferrosilicon plants there.[8] China also imposed a 30% tax on ferrosilicon exports effective June 1.[9]

Germany, Federal Republic of.—Degussa and PQ created a joint venture to produce and market precipitated silicas in the United States. A 50-million-pound-per-year plant was to be located at one of PQ's present plantsites. Production was to begin before the end of 1983.[10] Dynamit Nobel AG expanded capacity and made technical improvements at its Rheinfelden plant in Baden. Capacities for epoxy-silane and amino-silane have been increased to more than 500 metric tons per year. The expansion followed the startup of Dynamit Nobel's new silane facilities at its Mobile, Ala., plant in the United States.[11] Lonza Ltd.'s proposed expansion of its Weil plant at Waldshut includes a new production line for ultrafine silicon carbide and was to be completed in 2 years. The ultrafine silicon carbide was to be used in the manufacture of special ceramics.[12]

India.—Mettur Chemical and Industrial Corp. planned to begin marketing silicon metal by mid-1983. The metal was to be comparable in purity to that produced elsewhere in the world, and output was to be directed toward India's domestic market.[13]

Italy.—Montedison's S.p.A. Ferroleghe subsidiary resumed ferrosilicon production at its 20,000-ton-per-year plant in Domodossola. The facility had been closed since December 1980 owing to weak steel demand.[14]

Japan.—Japanese domestic producers of ferrosilicon, silicon metal, and other ferroalloys were hard hit by rising energy costs and competition from foreign imports. Faced with a rapidly declining market share, the domestic ferroalloy industry asked the Ministry of International Trade and Industry for a rescue scheme similar to the one granted the aluminum industry.[15] Japan imported about 261,000 tons of ferrosilicon and about 67,000 tons of metallurgical-grade silicon metal in 1982, about a 21% and 11% increase, respectively, over those of 1981. Norway, Brazil, China, the Philippines, Venezuela, Canada, the Republic of South Africa, and Iceland were the main sources of ferrosilicon.[16] China, Brazil, Norway, France, the Republic of South Africa, Portugal, and Canada were the principal suppliers of metallurgical-grade silicon metal.[17] Production of polycrystalline silicon for the Japanese semiconductor industry was approximately 666 tons, up slightly from about 653 tons in 1981.[18]

The Japan Ferroalloy Association formed

a study group late in 1982 to collect data on imports of ferrosilicon to determine if foreign producers were dumping their material on the Japanese market.[19]

Norway.—Rising power costs were the main problem Norwegian ferrosilicon and silicon metal producers faced in their efforts to remain competitive in the world market. Domestic producers asked the Government to cut the power tax and to devaluate Norway's currency to offset Sweden's October 8 devaluation. Government response was to reduce the power tax to 1.0 øre per kilowatt-hour in October, which would be in effect the remainder of the year. The tax was set at 1.3 øre per kilowatt-hour and 2.5 øre per kilowatt-hour for the first and second halves of 1983, respectively.[20] Tinfos Jernverk AS, which produces ferrosilicon at its Notodden plant, withdrew from the Fesil Group in July. The Fesil Group is now comprised of AS Bjølvefossen, AS Hafslund, and AS Ila og Lilleby Smelteverker, with ferrosilicon plants in Aalvik, Sarpsborg, and Trondheim. Elkem AS, which withdrew from the Fesil Group in 1980, is now the dominant ferrosilicon producer in Norway.[21] Fesil-Nord and Co. closed its ferrosilicon plant in Finnshes because of high power costs and a weak market.[22] Most Norwegian ferrosilicon and silicon metal producers operated much below capacity in 1982. Associated Metals and Minerals Corp. invested $39 million in the Orkla Industrier AS ferrosilicon operations. Orkla's ferrosilicon operations in Thamshavn have a capacity of 60,000 tons per year of 75% ferrosilicon. The companies planned to form a joint venture, named Orkla Metal.[23] Elkem, Orkla Metal AS & Co., AS Bjølvefossen, AS Hafslund, and AS Ila og Lilleby Smelteverker started preliminary talks for establishment of a company that would supersede the Fesil Group. If established, the new company's main market target would take in Continental Europe and the Middle and Far East. The Norwegian Government will not be a participant but will be asked to renegotiate power contracts and pollution requirements.[24]

Turkey.—Etibank converted an old calcium carbide furnace at its Antalya plant to production of 75% ferrosilicon. Power will be taken from the regular hydroelectric supply. Production capacity was reported to be 5,000 tons per year. In January 1982, the Turkish Government introduced a tariff of 20,000 lira per ton on imported ferrosilicon, which amounted to almost a quarter of the selling price of foreign ferrosilicon.[25] Etibank and Outokumpu Oy, Finland, formed a joint venture, Etikumpu, which will market Etibank's ferroalloys and other metals in Scandinavia.[26]

TECHNOLOGY

Advanced silicon ceramics, such as silicon carbide and silicon nitride, are noted for their resistance to corrosion, temperature, and wear as well as high strength and resistance to thermal shock. Of particular interest is the possible substitution of ceramic parts for conventional materials in gas turbines, diesels, and gasoline engines. Engines equipped with ceramic parts would run hotter, and cooling systems would be eliminated, making the motor lighter and more energy efficient. Reduced emissions and noise levels would be added benefits. A major objective of high-technology ceramics is to develop an all-ceramic engine and to develop ceramic replacements for heavier metals, such as cobalt, nickel, tungsten, and other rare-metal alloys.[27]

The General Electric Co.'s new Silicon Carbide Products Operation, Houston, Tex., will produce and market parts made of silicon carbide. The operation will, at first, manufacture wear parts for pumps, valves, compressors, and gas wells. The company developed a new process using boron and carbon additives that permit unfired parts to be sintered to high density and hardness at atmospheric pressure.[28] Carborundum Corp., Niagara Falls, N.Y., reported that pistons and cylinder liners fabricated from sintered alpha silicon carbide were successfully tested for several hours of operation in a diesel test engine at University College, Dublin, Ireland. The material has a strength above 65,000 pounds per square inch at 2,700° F and has enough chemical resistance to survive in engines that burn dirty and corrosive fuels. The engine operated without lubrication and cooling.[29] Kyoto Ceramics Co. Ltd., Kyoto, Japan, announced that it had conducted a running test of a ceramic engine installed in a passenger car. The engine was claimed to operate smoothly at temperatures up to 2,192° F.[30]

Detroit Diesel Allison, a division of General Motors Corp., Dearborn, Mich., completed operating tests on an experimental automotive gas turbine engine with silicon carbide and other ceramic components. Development of the turbine is funded by the U.S. Department of Energy (DOE), Office of Vehicle and Engine Research and Development.[31]

Photovoltaic research has concentrated on development of high-efficiency photovoltaic cells (solar cells), most of which are made from semiconductor-grade, single-crystal silicon. Solar cells, which convert sunlight directly into electricity through the photoelectric effect, are not yet competitive with fossil fuel and nuclear energy sources. Various technologies now being developed have the potential for lowering the cost of solar cells, but no major breakthroughs appear likely in the near future. All photovoltaic companies are researching ways to increase cell efficiency above the current level of about 15%.[32] DOE's Energy Research Advisory Board, in its report on Federal policies toward solar energy, recommended that new Federal spending concentrate on advanced research and development of compound semiconductors and silicon thin-film solar cells, with less emphasis on high-purity crystalline silicon solar cells.[33] Federal funding for photovoltaic research was cut from $150 million in 1981 to $53.7 million in 1982.

Energy Conversion Devices, Inc. (ECD), Troy, Mich., built a machine that will produce foot-square solar cells of amorphous silicon alloy on a stainless steel substrate. The company claims it has achieved the highest efficiency yet reached in laboratory-scale amorphous solar cells, 8.2%. ECD already has a joint venture with Standard Oil of Ohio, aimed at using noncrystalline thin-film technology for converting solar energy into electricity at costs competitive with conventional sources. ECD also has set up a joint venture with Sharp Corp., Japan—Sharp-ECD Solar Inc.—to produce and market ECD's amorphous silicon solar cells outside the United States.[34] Chronar Co., Princeton, N.J., reported that it can produce amorphous silicon thin-film photovoltaic devices that can convert sunlight into electricity at competitive prices. The process uses chemical deposition of silicon from high-order silanes.[35] RCA Laboratories, Princeton, N.J., reported development of amorphous silicon solar cells that operated at an efficiency of 10%, a goal that thin-film solar cell devices had to reach before large-scale production would be cost competitive.[36]

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Silver

By Robert G. Reese, Jr.[1]

Silver was mined in 60 countries in 1982. Peru replaced Mexico as the largest silver-producing nation for the year, while the U.S.S.R., the United States, and Canada were the third through fifth largest producers. Domestic refinery production declined in 1982. Domestic silver consumption increased slightly in 1982, with the largest gains in the sterlingware and contacts and conductors end-use categories. The price of silver declined throughout the first 6 months of the year before more than doubling by yearend.

Domestic Data Coverage.—Domestic mine production data for silver were developed by the Bureau of Mines from four separate voluntary surveys of U.S. operations. Typical of these surveys was the lode-mine production survey of gold, silver, copper, lead, and zinc mines. Of the 184 lode silver operations to which a survey form was sent, 47% responded, representing 90% of the total U.S. mine production figures shown in tables 1, 2, 4, 5, and 6. Production for the remaining 97 firms was estimated using prior reported production levels adjusted for economic trends and other sources such as company annual reports, news or journal articles, or State agency reports.

Table 1.—Salient silver statistics

	1978	1979	1980	1981	1982
United States:					
Mine production thousand troy ounces	39,385	37,896	32,329	r40,683	40,239
Value thousands	$212,681	$420,261	$667,278	r$427,922	$319,903
Ore (dry and siliceous) produced:					
Gold ore thousand short tons	3,499	4,202	5,511	8,758	13,087
Gold-silver ore do	738	756	872	1,041	1,213
Silver ore do	1,102	1,066	2,064	4,538	5,423
Percentage derived from:					
Dry and siliceous ores	55	51	51	54	68
Base metal ores	45	49	49	46	32
Refinery production[1] thousand troy ounces	44,018	38,982	36,171	44,487	43,825
Exports[2] do	22,400	35,563	80,851	27,903	25,470
Imports for consumption[2] do	75,641	92,381	78,795	94,115	117,458
Stocks, Dec. 31:					
Treasury[3] do	39,157	38,990	38,890	38,732	36,768
Industry[4] do	146,902	149,131	138,053	r117,386	126,820
Defense Department	6,450	5,670	4,510	3,810	1,750
Consumption:					
Industry and the arts do	160,165	157,258	124,694	r116,670	118,840
Coinage do	45	168	72	179	1,846
Price[5] per troy ounce	$5.40	$11.09	$20.63	$10.52	$7.95
World:					
Production thousand troy ounces	r344,978	r343,848	339,382	p362,308	e372,528
Consumption:[6]					
Industry and the arts do	442,600	419,800	349,400	363,300	357,200
Coinage do	36,300	27,800	13,700	6,000	11,800

eEstimated. pPreliminary. rRevised.
[1]From domestic ores.
[2]Excludes coinage.
[3]Excludes silver in silver dollars.
[4]Includes silver in COMEX warehouses and silver registered in Chicago Board of Trade.
[5]Average New York price. Source: Handy & Harman.
[6]Market economies only. Source: Handy & Harman.

Legislation and Government Programs.—Public Law 97-377, Further Continuing Appropriations for 1983, limited future sales of silver from the National Defense Stockpile in any 12-month period to no more than 10% of domestic mine production in the preceding year.

The General Services Administration sold over 670,000 ounces of silver for other Government agencies, which was mostly reclaimed material from Government laboratories and hospitals.[2]

The U.S. Treasury Department was authorized to mint and market two silver coins and one gold coin to commemorate the 1984 Olympics, scheduled to be held in Los Angeles, Calif. The silver coins contain 0.77 troy ounce of silver and were scheduled to be minted in 1983-84. Production of the George Washington Commemorative Half Dollar, authorized by Congress in late 1981, began during 1982. Over 1.8 million ounces of silver was consumed in minting these coins.

A report on the Securities and Exchange Commission's investigations into the runup and subsequent collapse of silver prices during late 1979 and early 1980 was issued in 1982.[3] The Commission concluded that excessive easy credit and poor supervision of clients accounts by security firms were the primary factors that produced the silver crisis. Some of the investigators recommendations were: (1) to study the possibility of having brokerage houses that deal with both securities and commodities establish separately financed companies to handle each type of business; and (2) to hold discussions with the Commodity Futures Trading Commission on issues such as the commodity exchange board's ability to change margin requirements to potentially benefit certain market participants, and the valuation of customer accounts by the brokerage houses during volatile markets.

A study on secondary silver, prepared for the Bureau of Mines by a private consulting firm, was completed in 1982.[4] Included in the final report was an estimate that the U.S. silver holdings of bullion, coins, and sterlingware was in excess of 2.5 billion ounces by yearend 1980. It was believed that most of this material was in unreported private holdings. It was believed that while all of this material could be a potential supply source, factors such as the form in which the material was held and price changes would determine the rate at which the material entered the market. Overall, the elasticity of this supply was estimated as quite low, although it was believed that the silver held in coins could be highly price-elastic.

DOMESTIC PRODUCTION

During 1982, silver production was reported at 198 mines including 14 placer operations. Silver was produced from precious metal ores at 130 mines while 54 mines produced silver as a byproduct of the processing of copper, lead, and zinc ores. The 25 largest mines accounted for 87% of total domestic mine output. Eleven mines each produced more than 1 million ounces of silver, which, when aggregated, equaled 65% of the total domestic production.

The price of silver dropped throughout the early months of the year and a number of domestic mines were either closed permanently or placed on care-and-maintainence status. A number of domestic copper mines that produce byproduct silver were closed in early 1982 reportedly because of low copper and silver prices and relatively high production costs. Several large silver mines closed later in the year as the price of silver neared its nadir. Subsequently, as the price of silver recovered some of these mines were reopened.

ASARCO Incorporated reported that its new Troy Mine in Montana, which began operations in the third quarter of 1981, reached full production in February 1982.[5] The mine milled 2,843,000 short tons of ore and produced 4,243,000 ounces of silver during 1982, making it the largest silver mine in the United States. Two other Asarco-operated mines, the Galena and Coeur in Idaho, were also among the top five producing mines in 1982. Asarco's refinery at Amarillo, Tex., produced more than 40 million ounces of silver from primary and secondary material in 1982, an increase of more than 5.7 million ounces from the previous year. A new precious metal scrap receiving and sampling facility at the refinery completed its first full year of operation in 1982.

The Duval Corp. reopened the Sierrita Mine in April 1982 at reduced production rates.[6] The mine had been closed in December 1981. Silver production was reported as 315,000 ounces. Notable however, was the use of a large-capacity movable crushing system in the pit. The corporation expects the system to reduce mining costs by 10% to 15% through reduced haulage costs.

Gulf Resources & Chemical Corp. reported that all of the Idaho assests of The Bunker Hill Corp. were sold to a group of four investors in late 1982. Included in the sale were the Bunker Hill Mine, the Crescent Mine, a concentrator, a lead smelter, an electrolytic zinc plant, a fertilizer plant, and land. However, none of the facilities were reopened by the end of 1982.

The Hecla Mining Co. reported that its Lucky Friday Mine in Idaho produced a mine record 3.84 million ounces of silver in 1982 through an increase in the silver content and amount of ore mined.[7] Progress continued on the Silver shaft project. By yearend, shaft development had reached 5,800 feet and the first ore was expected to be hoisted by late 1983. Shaft development also progressed at Hecla's Consolidated Silver Venture. This shaft was also expected to be completed in 1983 after which an exploration and development program was planned.

The Sherman Mine in Colorado, which Hecla operates under a long-term lease, was closed in January 1982, reportedly because of low silver prices and limited reserves of developed ore. Some exploration work was conducted after the mine was closed, but in June the mine was placed in a care-and-maintainence status and remained closed throughout the remainder of the year. Also in June 1982, Hecla decided to close permanently the Star-Morning Mine in Idaho. Salvage operations were completed by late 1982 and the mine was flooding on the lower levels.

The Homestake Mine in South Dakota, owned by the Homestake Mining Co., reopened in October 1982 following settlement of a 17-week strike.[8] The strike was only the second in the mine's history. Homestake reduced employment and wages several times at its Bulldog Mountain Mine during the first 7 months of 1982, reportedly because of low silver prices and cash losses at the mine.

The Phelps Dodge Corp. temporarily closed all of its open pit copper mines in mid-April. By yearend only the Morenci and Metcalf pits had reopened.[9] Phelps Dodge reported that silver production from all material processed at its refineries in El Paso, Tex., and Laurel Hill, N.Y., equaled 2.7 million ounces, a nearly 2-million-ounce reduction from the 1981 output. A new precious metal recovery plant at El Paso that began operation in late 1982 will enable Phelps Dodge to recover precious metal from its refinery slimes, thereby avoiding toll refining the material.

Production began at the Sixteen-to-One Mine and mill, operated by the Sunshine Mining Co., in 1982. The mine is a "trackless" operation and the cyanide leaching mill is capable of processing 500 tons of ore per day. The doré produced at the mill was shipped to Sunshine's new refinery in Idaho, which began operations in April 1982. With this refinery, Sunshine completed its vertical integration and is now capable of mining, milling, refining, and selling its own silver.

On June 12, 1982, Sunshine suspended production at its Sunshine Mine reportedly because of the low silver prices. In 1981, the 4 million ounces of silver produced by the Sunshine Mine made it the largest domestic mine. The mine was subsequently reopened in November 1982 and full production was expected in early 1983.

Other companies that suspended operations during June 1982 included Silver King Mines Inc., Clayton Silver Mines Inc., and Occidental Minerals Corp. Silver King closed the Taylor Mine and mill, Clayton closed the Clayton Mine, and Occidental closed the Candelaria project. Officials at the companies cited the low silver prices when announcing the closures. The Taylor Mine was reopened in September, the Candelaria Mine in October, and the Clayton Mine in December.

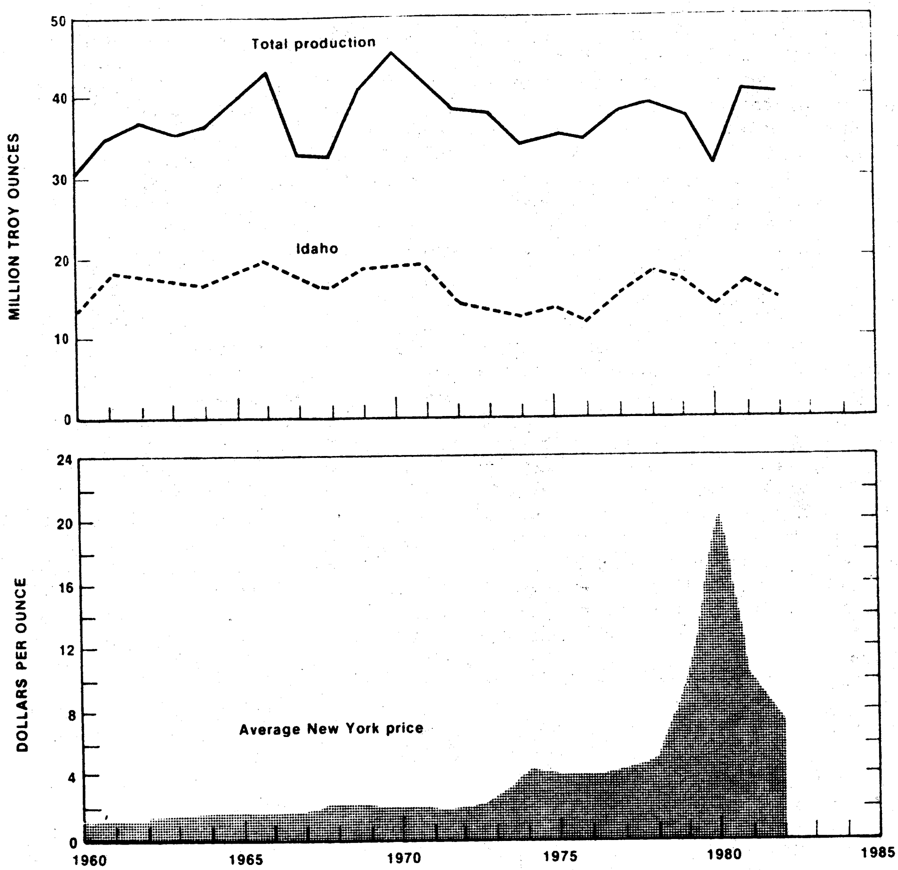

Figure 1.—Silver production in the United States and price per ounce.

CONSUMPTION AND USES

Industrial consumption of silver increased slightly in 1982. The declining silver price during the first 6 months of the year contributed to the increase.

Although total industrial consumption increased slightly, individually 7 of 13 end-use categories recorded consumption decreases. The largest decrease was in catalysts. Other large decreases were in coins, medallions, and commemorative objects and electroplated ware. The largest gains in silver consumption were in sterlingware and contacts and conductors.

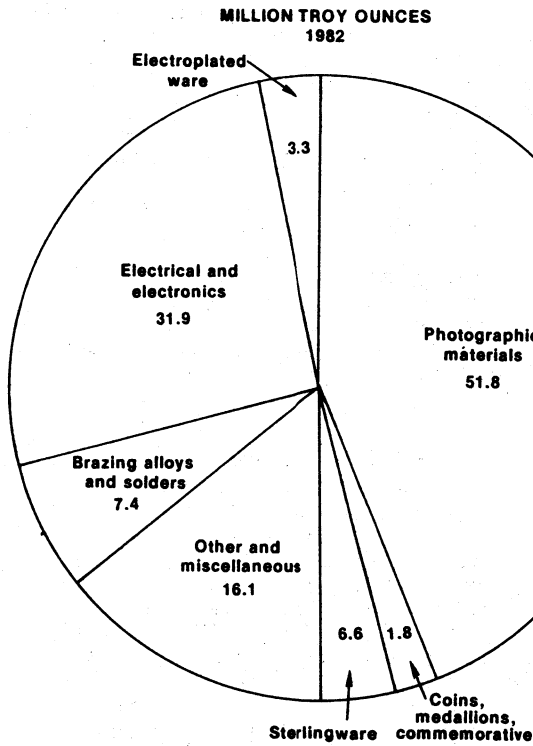

Figure 2.—Silver consumption in the United States in 1982.

STOCKS

Refiner, fabricator, and dealer stocks at yearend 1982 equaled nearly 20.4 million ounces, essentially unchanged from a year earlier. However, during the first half of 1982 industrial stocks increased to 22.7 million ounces before declining in the third and fourth quarters. Silver depository stocks held by Commodity Exchange, Inc. (COMEX), declined to 61.5 million ounces from 77.6 million ounces during the first 9 months of 1982. In the fourth quarter, these COMEX stocks increased to 90.7 million ounces by yearend. Similarly, the silver depository stocks held by the Chicago Board of Trade (CBT) declined from 18.9 million ounces at yearend 1981 to 13.5 million ounces at the end of September 1982. By the end of 1982 these stocks had climbed to 15.5 million ounces.

The National Defense Stockpile contained 137.5 million ounces of silver at yearend 1982, all of which remained classified as excess to U.S. defense needs. Public Law 97-35, the Omnibus Budget Reconciliation Act of 1981, authorized disposal of 46,537,000 ounces of silver beginning on October 1, 1981; 44,682,000 ounces beginning on October 1, 1982; and 13,900,000 ounces beginning on October 1, 1983. However, sales of the silver remained suspended throughout 1982 pending a redetermination that the silver authorized for disposal was not required for national defense purposes.

PRICES

The price of silver fell through the first 6 months of 1982. Analysts attributed the weakness in silver prices to the worldwide economic recession, which they believed negated factors that normally would have been expected to increase the demand and consequently the price of silver. As a result, events such as declining U.S. interest rates, the weakening of the dollar in foreign exchange, forecasts of increased U.S. budget deficits, and foreign wars were unable to prevent the silver price from falling to $4.88 per ounce on June 21, 1982. This was the lowest price for silver since February 1978.

After reaching a 4-year low on June 21, the price of silver more than doubled by yearend. The closing of mines in the United States and the halting of silver sales from the National Defense Stockpile were felt to have contributed to correcting a supply-demand imbalance and, as a result, to have had a positive impact on the silver price. Analysts also believed that concerns about the financial stability of some countries with large foreign debts, declining U.S. interest rates, and an increasing U.S. money supply contributed to the price rise.

Prices on the London Metal Exchange (LME) followed the same pattern as in the United States. The price declined from $8.06 per ounce at the beginning of January 1982 to $4.90 per ounce on June 21. From this low, the price steadily increased, finishing the year at $10.87 per ounce. The LME high and low prices for the year were $11.11 on December 29 and $4.90 on June 21, respectively. The average for the year was $7.92 per ounce.

The silver trading volume on COMEX was 14.2 billion ounces in 1982, a significant increase from the previous year's volume of 6.2 billion ounces. The trading volume at CBT declined to 1.2 billion ounces from 1.3 billion ounces in 1981.

FOREIGN TRADE

U.S. exports of silver declined approximately 9% from the 27.9 million ounces exported in 1981. Exports of refined bullion, ore and concentrates, and doré and precipitates all declined in 1982, while shipments of waste and sweepings increased. The countries receiving U.S. silver exports remained the same as in 1981, except no shipments were made to Spain in 1982.

The United States was a net importer of silver in 1982. Net import reliance calculated as a percent of apparent consumption was nearly 56%. U.S. imports increased nearly 25% from the 94.1 million ounces imported in 1981.

Imports for consumption of refined bullion increased 28% in 1982 from 1981. The three largest suppliers of refined bullion were the same in 1982 as in 1981; however, while imports from Canada and Mexico increased by 8% and 22%, respectively, imports from Peru declined by 37%. Imports of refined bullion from the United Kingdom were over 50 times the amount of bullion imported from that country in 1981, and approximately 80% of this material entered the United States during the fourth quarter of 1982. Similarly, 70% of the refined bullion from Belgium-Luxembourg entered the United States during the fourth quarter of 1982. In 1981, no silver had been imported from Belgium-Luxembourg.

Imports of ore and concentrates also increased by 28% in 1982, while imports of waste and sweepings increased by over 38%. For ores and concentrates, most of the increase was accounted for by the near doubling of shipments from Peru. For waste and sweepings, increased shipments from Brazil and Chile more than made up for lower shipments from Canada, Hong Kong, and the United Kingdom. Imports of doré and precipitates all declined by nearly 19% in 1982.

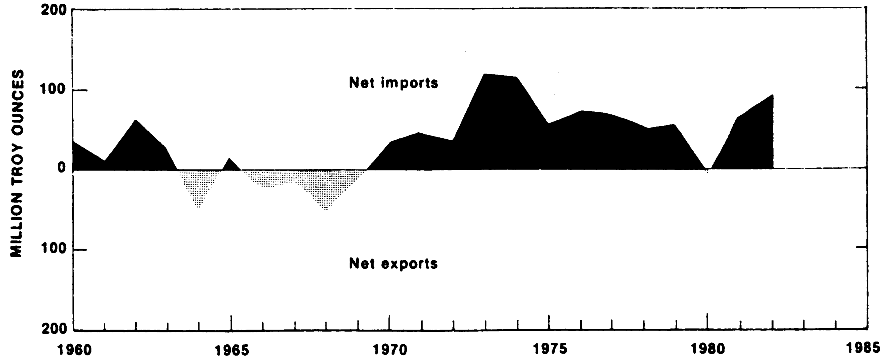

Figure 3.—Net exports or imports of silver, 1960-82.

WORLD REVIEW

Peru replaced Mexico as the largest silver-producing nation in 1982. The five largest silver-producing countries were Peru, Mexico, the U.S.S.R., the United States, and Canada. It was believed by some analysts that mine production of silver was maintained in some countries regardless of the cost of production, the silver price, or the effects of the recession so that the countries could earn foreign exchange credits to service their debts.

Consumption of silver in 1982 in the market economy countries for industrial and coinage use totaled 369 million ounces, an increase of 15.9 million ounces from 1981 revised figures.[10] Industrial uses increased by 13.1 million ounces and accounted for 97% of world consumption in 1982. Coinage in 1982 increased by 2.8 million ounces to 11.8 million ounces. Total consumption by market economy countries exceeded their primary production by 104 million ounces, according to Handy & Harman estimates. Secondary silver was obtained from the following sources: old scrap, 81 million ounces; outflow from Indian stocks, 35 million ounces; demonetized coin, 13 million ounces; and U.S. and foreign government stock withdrawals, 10.1 million ounces. Privately held bullion stocks increased by 35.1 million ounces according to Handy & Harman.

Australia.—In mid-1982, MIM Holdings Ltd., 44% owned by Asarco, completed a 20% expansion of their silver-lead-zinc ore mining and milling capacity at the Mount Isa Mine.[11] MIM Holdings produced 14,913,000 ounces of silver in 1982 compared with 11,768,000 ounces in 1981, and 14,655,000 ounces in 1980. In order to maintain this production rate in the next decade, exploration and preparations for test mining continued at the Hilton Mine.

Production from the Woodlawn Mine in New South Wales was 1,362,000 ounces in 1982, a decrease of approximately 100,000 ounces from the previous year. Reserves were estimated at more than 6 million tons of ore.

Canada.—Cominco Ltd. reported silver production of 9,681,000 troy ounces from their smelter and refining complex at Trail, British Columbia, despite a 5-week shutdown at midyear.[12] The production at Trail in 1981 was 7,721,000 ounces. Purchases of custom concentrates with high silver content accounted for the increased output. Company-owned mines supplied 3,488,900 ounces of silver in 1982. Employment at Trail declined from 4,955 workers to 4,036 at yearend. Completion of construction projects, production-related layoffs, rationalization of crew size, and retirements accounted for the smaller work force at yearend 1982. Cominco reported that the Sullivan Mine in British Columbia produced 2.4 million tons of ore in 1982, the largest production at the mine since 1964. The average ore grade was 1.9 ounces per ton. Employment at the mine declined by 81 to 959 workers at yearend.

Noranda Mines Ltd. reported a decline in the refinery production of silver in 1982.[13] Output decreased to 14,226,000 ounces from 18,996,000 ounces in 1981 because of a 4-month strike in their Division CCR. Noranda's direct interest in various silver-producing mines in Canada and other countries provided them with 7,420,000 ounces of silver in 1982.

Mine production at Brunswick Mining and Smelting Corp. Ltd. was 7,014,000 ounces in 1982. Smelter output was 3,175,000 ounces. The mine production represented the results of the first full year of operation following a production capacity expansion to 11,000 tons of ore per day. The production of doré silver set a new company annual record.

Honduras.—On August 26, 1982, management at Rosario Resources Corp., a wholly owned subsidiary of AMAX Inc., reached an agreement with leaders of the local mine workers union to reduce the number of workers at its El Mochito Mine. Maintenance of past production levels was possible because of the successful utilization of mechanized mining methods and improved work procedures. On August 27, 1982, the Government of Honduras approved a new tax law that reduced royalties and import and export taxes. The labor agreement and tax change were believed to have averted the possible near-term closure of the El Mochito Mine. Silver production at the mine was 2,052,000 ounces in 1982 and 1,667,000 ounces in 1981.[14]

Mexico.—On June 11, 1982, production began at the Real de Angeles Mine in the Mexican State of Zacatecas. The mine, jointly owned by Frisco S.A. de C.V. (33%), Fomento Minero (33%), and Placer Development Ltd. (34%) produced silver, lead, and zinc. Reserves were estimated at nearly 93 million tons of ore. Expected annual production, in excess of 7 million troy ounces, would make the Real de Angeles one of the largest silver producers in the world.

Lacana Mining Corp. reported production of silver at its 30% owned Torres mining complex, Guanajuato, at 4.5 million ounces.[15] The mill processed more than 648,000 tons of ore averaging 7.8 ounces of silver per ton. The Torres complex is composed of a centrally located 2,200-ton-per-day flotation concentrator fed by ore from four mines: the Torres-Cedros, the Peregrina-Triumvirato, the Cebada, and the Bolanitos. Other partners in the mining operations are Cía. Fresnillo, S.A. de C.V., and Industrias Peñoles, S.A. de C.V.

Lacana owns 40% of the Encantada Mining Group, Coahuila, which is composed of a 1,300-ton-per-day flotation concentrator fed by three mines, the Encantada, the Los Angeles, and the Plomo. Silver production in 1982 totaled 2,104,779 ounces from 327,637 tons of ore. Lacana's partner in the Encantada Mining Group is Industrias Peñoles S.A. de C.V.

Silver production at Industria Minera Mexico S.A. was reported as 16,166,000 ounces in 1982, a decrease of nearly 2.7 million ounces from 1981.

Peru.—Peruvian mine production of silver increased primarily because of production increases at Cía. de Minas Buenaventura S.A. Buenaventura was the second largest silver producer in Peru in 1982. The company had increased the ore capacities of its Uchucchacua unit to 21,000 tons per month from 15,000 tons, of its Julcani unit to 21,000 tons per month from 16,500 tons, and of its Orcopampa unit to 12,500 tons per month from 9,000 tons. Empresa Mineral del Centro del Perú was the largest silver producer in the country with an output of 11,767,000 ounces in 1982. Southern Peru Copper Corp. reported that silver production at its Toquepala and Cuajone copper mines totaled 2,260,000 ounces in 1982, an increase of 207,000 ounces from that of 1981.

TECHNOLOGY

Reported silver-related research and development was widespread in 1982. A sample of the reported work included: (1) the development of equipment for rapid direct assays of sample material;[16] (2) successful laboratory tests to extract silver from certain low-grade ores using hydrometallurgy techniques;[17] (3) development of a method to recover silver from photographic and photocopying wastes while minimizing the discharge of silver into wastewaters;[18] and (4) the development of new uses for silver in electronics and medicine.

The Bureau of Mines silver-related research was concentrated on the recovery of silver from electronic scrap and the recovery of silver from low-grade resources. A report was published on the results of a laboratory study to recover silver from cyanide mill tailings containing manganese oxide and 1.7 ounces of silver per ton.[19] This material was leached with an acidic ferrous chloride-sodium chloride solution. The study found that the solution extracted 82% of the silver in the tailings and that subsequently, 99% of the leached silver could be recovered by cementation on iron powder.

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[1]Physical scientist, Division of Nonferrous Metals.

[2]Ounce as used throughout this chapter refers to the troy ounce.

[3]Securities and Exchange Commission. Silver Crisis Report of 1980, October 1982, 279 pp.

[4]Wolfe, T. W., B. P. Malashevich, C. Chandler, C. Morgan, B. Rubenking, and V. Honnold. The Price-Responsiveness of Secondary Silver. BuMines Open File Rept. 74-82, 1982, 146 pp.; available for reference at Bureau of Mines facilities in Tusaloosa, Ala., Juneau, Alaska, Denver, Colo., Avondale, Md., Twin Cities, Minn., Rolla, Mo., Reno, Nev., Albany, Oreg., Pittsburgh, Pa., Salt Lake City, Utah, and Spokane, Wash.; Office of the Under Secretary of Defense for Research and Engineering Acquisitions Management-Industrial Resources, U.S. Department of Defense; National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C.; and from National Technical Information Service, Springfield, Va. PB 82-208422.

[5]ASARCO Incorporated. 1982 Annual Report. 36 pp.

[6]Pennzoil Co. 1982 Annual Report. 40 pp.

[7]Hecla Mining Co. 1982 Annual Report. 28 pp.

[8]Homestake Mining Co. 1982 Annual Report. 28 pp.

[9]Phelps Dodge Corp. 1982 Annual Report. 36 pp.

[10]Handy & Harman. The Silver Market, 1982. 67th Annual Report. 28 pp.

[11]Work cited in footnote 5.

[12]Cominco Ltd. 1982 Annual Report. 32 pp.

[13]Noranda Mines Ltd. 1982 Annual Report. 48 pp.

[14]AMAX Inc. 1982 Annual Report. 32 pp.

[15]Lacana Mining Corp. 1982 Annual Report. 27 pp.

[16]Mining Journal. Metal Analysis Probe. V. 299, No. 7671, Aug. 27, 1982, p. 148.

———. New Exploration Method. V. 299, No 7689, Dec. 31, 1982, p. 464.

[17]Canadian Mining Journal. New Hydrometallurgical Process Shows Promise With Low Grade Silver Ores. V. 103, No. 3, March 1982, pp. 56, 58.

[18]Krause, C. Silver Recovery From ORNL Wastes. Oak Ridge Nat. Lab. Rev., v. 15, No. 4, Fall 1982, pp. 2-7.

[19]Bremner, P. R. Silver Recovery From Cyanide Tailings Using an Acidic NaCl-$FeCl_2$ Leachant. BuMines RI 8649, 1982, 7 pp.

Table 2.—Mine production of recoverable silver in the United States, by month

(Thousand troy ounces)

Month	1980	1981	1982
January	3,271	3,062	3,642
February	3,365	3,404	3,282
March	3,280	3,408	4,038
April	3,335	3,314	3,732
May	3,006	3,151	3,712
June	3,163	3,315	3,567
July	1,993	3,577	3,089
August	1,741	3,408	2,987
September	1,776	3,503	3,014
October	2,074	r3,795	2,889
November	2,144	3,354	3,240
December	3,181	3,392	3,047
Total	32,329	r40,683	40,239

rRevised.

Table 3.—Twenty-five leading silver-producing mines in the United States in 1982, in order of output

Rank	Mine	County and State	Operator	Source of silver
1	Troy	Lincoln, Mont	ASARCO Incorporated	Silver ore.
2	Lucky Friday	Shoshone, Idaho	Hecla Mining Co	Do.
3	Galena	do	ASARCO Incorporated	Do.
4	Coeur	do	do	Do.
5	Sunshine	do	Sunshine Mining Co	Do.
6	Utah Copper	Salt Lake, Utah	Kennecott Corp	Copper ore.
7	Escalante	Iron, Utah	Ranchers Exploration & Development Corp.	Silver ore.
8	DeLamar	Owyhee, Idaho	Earth Resources Co	Gold-silver ore.
9	Twin Buttes	Pima, Ariz	Anamax Mining Co	Copper ore.
10	Bulldog Mountain	Mineral, Colo	Homestake Mining Co	Silver ore.
11	Candelaria	Mineral, Nev	Candelaria Partners	Do.
12	Black Pine	Granite, Mont	Black Pine Mining Co	Do.
13	Buick	Iron, Mo	Amax Lead Co. of Missouri	Lead ore.
14	Eisenhower	Pima, Ariz	Eisenhower Mining Co	Copper ore.
15	Taylor	White Pine, Nev	Silver King Mines, Inc	Silver ore.
16	Berkeley Pit	Silver Bow, Mont	The Anaconda Company	Copper ore.
17	Mission	Pima, Ariz	ASARCO Incorporated	Do.
18	Bagdad	Yavapai, Ariz	Cyprus Bagdad Copper Co	Do.
19	Sixteen-to-One	Esmeralda, Nev	Sunshine Mining Co	Gold-silver ore.
20	Sierrita	Pima, Ariz	Duval Corp	Copper ore.
21	Star unit	Shoshone, Idaho	Hecla Mining Co	Lead-zinc ore.
22	San Manuel	Pinal, Ariz	Magma Copper Co	Copper ore.
23	St. Cloud	Sierra, N. Mex	St. Cloud Mining Co	Silver ore.
24	Magma	Pinal, Ariz	Magma Copper Co	Copper Ore.
25	Morenci	Greenlee, Ariz	Phelps Dodge Corp	Do.

Table 4.—Silver produced in the United States, by State, type of mine, and class of ore yielding silver, in terms of recoverable metal

State	Placer (troy ounces of silver)	Lode					
		Gold ore		Gold-silver ore		Silver ore	
		Short tons	Troy ounces of silver	Short tons	Troy ounces of silver	Short tons	Troy ounces of silver
1980: Total	467	5,510,745	749,785	872,019	1,953,874	2,064,191	13,699,057
1981: Total	1,839	[r]8,758,364	[r]754,037	[r]1,040,878	[r]2,263,535	[r]4,538,322	[r]19,095,412
1982:							
Alaska	1,798	2,360	282	--	--	--	--
Arizona	--	W	W	W	W	95,141	105,563
California	189	36,544	7,869	W	W	W	W
Colorado	25	W	W	11,983	8,565	W	W
Idaho	--	175,279	3,375	W	W	692,488	12,649,936
Illinois	--	--	--	--	--	--	--
Michigan	--	--	--	--	--	--	--
Missouri	--	--	--	--	--	--	--
Montana	--	3,882,855	147,079	12,292	29,821	3,048,420	5,246,510
Nevada	--	6,520,154	298,795	353,333	718,638	1,158,144	1,852,470
New Mexico	--	W	W	14,932	58,971	W	W
New York	--	--	--	--	--	--	--
South Dakota	--	1,167,886	26,241	--	--	--	--
Tennessee	--	--	--	--	--	--	--
Utah	--	--	--	W	W	W	W
Washington	--	W	W	--	--	W	W
Total	2,012	13,087,462	852,500	1,213,247	2,769,495	5,422,706	23,577,319
Percent of total silver	([1])	XX	2	XX	7	XX	59

State	Lode					
	Copper ore		Lead ore		Zinc ore	
	Short tons	Troy ounces of silver	Short tons	Troy ounces of silver	Short tons	Troy ounces of silver
1980: Total	220,293,487	11,135,824	10,080,986	2,534,828	370,702	20,956
1981: Total	[r]281,939,595	13,952,838	8,524,045	1,839,198	[r]561,970	[r]28,863
1982:						
Alaska	--	--	--	--	--	--
Arizona	127,180,580	6,058,403	W	W	--	--
California	--	--	--	--	--	--
Colorado	--	--	W	W	--	--
Idaho	--	--	W	W	--	--
Illinois	--	--	--	--	--	--
Michigan	W	W	--	--	--	--
Missouri	--	--	9,403,523	2,241,159	--	--
Montana	14,161,038	739,338	--	--	--	--
Nevada	--	--	--	--	--	--
New Mexico	W	W	--	--	--	--
New York	--	--	--	--	611,748	26,660
South Dakota	--	--	--	--	--	--
Tennessee	--	--	--	--	--	--
Utah	W	W	--	--	--	--
Washington	--	--	--	--	--	--
Total	190,713,274	9,411,564	9,407,482	2,244,737	611,748	26,660
Percent of total silver	XX	23	XX	6	XX	([1])

See footnotes at end of table.

Table 4.—Silver produced in the United States, by State, type of mine, and class of ore yielding silver, in terms of recoverable metal—Continued

State	Lode				Total[2]	
	Copper-lead, lead-zinc, copper-zinc, and copper-lead-zinc ores		Old tailings, etc.			
	Short tons	Troy ounces of silver	Short tons	Troy ounces of silver	Short tons	Troy ounces of silver
1980: Total	3,256,562	2,112,419	67,623	122,163	242,516,315	32,329,373
1981: Total	3,186,988	2,369,785	286,419	377,666	[r]308,836,581	[r]40,683,173
1982:						
Alaska	--	--	--	--	2,360	2,080
Arizona	--	--	W	W	127,380,891	6,300,671
California	--	--	--	W	37,603	34,048
Colorado	W	W	--	--	732,770	1,934,312
Idaho	W	W	W	W	1,743,839	14,830,351
Illinois	--	--	--	W	--	W
Michigan	--	--	--	--	W	W
Missouri	--	--	--	--	9,403,523	2,241,159
Montana	--	--	192,140	5,963	21,296,745	6,168,711
Nevada	--	--	130,516	272,360	8,162,147	3,142,263
New Mexico	--	--	--	--	11,371,434	804,594
New York	--	--	--	--	611,748	26,660
South Dakota	--	--	--	--	1,167,886	26,241
Tennessee	W	W	--	--	W	W
Utah	--	--	W	W	37,190,550	4,342,333
Washington	--	--	--	--	W	W
Total	2,125,147	919,329	433,446	[3]435,585	223,014,512	40,239,201
Percent of total silver	XX	2	XX	1	XX	100

[r]Revised. W Withheld to avoid disclosing company proprietary data; included in "Total." XX Not applicable.
[1]Less than 1/2 unit.
[2]Data may not add to State totals because of items withheld to avoid disclosing company proprietary data.
[3]Includes byproduct silver recovered from tungsten ore in California and fluorspar in Illinois and molybdenum ore in Nevada.

Table 5.—Mine production of recoverable silver in the United States, by State

(Troy ounces)

State	1978	1979	1980	1981	1982
Alaska	2,052	W	8,354	2,372	2,080
Arizona	6,637,838	7,478,942	6,267,588	8,055,231	6,300,671
California	58,014	64,185	49,257	53,286	34,048
Colorado	4,217,181	2,808,934	2,987,058	3,008,994	1,934,312
Idaho	18,379,417	17,144,209	13,694,902	16,545,648	14,830,351
Illinois	W	W	W	W	W
Michigan	W	W	W	W	W
Missouri	2,056,053	2,201,112	2,357,236	1,837,011	2,241,159
Montana	2,918,317	3,301,928	2,023,893	2,988,810	6,168,711
Nevada	803,887	560,435	939,997	3,039,480	3,142,263
New Mexico	894,833	W	W	1,632,346	804,594
New York	20,911	10,538	20,702	28,829	26,660
Oregon	1,714	1,572	841	7,487	--
South Carolina	--	--	--	W	--
South Dakota	53,099	57,973	51,257	55,792	26,241
Tennessee	W	W	W	W	W
Texas	W	--	--	--	--
Utah	2,885,065	2,454,136	2,203,289	2,882,671	4,342,333
Washington	W	W	W	67,390	W
Total	39,385,370	37,895,524	32,329,373	r40,683,173	40,239,201

rRevised. W Withheld to avoid disclosing company proprietary data; included in "Total."

Table 6.—Silver produced in the United States from ore, old tailings, etc., by State and method of recovery, in terms of recoverable metal

State	Total ore, old tailings, etc. treated[1 2] (thousand short tons)	Ore and old tailings to mills: Thousand short tons[1 2]	Recoverable in bullion: Amalgamation (troy ounces)	Recoverable in bullion: Cyanidation (troy ounces)	Concentrates smelted and recoverable metal: Concentrates (short tons)	Concentrates smelted and recoverable metal: Troy ounces	Crude ore, old tailings, etc., to smelters[1]: Thousand short tons	Crude ore, old tailings, etc., to smelters[1]: Troy ounces
1980: Total	274,015	273,270	1,502	2,637,809	6,068,875	28,643,779	746	1,045,816
1981: Total	r340,230	r339,555	6	4,627,666	r7,177,323	r34,815,156	675	1,238,506
1982:								
Alaska	2	2	--	--	20	100	(3)	182
Arizona	153,056	152,747	--	742	2,495,992	6,057,964	309	241,965
California	4 40	4 38	--	1,000	1,047	26,010	2	6,849
Colorado	4 974	4 974	--	1,800	59,454	1,931,512	(3)	975
Idaho	4 1,744	4 1,741	--	1,639,994	68,049	13,152,968	3	37,389
Illinois	--	--	--	--	W	W	--	--
Michigan	W	W	--	--	W	W	--	--
Missouri	9,404	9,404	--	--	846,592	2,241,159	--	--
Montana	4 21,305	4 21,211	--	146,217	247,285	5,981,604	14	40,890
Nevada	4 5 12,722	4 5 12,719	--	2,329,609	17,955	807,103	3	5,551
New Mexico	4 11,400	4 11,326	--	12,628	314,726	733,786	74	58,180
New York	671	671	--	--	99,931	26,660	--	--
South Dakota	1,168	1,168	--	26,241	--	--	--	--
Tennessee	W	W	--	--	W	W	--	--
Utah	5 37,219	5 37,108	--	1,936,278	739,432	2,119,353	111	286,702
Washington	W	W	--	3,043	W	W	(3)	2,686
Total	258,501	257,985	--	6,097,552	5,258,172	33,458,268	516	681,369

rRevised. W Withheld to avoid disclosing company proprietary data; included in "Total."
1Includes some nonsilver-bearing ore not separable.
2Excludes tonnages of fluorspar, molybdenum, and tungsten ores from which silver was recovered as a byproduct.
3Less than 1/2 unit.
4Includes ore from which silver was recovered by heap leaching.
5Includes ore from which silver was recovered by vat leaching.

Table 7.—Silver produced at amalgamation and cyanidation mills in the United States and percentage of silver recoverable from all sources, by year

Year	Bullion and precipitates recoverable (troy ounces)		Silver recoverable from all sources (percent)			
	Amalgamation	Cyanidation	Amalgamation	Cyanidation	Smelting[1]	Placers
1978	654	2,600,357	(2)	6.60	93.39	0.01
1979	170	2,374,767	(2)	6.27	93.73	(2)
1980	1,502	2,637,809	(2)	8.16	91.84	(2)
1981	6	4,267,666	(2)	11.37	88.62	.01
1982		6,097,552	--	15.15	84.84	.01

[1]Crude ores and concentrates.
[2]Less than 0.005%.

Table 8.—Silver produced at refineries in the United States, by source

(Thousand troy ounces)

Source	1981	1982
Concentrates and ores:		
Domestic	44,487	43,825
Foreign	2,520	344
Total	47,007	[1]44,170
Old scrap:		
Coins	1,118	NA
Other	37,949	27,171
Total	39,067	27,171
Total net production	86,074	71,341
New scrap	44,738	37,812
Grand total	130,812	109,153

[1]Data do not add to total shown because of independent rounding.

Table 9.—U.S. consumption of silver, by end use

(Thousand troy ounces)

End use[1]	1981	1982
Electroplated ware	3,904	3,254
Sterlingware	4,407	6,579
Jewelry	5,368	6,260
Photographic materials	51,025	51,769
Dental and medical supplies	1,709	1,688
Mirrors	581	970
Brazing alloys and solders	7,718	7,384
Electrical and electronic products:		
Batteries	3,803	4,167
Contacts and conductors	26,411	27,730
Bearings	r297	228
Catalysts	3,830	2,417
Coins, medallions, commemorative objects	2,622	1,832
Miscellaneous[2]	4,995	4,562
Total net industrial consumption	r116,670	118,840
Coinage	179	1,846
Total consumption	r116,849	120,686

rRevised.
[1]End use as reported by converters of refined silver.
[2]Includes silver-bearing copper, silver-bearing lead anodes, ceramics, paints, etc.

Table 10.—U.S. monthly silver prices[1]

(Dollars per troy ounce)

Month	1981			1982		
	Low	High	Average	Low	High	Average
January	12.72	16.45	14.75	7.80	8.32	8.03
February	12.37	14.05	13.02	7.80	8.66	8.27
March	11.52	13.25	12.34	6.90	7.81	7.21
April	10.90	12.27	11.44	6.94	7.59	7.31
May	10.31	11.34	10.85	6.26	6.89	6.67
June	8.57	10.86	10.00	4.88	6.06	5.58
July	8.29	9.10	8.63	5.57	7.30	6.50
August	8.30	9.64	8.93	6.22	8.31	7.14
September	8.75	11.32	10.04	7.64	9.31	8.73
October	8.96	9.63	9.25	7.96	10.34	9.46
November	8.03	9.25	3.55	9.18	10.83	9.89
December	7.95	8.92	8.44	10.08	11.21	10.59
Average	7.95	16.45	10.52	4.88	11.21	7.95

[1]Based on the Handy & Harman daily quotation.

Table 11.—Value of silver exported from and imported into the United States, by year

(Thousand dollars)

Year	Exports	Imports
1980	1,909,733	1,606,010
1981	332,470	1,028,450
1982	208,748	927,079

Table 12.—U.S. exports of silver in 1982, by country

Country	Ore and concentrates		Waste and sweepings		Doré and precipitates		Refined bullion		Total[1]	
	Thousand troy ounces	Value (thousands)	Thousand troy ounces	Value (thousands)	Thousand troy ounces	Value (thousands)	Thousand troy ounces	Value (thousands)	Thousand troy ounces	Value (thousands)
Belgium-Luxembourg	--	--	1,232	$10,081	3	$17	55	$331	1,290	$10,429
Canada	37	$314	1,641	14,382	1,035	9,039	6,702	53,886	9,416	77,621
France	--	--	133	1,143	--	--	102	797	235	1,940
Germany, Federal Republic of	9	53	555	4,428	94	871	1,620	15,886	2,279	21,238
Japan	--	--	--	--	193	2,031	4,235	33,583	4,428	35,615
United Kingdom	--	--	7,159	55,797	196	1,924	1	6	7,357	57,727
Other	1	1	216	1,813	88	874	160	1,488	466	4,176
Total[1]	47	368	10,937	87,644	1,610	14,756	12,876	105,977	25,470	208,748

[1]Data may not add to totals shown because of independent rounding.

Table 13.—U.S. imports for consumption of silver in 1982, by country

Country	Ore and concentrates		Waste and sweepings		Doré and precipitates		Refined bullion		Total[1]	
	Thousand troy ounces	Value (thousands)	Thousand troy ounces	Value (thousands)	Thousand troy ounces	Value (thousands)	Thousand troy ounces	Value (thousands)	Thousand troy ounces	Value (thousands)
Belgium-Luxembourg	6	$4	2	$17	--	--	8,934	$69,133	8,943	$69,154
Brazil	223	1,766	1,531	2,519	--	--	41	245	1,795	4,530
Canada	1,081	8,031	573	4,197	680	$5,696	35,056	285,420	37,389	303,345
Chile	959	5,952	209	1,771	2,178	16,287	606	4,817	3,952	28,826
Dominican Republic	--	--	--	--	807	6,352	--	--	807	6,352
France	--	--	(2)	1	37	198	801	6,739	838	6,937
Germany, Federal Republic of	--	--	--	--	33	229	239	1,903	272	2,133
Honduras	1,137	8,041	--	--	--	--	--	--	1,137	8,041
Hong Kong	--	--	60	451	--	--	143	1,069	203	1,520
Japan	38	462	148	447	73	586	273	2,437	532	3,932
Korea, Republic of	109	968	--	--	--	--	869	6,915	978	7,883
Mexico	2,234	14,797	54	426	512	1,834	23,569	187,937	26,368	204,994
Netherlands	--	--	--	--	--	--	1,204	6,724	1,204	6,724
Peru	5,615	43,782	--	--	791	5,787	11,874	93,056	18,280	142,624
Thailand	--	--	75	689	--	--	749	6,162	823	6,851
United Kingdom	774	5,489	2	2	10	75	11,614	105,695	12,401	111,261
Yugoslavia	--	--	--	--	--	--	643	5,169	643	5,169
Other	354	2,347	183	1,458	52	264	302	2,735	891	6,804
Total[1]	12,530	91,638	2,837	11,979	5,173	37,308	96,917	786,154	117,458	927,079

[1]Data may not add to totals shown because of independent rounding.
[2]Less than 1/2 unit.

Table 14.—Silver: World production, by country[1]

(Thousand troy ounces)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Algeria[e]	75	100	100	110	110
Argentina	2,164	2,209	2,305	2,508	2,200
Australia	26,123	26,756	25,375	23,896	[3]29,196
Bolivia	6,285	5,742	6,099	6,394	[3]5,472
Brazil[4]	506	1,065	737	765	750
Bulgaria[e]	900	920	930	930	930
Burma	377	340	587	450	[3]526
Canada	40,733	36,874	33,340	36,298	[3]38,709
Chile	8,210	8,740	9,598	11,610	[3]11,799
China[e]	1,500	2,000	2,500	2,500	2,500
Colombia[5]	77	99	152	143	138
Costa Rica[e]	2	2	2	2	2
Czechoslovakia[e]	1,300	1,300	1,300	1,300	1,300
Dominican Republic	1,848	2,276	1,623	2,062	2,200
Ecuador	29	35	29	32	10
El Salvador	185	152	146	[e]110	100
Fiji	10	11	7	8	9
Finland	1,069	1,028	1,430	1,215	1,200
France	2,755	2,408	2,427	1,705	800
German Democratic Republic[e]	1,600	1,550	1,510	1,447	1,400
Germany, Federal Republic of	799	1,039	1,038	1,263	1,200
Ghana	19	20	[e]18	[e]17	14
Greece	1,360	1,752	1,672	[e]1,600	1,500
Greenland	[r]699	[r]763	771	720	[3]760
Guatemala	10	10	10	[e]8	8
Honduras	2,788	2,434	1,766	1,823	2,200
Hungary[e]	32	32	33	33	30
India[5]	388	370	366	555	463
Indonesia	[r]825	[r]793	701	830	870
Ireland	631	1,059	771	700	700
Italy[5 6]	890	1,065	1,366	1,768	1,700
Japan	9,664	8,680	8,603	9,010	[3]9,831
Korea, North[e]	1,600	1,600	1,600	1,600	1,600
Korea, Republic of	1,385	2,278	2,292	3,061	3,000
Malaysia (Sabah)	459	[r]432	437	472	470
Mauritania	19	--	--	--	--
Mexico	50,779	49,408	47,344	53,204	[3]49,841
Morocco	3,131	3,283	3,154	2,500	3,000
Namibia	1,866	2,106	2,172	2,736	[3]2,812
New Zealand	2	2	1	[e]1	1
Nicaragua	482	389	164	150	140
Papua New Guinea	1,681	1,428	1,180	1,363	[3]1,387
Peru	37,022	39,248	42,989	46,940	[e]53,639
Philippines	1,640	1,838	1,952	2,012	1,900
Poland	21,862	22,569	24,627	20,576	[3]21,058
Portugal	23	35	20	39	40
Romania	1,030	965	900	850	850
Solomon Islands	NA	([7])	([7])	([7])	([7])
South Africa, Republic of	3,110	3,240	5,500	7,568	[3]6,943
Spain	[r]2,373	[r]2,294	4,526	5,347	5,500
Sweden	5,007	5,649	5,112	5,337	[3]5,626
Taiwan	75	85	95	215	500
Tunisia	281	231	235	84	[3]115
Turkey	219	250	200	250	220
U.S.S.R.[e 5]	46,000	46,000	46,000	46,500	46,900
United States	39,385	37,896	32,329	40,683	[3]40,239
Yugoslavia[5]	5,125	5,214	4,790	4,437	[3]3,343
Zaire	4,391	3,892	2,733	3,000	3,000
Zambia	1,069	914	764	714	[3]887
Zimbabwe	1,109	978	954	857	890
Total	[r]344,978	[r]343,848	339,382	362,308	372,528

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.

[1]Recoverable content of ores and concentrates produced unless otherwise noted. Table includes data available through June 14, 1983.

[2]In addition to the countries listed, Austria and Thailand may produce silver, but information is inadequate to make reliable estimates of output levels.

[3]Reported figure.

[4]Officially reported output, including that obtained from treatment of gold, as follows in troy ounces: 1978—21,348; 1979—14,725; 1980—15,657; 1981—17,072; 1982—not available; and that recovered from treatment of lead, as follows in troy ounces: 1978—484,157; 1979—1,050,717; 1980—721,205; 1981—747,472; 1982—not available.

[5]Smelter and/or refinery production.

[6]Includes production from imported ores.

[7]Less than 1/2 unit.

Sodium Compounds

By Dennis S. Kostick[1]

The 1982 decline in domestic production of natural and synthetic soda ash reflected the decline in U.S. demand, which was at its lowest level since 1975. However, U.S. exports of soda ash reached a record high level of 1.11 million short tons. Soda ash consumption in the United States declined because of economic conditions that affected all end-use sectors, especially glass. Despite the world economic recession that reduced international trade in almost all mineral commodities, exports of U.S. soda ash from natural sources excelled because of the price advantage over more expensive foreign soda ash manufactured by the Solvay process.

Production of natural and synthetic sodium sulfate declined for the third consecutive year to less than 1 million tons for the first time since 1950 and the lowest level since 1949. Domestic apparent consumption of sodium sulfate increased slightly compared with revised 1981 consumption.

Domestic Data Coverage.—Domestic production data for soda ash and natural sodium sulfate were developed by the Bureau of Mines from monthly and annual voluntary surveys of U.S. operations. Of the eight soda ash operations and four natural sodium sulfate operations to which a survey request was sent, 100% responded, representing 100% of the total production shown in table 1.

Table 1.—Salient sodium compound statistics

(Thousand short tons and thousand dollars)

	Soda ash		Sodium sulfate	
	1981	1982	1981	1982
United States:				
Production[1]	8,281	7,819	r1,077	895
Value[2]	$787,469	$721,257	r$76,499	$74,554
Exports	1,051	1,109	124	111
Value	$121,107	$140,616	$12,980	$12,162
Imports for consumption	12	18	275	394
Value	$1,625	$2,410	$19,135	$28,758
Stocks, producer	[3]263	[3]324	[4]66	[4]30
Consumption, apparent	7,112	6,667	r1,195	1,214
World: Production	p30,895	e30,572	p6,056	e5,784

eEstimated. pPreliminary. rRevised.
[1]Includes natural and synthetic. Total production data for sodium sulfate obtained from U.S. Bureau of the Census.
[2]The value for soda ash includes synthetic soda ash. The value for synthetic sodium sulfate is based upon the average value for natural sodium sulfate.
[3]Includes synthetic soda ash.
[4]Natural only.

DOMESTIC PRODUCTION

Domestic production of natural and synthetic soda ash decreased in 1982 compared with the total reported in 1981. The U.S. soda ash industry operated at 69% of total nameplate capacity; however, this calculation included Tenneco Minerals Co.'s full nameplate capacity, which was not expected to be achieved in 1982. Because

Tenneco anticipated producing at one-third of its nameplate capacity in 1982, a more realistic industry operating rate would be 73%.

Domestic production of natural and synthetic sodium sulfate decreased 17% in 1982. Production data on natural sodium sulfate in table 4 were withheld in 1982 to avoid revealing company proprietary data. Data from the two reporting natural sodium sulfate producers were included in total production as recorded by the U.S. Bureau of the Census.

Table 2.—Producers of soda ash and natural sodium sulfate in 1982

Product and company	Plant nameplate capacity (thousand short tons)	Plant location	Source of sodium
Soda ash, natural:			
Allied Chemical Co	2,200	Green River, Wyo.	Underground trona.
FMC Corp	2,850	do	Do.
Kerr-McGee Chemical Corp	1,300	Argus, Calif.	Dry lake brine.
Do	150	Westend, Calif.	Do.
Stauffer Chemical Co. of Wyoming	1,960	Green River, Wyo.	Underground trona.
Tenneco Minerals Co	1,000	do	Do.
Texasgulf Chemicals Co	1,000	Granger, Wyo.	Do.
Soda ash, synthetic:			
Allied Chemical Co	900	Syracuse, N.Y	Ammonia-soda process.
Total	11,360		
Sodium sulfate:			
Great Salt Lake Minerals & Chemical Corp	40	Ogden, Utah	Salt lake brine.
Kerr-McGee Chemical Corp	225	Westend, Calif.	Dry lake brine.
Ozark-Mahoning Co	70	Brownfield, Tex.	Subterranean brine.
Do	100	Seagraves, Tex	Do.
Total	435		

Kerr-McGee Chemical Corp. terminated sodium sulfate production at its Trona plant in California. Equipment and process obsolescence and high maintenance costs were cited as the reasons for the decision. The loss of the 200,000-ton-per-year facility reduced the supply available to the domestic sodium sulfate market but was partially offset by the announcement by Ozark-Mahoning Co., the Nation's other major natural sodium sulfate producer, that it planned to expand capacity from 100,000 to 150,000 tons per year at its Seagraves, Tex., plant. The expansion was scheduled to be completed by early 1984.[2]

Tenneco, the fifth soda ash producer in Wyoming, commissioned its new mine in June. Although Tenneco came onstream at a time when the domestic soda ash market was weak, the company continued efforts to reach nameplate capacity production by 1984.[3]

In a barter agreement with Church and Dwight Co., Allied Chemical Co. planned to mine and process trona to produce soda ash for Church and Dwight's sodium bicarbonate facility in Green River, Wyo. In exchange, Allied acquired a number of sodium leases held by Church and Dwight since 1968.[4]

Table 3.—Manufactured and natural sodium carbonates produced in the United States

(Thousand short tons and thousand dollars)

Year	Manufactured soda ash (ammonia-soda process)[1] [2] Quantity	Natural sodium carbonates[3] Quantity	Natural sodium carbonates[3] Value	Total quantity
1978	[e]1,500	6,790	370,147	8,290
1979	W	W	[4]543,812	8,253
1980	W	W	[4]768,168	8,275
1981	W	W	[4]787,469	8,281
1982	W	W	[4]721,257	7,819

[e]Estimated. W Withheld to avoid disclosing company proprietary data.

[1]Current Industrial Reports, Inorganic Chemicals, U.S. Bureau of the Census. Bureau of Mines responsible for data compilation after January 1979.

[2]Includes quantities used to manufacture caustic soda, sodium bicarbonate, and finished light and dense soda ash.

[3]Soda ash and trona (sesquicarbonate).

[4]Includes value for synthetic soda ash.

Table 4.—Manufactured and natural sodium sulfate produced in the United States[1]

(Thousand short tons and thousand dollars)

Year	Manufactured and natural[2]			Natural	
	Lower purity[3] (99% or less)	High purity	Total	Quantity	Value
1978	660	509	r1,169	605	27,865
1979	612	509	1,121	533	29,689
1980	676	464	41,139	583	36,389
1981	r666	r411	r1,077	608	43,186
1982	495	400	895	W	W

rRevised. W Withheld to avoid disclosing company proprietary data.
[1]All quantities converted to 100% Na_2SO_4 basis.
[2]Current Industrial Reports, Inorganic Chemicals, U.S. Bureau of the Census.
[3]Includes Glauber's salt.
[4]Data do not add to total shown because of independent rounding.

CONSUMPTION AND USES

Soda ash was successfully used to reverse the effects of acid rain in a 9-acre pond in the Adirondack Mountains in New York. Prior to treatment, the pH of the pond water was 4.6; however, after 5 tons of soda ash was applied, the pH increased to 7.5, thereby enabling aquatic life to flourish again. Although less expensive lime was more commonly used as a neutralizing agent for acidic waters, experiments in Sweden indicated that soda ash was four to five times more effective.[5]

Market displacement of glass containers by polyethylene terephthalate bottles continued to concern glass-container producers throughout the world. The U.S. and European soda ash industry shared the concern because glass containers were the largest use of soda ash. If this market sector should deteriorate further in the near future, the world soda ash market would be severely affected. Increased use of cullet glass and passage of returnable-bottle legislation in some regions have also adversely impacted domestic soda ash demand. U.S. consumption of soda ash in glass bottles and containers declined an estimated 17% since the peak consumption year of 1978.

The total U.S. primary demand for soda ash in 1982 was 6.67 million tons. The estimated consumption of soda ash by end use is shown in table 5.

Apparent consumption of sodium sulfate in 1982 was 1.21 million tons. The major end uses of sodium sulfate were pulp and paper, 48%; detergents, 39%; and glass and miscellaneous, 13%.

Table 5.—Estimated consumption of soda ash in 1982, by end use

(Thousand short tons)

End use	
Glass:	
Bottle and container	2,500
Flat	500
Fiber	220
Other	280
Total	3,500
Chemical	1,300
Soaps and detergents	500
Pulp and paper	275
Water treatment	230
Other[1]	862
Total	3,167
Grand total	6,667

[1]Includes soda ash used in petroleum and metal refining, leather tanning, enamels, etc.

STOCKS

The economic recession in 1982 adversely affected soda ash sales and contributed to large yearend inventories stored on team-tracks, in terminals, in warehouses, and in plant silos. Also, the entrance of Tenneco into the U.S. industry added to the total soda ash supply. As a result, yearend stocks reported by producers increased 23%.

Yearend stocks of natural sodium sulfate decreased 55% because weather problems affected production by Great Salt Lake Minerals & Chemical Corp. and Kerr-McGee closed its Trona plant, thereby necessitating sales from their inventories.

PRICES

The f.o.b. list price of dense, bulk soda ash from Wyoming declined from $92 per ton in January to $84 by November. Kerr-McGee lowered its f.o.b. list price of dense, bulk soda ash from $109.25 to $107.25 per ton effective October 1, 1982. The average value of bulk natural soda ash, f.o.b. Green River, Wyo., and Searles Valley, Calif., as reported by producers, in 1982 was $88.35 per ton. The average value of bulk natural sodium sulfate, f.o.b. mine or plant, as reported by producers, was $83.30 per ton.

Table 6.—Sodium compounds yearend prices

		1981	1982
Sodium carbonate (soda ash):			
Light, paper bags, carlots, works	per ton	$150.00	$150.00
Light, bulk, carlots, works	do	123.00	123.00
Dense, paper bags, carlots, works	do	112.00	$112.00- 118.00
Dense, bulk, carlots, works	do	92.00	88.00
Sodium sulfate (100% Na_2SO_4):			
Technical detergent, rayon grade, bags, carlots	do	$70.00- 72.00	90.00- 96.00
Sodium sulfate, bulk, carlots, works[1]	do	78.00	96.00- 103.00
Domestic salt cake, bulk, works[1]	do	47.00- 52.00	47.00- 52.00
National Formulary (N.F. XII), drums	per pound	.235	.235

[1]East of Mississippi River.

Source: Chemical Marketing Reporter. Current Prices of Chemicals and Related Materials. V. 222, No. 26, Dec. 27, 1982, p. 32.

FOREIGN TRADE

The United States remained the largest soda ash producer in the world in 1982, representing more than one-fourth of total world output. According to the U.S. Bureau of the Census, U.S. exports of 1.11 million tons to 57 countries were distributed on a regional basis as follows: South America, 29.4%; North America, 20.1%; Asia, 18.2%; Europe, 14.2%; Africa, 13.6%; Oceania, 2.3%; the Caribbean, 1.2%; and Central America, 1.0%.

In a dumping case brought before the European Economic Community (EEC) Commission by the European Council of Chemical Manufacturer's Association (CEFIC), an antidumping duty of 24.63 European Currency Units (ECU)[6] was imposed on future shipments of dense soda ash entering the EEC from the United States. Allied and FMC Corp. were exempt from the action because they promised to increase their export prices and Texasgulf Chemicals Co. was given a 22.24 ECU duty.[7] The investigation was based on allegations of a 10% price differential between the price of imported soda ash from the United States and the EEC soda ash price, which eroded by 5% the market share of the United Kingdom producer.

Table 7.—U.S. exports of sodium carbonate and sodium sulfate

(Thousand short tons and thousand dollars)

Year	Sodium carbonate		Sodium sulfate	
	Quantity	Value	Quantity	Value
1979	997	86,663	102	8,516
1980	1,094	121,945	129	12,740
1981	1,051	121,107	124	12,980
1982	1,109	140,616	111	12,162

Source: U.S. Bureau of the Census.

Table 8.—U.S. imports for consumption of sodium sulfate

(Thousand short tons and thousand dollars)

Year	Crude (salt cake)[1]		Anhydrous		Total[1]	
	Quantity	Value	Quantity	Value	Quantity	Value
1979	85	3,763	104	5,748	[2]188	9,511
1980	97	4,872	133	8,370	230	13,242
1981	136	8,038	139	11,097	275	19,135
1982	210	13,820	184	14,938	394	28,758

[1]Includes Glauber's salt as follows: 1979—926 tons ($24,854); 1980—1,418 tons ($37,372); 1981—30 tons ($13,800); and 1982—2 tons ($1,241).
[2]Data do not add to total shown because of independent rounding.

Source: U.S. Bureau of the Census.

Table 9.—U.S. imports for consumption of sodium carbonate and bicarbonate

(Thousand short tons and thousand dollars)

	1981		1982	
	Quantity	Value	Quantity	Value
Sodium carbonate	12	1,625	18	2,410
Sodium bicarbonate	3	680	7	1,360
Total	15	2,305	25	3,770

Source: U.S. Bureau of the Census.

WORLD REVIEW

Egypt.—The General Organization for Industrialization, a department in the Ministry of Industry and Mineral Wealth, solicited engineering contracts to expand capacity at the synthetic soda ash plant of Misr Chemical Industries at El-Mex, near Alexandria. The expansion was scheduled to raise capacity from 80,000 to 200,000 tons per year by 1986.[8]

Europe.—At the request of CEFIC, the EEC Commission investigated reports of underpriced light soda ash imported into the EEC from the Council for Mutual Economic Assistance (CEMA) countries. The rising level of imports from CEMA sources affected soda ash sales of the West European producers, whose production costs were cited as rising 230% since 1979, primarily because of escalating energy costs. Imports of soda ash into the EEC during this time had risen an average of 46%, but in certain countries imports had declined.

After months of investigation, new legislation imposed an antidumping duty as either a fixed percentage of the price per ton delivered to the EEC border or the amount by which the EEC border price was less than a stipulated price expressed in ECU, whichever amount was higher. Because the price varied among the CEMA countries, the new percentage and ECU duties were, respectively: Bulgaria, 14.09% and 113.85 ECU; German Democratic Republic, 40.86% and 127.24 ECU; Poland, 9.68% and 113.85 ECU; Romania, 18.79% and 117.62 ECU; and the U.S.S.R., 37.26% and 129.60 ECU.[9]

India.—The Gujarat Industrial Investment Corp., a development company in the State of Gujarat, signed an agreement for Akzo Zout Chemie BV of the Netherlands to supply technical assistance for the construction of a 200,000-ton-per-year synthetic soda ash plant at Saurashtra. Klöckner Ina S.A. of the Federal Republic of Germany was to act as an advisor and financial coordinator of the project. The plant was scheduled for completion in 1985.[10]

Japan.—The Japanese Fair Trade Commission began investigating possible illegal trade restrictions by the Japanese soda ash industry against imports of U.S. soda ash. Asahi Glass Co., Central Glass Co. Ltd., Tokuyama Soda Co., Ltd., Toyo Soda Industries Co. Ltd. (all producers), and Toko Terminal Co., the only terminal operator that handles Japanese imports of soda ash, were named in the investigation. Should the defendents be found guilty of restraining soda ash imports and the trade barrier be subsequently lifted, U.S. soda ash exporters anticipated a greater opportunity to increase shipments of soda ash to Japan in the future.[11]

South Africa, Republic of.—AECI Ltd., the largest South African chemical company, studied the feasibility of constructing a 300,000-ton-per-year synthetic soda ash plant. The company, 40% owned by Anglo American Industrial Corp. of South Africa and 40% by Imperial Chemical Industries Ltd. of the United Kingdom, planned to be an equal partner with the South African Industrial Development Corp. Richards Bay on the east coast was favored for the proposed complex because the area had an existing infrastructure.[12]

Spain.—An August 1981 fire damaged the anhydrous sodium sulfate operation of Criaderos Minerales y Derivados S.A. in Cerezo del Rio Tiron, Burgos Province. In the latter half of 1982, the mine was scheduled to resume production at its previous rate of 100,000 tons per year, with the goal of increasing capacity to 150,000 tons per year by yearend.[13]

Thailand.—After 5 years of delays caused by difficulties over site and process technology selections and funding arrangements, a soda ash joint venture agreement was signed at midyear by all members of the Association of Southeast Asian Nations (ASEAN). ASEAN Soda Ash Co., Ltd., was formed to operate the 400,000-ton-per-year plant, with Thailand holding 60% equity in the project; Indonesia, Malaysia, and the Philippines each had 13%, and Singapore, 1%. The Japanese Export-Import Bank provided 70% of the financing for the $377 million project. Two Japanese glass producers—Asahi Glass, and Central Glass—also agreed to participate in the project.[14]

Table 10.—Sodium carbonate: World production, by country[1]

(Short tons)

Country	1978	1979	1980	1981[p]	1982[e]
Albania[e]	25,600	25,700	27,600	27,600	27,600
Australia[e]	180,000	180,000	205,000	190,000	190,000
Austria[e]	190,000	190,000	190,000	190,000	190,000
Belgium	471,175	[r]441,197	360,376	300,931	330,000
Brazil	132,995	130,799	194,007	207,234	210,000
Bulgaria	1,426,689	1,650,749	1,629,977	1,618,948	1,655,000
Canada[e]	500,000	500,000	500,000	500,000	500,000
Chad[e] [2]	12,000	12,000	8,800	5,500	5,500
Chile[e]	12,000	12,000	12,000	11,000	NA
China	1,464,970	1,638,033	1,778,026	1,832,221	1,875,000
Colombia	184,275	146,846	137,380	137,800	137,800
Czechoslovakia	133,380	131,175	135,192	130,293	132,000
Denmark[3]	2,247	3,036	148	164	165
Egypt	4,409	[r] [e]5,500	20,777	25,754	22,910
France	[r]1,488,449	[r]1,708,470	1,719,824	[e]1,765,000	1,765,000
German Democratic Republic	939,455	948,519	954,880	967,859	967,800
Germany, Federal Republic of	1,355,535	1,544,250	1,555,481	1,310,770	1,320,000
Greece[e]	1,100	1,100	1,100	1,100	1,100
India	[r]635,413	[r]597,779	578,320	[e]676,000	660,000
Italy[e]	105,000	105,000	105,000	105,000	100,000
Japan	1,280,410	1,493,015	1,494,107	1,298,185	1,270,000
Kenya[2]	168,127	246,747	224,616	[e]275,000	330,000
Korea, Republic of	194,106	224,642	244,625	222,736	220,000
Mexico[4]	456,356	462,970	[e]495,000	[e]495,000	495,000
Netherlands	[r]308,647	[e]460,000	[e]460,000	[e]460,000	460,000
Norway[e]	28,700	29,800	29,800	29,800	29,800
Pakistan	[r]81,592	[r]82,958	84,878	102,267	118,157
Poland	[r]730,832	753,980	839,960	772,719	770,000
Portugal	144,901	201,469	[e]195,000	[e]190,000	190,000
Romania	990,977	984,363	1,032,865	1,069,241	1,060,000
Spain	550,053	[e]550,000	[e]550,000	[e]550,000	550,000
Sweden[e]	1,000	1,000	1,000	1,000	1,000
Switzerland[e]	50,000	50,000	50,000	51,000	51,000
Taiwan	84,869	88,973	102,008	79,437	65,000
Turkey[e]	70,000	75,000	65,000	65,000	65,000
U.S.S.R	5,355,022	5,271,246	5,269,042	5,357,227	5,357,227
United Kingdom[e]	1,760,000	[r]1,540,000	1,500,000	1,430,000	1,430,000
United States[4]	8,290,000	8,253,000	8,275,000	8,281,000	[5]7,819,000
Yugoslavia	183,369	181,200	142,274	162,212	[5]200,488
Total	[r]29,993,653	[r]30,922,516	31,169,063	30,894,998	30,571,547

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.
[1]Table includes data available through May 2, 1983. Synthetic unless otherwise specified.
[2]Natural only.
[3]Production for sale only; excludes output consumed by producers.
[4]Includes natural and synthetic.
[5]Reported figure.

Table 11.—Sodium sulfate: World production, by country[1]

(Thousand short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Natural:					
Argentina	45	40	42	57	[3]62
Canada	415	[r]489	530	[e]610	605
Chile[4]	4	2	1	([5])	1
Egypt	3	[r]3	3	[e]3	4
Iran	39	[e]25	10	11	11
Mexico[6]	365	[r]398	410	[r e]458	469
South Africa, Republic of	NA	NA	14	5	[3]3
Spain	229	229	172	292	276
Turkey	71	[r]157	69	89	88
U.S.S.R.[e 7]	[r]364	375	[r]386	[r]386	397
United States	605	533	583	608	[8]W
Total	[r]2,140	[r]2,251	2,220	2,519	1,916
Synthetic:					
Austria[e]	[r]61	[r]61	[r]61	[r]61	61
Belgium[e]	[r]276	[r]276	[r]276	[r]276	276
Chile[9]	48	76	78	64	64
Finland[e]	55	50	50	50	50
France	138	168	165	[e]165	165
German Democratic Republic	144	[e]140	[e]140	[r e]139	139
Germany, Federal Republic of	233	[r]232	248	281	276
Greece[e]	7	8	12	[e]12	13
Hungary[e]	11	11	11	11	11
Italy	[r]1,116	[r]1,192	[r e]1,102	[r e]992	937
Japan	353	373	342	313	284
Netherlands[e]	55	55	55	55	55
Portugal	[r]57	49	58	64	63
Spain[10]	134	[e]193	[e]193	[r e]193	187
Sweden	116	116	116	116	116
U.S.S.R.[e 7]	265	265	[r]276	[r]276	276
United States[11]	564	588	556	469	[8]895
Total	[r]3,633	[r]3,853	3,739	3,537	3,868

[e]Estimated. [p]Preliminary. [r]Revised. W Withheld to avoid disclosing company proprietary data. NA Not available.

[1]Table includes data available through May 18, 1983.

[2]In addition to the countries listed, China, Norway, Poland, Romania, Switzerland, and the United Kingdom are known to or are assumed to have produced synthetic sodium sulfate, and other unlisted countries may have produced this commodity, but production figures are not reported, and available general information is inadequate for the formulation of reliable estimates of output levels.

[3]Reported figures.

[4]Natural mine output, excluding byproduct output from the nitrate industry, which is reported separately under manufactured.

[5]Less than 1/2 unit.

[6]Series revised to reflect output reported by Mexico's principal producer, Industrias Peñoles, S.A. In 1979, and probably in other years, an additional 20,000 tons (estimated) of natural sodium sulfate was produced by a smaller producer.

[7]Conjectural estimates based on 1968 information on natural sodium sulfate and general economic conditions.

[8]Natural sodium sulfate included with synthetic sodium sulfate production.

[9]Byproduct of nitrate industry.

[10]Quantities of synthetic sodium sulfate credited to Spain are reported in official sources in such a way as to indicate that they are in addition to the quantities reported as mined (reported in this table under "Natural"), but some duplication may exist.

[11]Derived approximate figures; data presented are the difference between reported total sodium sulfate production (natural and synthetic undifferentiated) and reported natural sodium sulfate sold by producers (reported under "Natural" in this table).

TECHNOLOGY

FMC was granted a patent in 1982 for a solution mining process to recover alkali values from trona. In the process, 2 to 7 weight-percent of sodium hydroxide in aqueous solution was contacted with the subterranean ore, after which the sodium carbonate-bearing solution was recovered and carbonated to precipitate sodium sesquicarbonate and/or sodium bicarbonate. The crystallized sodium carbonate was calcined to produce sodium carbonate monohydrate or anhydrous sodium carbonate. The mother liquor was regenerated using slaked lime and water to convert residual sodium carbonate to sodium hydroxide and a calcium carbonate precipitate. The calcium carbonate was calcined to produce lime and carbon dioxide for regenerating the mining solvent and the carbonating medium, respectively.[15]

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[1]Physical scientist, Division of Industrial Minerals.
[2]Chemical Marketing Reporter. Sodium Sulfate Supplies Short as Byproduct Production Is Cut. V. 221, No. 23, June 7, 1982, p. 4.
[3]Mining Congress Journal. V. 68, No. 4, August 1982, p. 7.
[4]Chemical Week. Trona Agreement. V. 130, No. 2, Jan. 13, 1982, p. 17.
[5]Denver Post. Soda Ash Found To Reverse Effects of Acid Rain in Pond. Oct. 28, 1982, p. 6A.
[6]1 ECU equaled US$0.932089 on Sept. 30, 1982.
[7]Official Journal of the European Community. Commission Regulation (EEC) No. 3018/82, v. 25, Nov. 13, 1982, pp. L317/5-L317/7.
[8]European Chemical News. Egypt Shortlists Bidders for Soda Ash Plant Near Alexandria. V. 39, No. 1048, Sept. 6, 1982, p. 29.
[9]———. Antidumping Duties Imposed on East Bloc Soda Ash Imports. V. 39, No. 1053, Oct. 11, 1982, p. 12.
[10]———. Akzo/Klockner Team Wins Indian Contest for Soda Ash Plant. V. 38, No. 1026, Apr. 5, 1982, p. 26.
[11]———. Japanese in Soda Ash Cartel Investigation. V. 39, No. 1050, Sept. 20, 1982, p. 8.
[12]———. AECI Considers Plan for First Soda Ash Plant in South Africa. V. 39, No. 1045/6, Aug. 16-23, 1982, p. 21.
[13]———. Sodium Sulfate Plans. V. 38, No. 1015, Jan. 18, 1982, p. 32.
[14]Industrial Minerals. Soda Ash Plans To Take Shape. V. 180, September 1982, p. 16.
[15]Pinsky, M. L., and J. Walden (assigned to FMC Corp.). Recovery of Alkali Values From Trona Deposits. U.S. Pat. 4,344,650, Aug. 17, 1982.

Stone

By Harold A. Taylor, Jr.,[1] and Valentin V. Tepordei[1]

A total of 790 million tons of crushed stone valued at $2.9 billion, f.o.b. plant, was estimated to have been produced in the United States in 1982. This tonnage is the lowest production reported in 17 years, 9% less than that of 1981 and 28% below the record production of 1979, reflecting mainly the impact of the recession on the construction industry. About three-quarters of crushed stone production continued to be limestone, followed by granite, traprock, sandstone, shell, marl, volcanic cinder, marble, and slate, in order of volume.

Production of dimension stone totaled 1.33 million tons valued at $145 million in 1982, indicating little change in tonnage during the past 5 years. Roughly one-half of the dimension stone tonnage was granite, followed by limestone and sandstone.

Exports of crushed stone in 1982 decreased 43% and imports decreased 44%. Ninety-three percent of the exported and 83% of the imported crushed stone was limestone. Apparent consumption of crushed stone was 790 million tons.

Exports of dimension stone decreased 10% in value to $19 million in 1982. Imports of dimension stone increased 28% in value to $170 million and surpassed in value domestic production for the first time. Imports of dimension granite increased very significantly for the second year to yield a 2-year value increase of 252% to $80 million in 1982.

Domestic Data Coverage.—To reduce the Federal Government's paperwork and costs, as well as respondent's reporting burden, the Bureau of Mines had implemented new canvassing procedures for its stone surveys. Beginning with 1981 data, the survey of stone producers is to be conducted for odd-numbered years only.

In even-numbered years, the preliminary survey, which collects production information on a sample basis for the first 9 months only, is used to generate State annual preliminary estimates. This survey canvasses the large companies in each State producing up to 75% of the State total tonnage. The preliminary production estimates for 1982 will be revised in the 1983 stone chapter.

Table 1.—Salient stone statistics in the United States

(Thousand short tons and thousand dollars)

	1978	1979	1980	1981	1982
Sold or used by producers:					
Dimension stone	1,394	1,350	1,315	1,331	p1,330
Value	$113,100	$122,800	$138,900	$150,463	p$145,113
Crushed stone[1]	1,049,600	1,099,500	983,500	r872,600	p790,030
Value	$2,773,000	$3,275,900	$3,265,800	r$3,125,000	p$2,918,300
Total stone[2] [3]	1,051,000	1,100,850	984,815	r874,000	p791,400
Total value[3]	$2,886,000	$3,398,700	$3,404,700	r$3,276,000	p$3,063,000
Exports (value)	$31,400	$40,200	$36,400	r$46,647	$37,704
Imports for consumption (value):					
Dimension stone	$51,700	$65,800	$88,900	r$132,904	$169,908
Crushed stone	$13,100	$16,000	$13,900	r$13,473	$16,382

pPreliminary. rRevised.
[1]Includes volcanic cinder and scoria in 1979-82.
[2]Does not include American Samoa, Guam, Puerto Rico, and the Virgin Islands.
[3]Data may not add to totals shown because of independent rounding.

Legislation and Government Programs.—On January 1, 1982, a temporary restraint of the Mine Safety and Health Administration's (MSHA) enforcement of safety rules in surface mining of stone and sand and gravel operations went into effect, as a result of limitations in funding imposed by the U.S. Congress. This temporary restraint was lifted on July 15, 1982, and MSHA inspectors resumed enforcing the safety rules, this time under new guidelines that reduced the number of significant and substantial violations.

On January 6, 1982, the Surface Transportation Assistance Act of 1982 became Public Law 97-424. This law extends the Federal Highway Trust Fund to September 30, 1988, and increases the Federal fuel taxes from 4 to 9 cents per gallon, effective April 1, 1983, as well as other fees paid by highway users. The levels of funding established in the act are the highest ever for highways and mass transportation, and the highest in constant dollars since the early seventies. The additional funding was expected to increase crushed stone demand significantly.

CRUSHED STONE[2]

DOMESTIC PRODUCTION

The preliminary production estimates indicate that in 1982 the output of crushed stone decreased in every geographic region. The South Atlantic region continued to lead the Nation in the production of crushed stone with an estimated 186 million tons or 24% of the U.S. total. Areas with the most significant percentage reduction in production levels were New England, the East North Central, the Mountain, and the Pacific regions.

The five leading States, in order of volume, continued to be Texas, Florida, Pennsylvania, Illinois, and Missouri. Their combined estimated production represented 32% of the national total.

FOREIGN TRADE

Exports.—Exports of crushed stone decreased 43% to 2.1 million tons; of this, 93% was limestone of which 97% went to Canada. Exports of quartzite, while small in total amount, showed a significant increase in 1982 to 47,000 tons.

Imports.—Imports of crushed stone decreased 44% in 1982 to 1.9 million tons while the value increased 22% to $16.4 million. Approximately 75% of this tonnage was limestone, 99% of which came from Canada.

Imports of calcium carbonate fines decreased 29% to 192,000 tons; of this, 90% came from the Bahamas.

WORLD REVIEW

The estimated world annual production of crushed stone in 1982, excluding centrally planned economy countries, was approximately 2.4 billion tons, a decrease of about 10% from that of 1981. Of this total, the United States produced about one-third.

Preliminary estimations of crushed stone production in Canada indicated a decrease of 27% in 1982 to 62 million tons valued at $255 million, compared with the final 1981 figures. The estimated average price increased by 12% to $4.12 per ton. The Provinces of Quebec and Ontario continued to be the largest producers of crushed stone with about 46% and 34%, respectively, of the total.

TECHNOLOGY

The 37th annual convention of the National Limestone Institute was held in January 1982 in Washington, D.C. Environmental and mine safety regulations, surface mine rehabilitation, production and marketing of agricultural limestone, and the future of the Highway Trust Fund and its role in reconstruction of the highway system were the main topics.[3]

The 65th annual convention of the National Crushed Stone Association was held in February 1982 in Las Vegas, Nev., in conjunction with the biennial International Concrete & Aggregates Show. Topics covered included plant automation through the use of computerized controls, improvements in quarry production, new trends in the marketing of stone in the eighties, and the effects of current and proposed legislation and regulations on the crushed stone industry, including the Highway Trust Fund.[4]

In April 1982, the 18th Annual Forum on Geology of Industrial Minerals, sponsored by the Indiana Geological Survey and Indiana University's Department of Geology, was held in Bloomington, Ind.[5] Most of the papers dealt with construction materials, the theme of the conference.

A new process that produces glass fibers from a 50-50 mixture of limestone and slate mining waste was developed by a research team at the University of California at Los Angeles, working on a project sponsored by the Bureau of Mines, U.S. Department of the Interior.[6] The fibers are alkali resistant and could become a substitute for asbestos in reinforcing concrete, among other applications. The raw materials for the new product are abundant and inexpensive.

Several articles dealing with quarry operation,[7] drilling,[8] screening,[9] conveying,[10] and reclamation and rehabilitation in crushed stone operations[11] were published in 1982.

Table 2.—Crushed stone[1] sold or used in the United States, by region

(Thousand short tons and thousand dollars)

Region	1981		1982[p]	
	Quantity	Value	Quantity	Value
Northeast:				
New England	[r]18,335	[r]92,173	16,100	79,700
Middle Atlantic	94,374	383,329	89,800	391,500
North Central:				
East North Central	151,660	505,002	125,600	422,200
West North Central	90,596	286,472	88,400	285,800
South:				
South Atlantic	205,895	802,184	185,600	744,900
East South Central	87,943	316,346	83,500	312,600
West South Central	124,014	389,146	116,500	362,600
West:				
Mountain	27,872	101,852	23,600	96,000
Pacific	71,952	248,631	60,900	222,900
Total[2]	[r]872,600	[r]3,125,000	790,030	2,918,300

[p]Preliminary. [r]Revised.
[1]Includes volcanic cinder and scoria.
[2]Data may not add to totals shown because of independent rounding.

Table 3.—Crushed stone[1] sold or used by producers in the United States, by State

(Thousand short tons and thousand dollars)

State	1981		1982[p]	
	Quantity	Value	Quantity	Value
Alabama	20,706	88,377	21,200	89,600
Alaska	5,359	26,855	5,100	25,200
Arizona	6,315	26,263	5,200	22,200
Arkansas	13,834	47,260	13,100	48,500
California	34,560	118,698	28,500	105,400
Colorado	6,969	24,083	6,900	27,800
Connecticut	[r]6,837	[r]36,745	6,100	32,700
Florida	65,067	226,192	53,100	182,300
Georgia	35,730	153,751	34,800	153,500
Hawaii	6,036	31,403	4,500	26,600
Idaho	1,437	6,206	1,200	6,000
Illinois	44,159	165,218	42,900	148,300
Indiana	25,349	79,910	20,300	65,500
Iowa	22,424	82,891	22,600	88,800
Kansas	14,143	45,738	14,400	41,100
Kentucky	32,433	108,257	29,500	104,300
Louisiana[2]	W	W	W	W
Maine	1,375	5,532	1,200	4,000
Maryland	16,485	74,289	15,100	73,500
Massachusetts	7,997	41,037	6,900	33,500
Michigan	30,013	94,324	20,700	67,100
Minnesota	6,995	18,438	7,100	20,900
Mississippi[3]	W	W	W	W
Missouri	40,910	116,297	38,600	113,300
Montana	1,582	5,139	1,400	4,700
Nebraska	3,139	14,024	3,100	14,300
Nevada	1,343	5,664	1,300	4,500
New Hampshire	665	2,599	600	3,100
New Jersey	10,434	57,819	10,700	57,800
New Mexico	4,162	12,485	2,800	13,700
New York	30,681	117,689	28,700	132,800
North Carolina	28,833	117,092	27,500	117,600
Ohio	36,950	125,588	30,300	105,200
Oklahoma	29,930	83,407	30,100	84,200

See footnotes at end of table.

Table 3.—Crushed stone[1] sold or used by producers in the United States, by State —Continued

(Thousand short tons and thousand dollars)

State	1981		1982[p]	
	Quantity	Value	Quantity	Value
Oregon	16,482	46,055	14,200	41,900
Pennsylvania	53,258	207,821	50,400	200,900
Rhode Island	141	1,116	130	1,100
South Carolina	14,825	49,830	14,000	53,000
South Dakota	2,985	9,085	2,600	7,400
Tennessee[4]	W	W	W	W
Texas	72,454	219,085	68,000	205,000
Utah	2,840	12,157	2,500	9,800
Vermont	1,319	5,144	1,200	5,300
Virginia	37,071	152,630	35,200	142,300
Washington	9,516	25,619	8,600	23,800
West Virginia	7,885	28,399	5,900	22,700
Wisconsin	15,189	39,962	11,400	36,100
Wyoming	3,224	9,857	2,300	7,300
Other	[r]42,601	[r]159,106	38,100	143,600
Total[5]	[r]872,600	[r]3,125,000	790,030	2,918,300

[p]Preliminary. [r]Revised. W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes volcanic cinder and scoria.
[2]Produced shell and other stone.
[3]Produced limestone and marl.
[4]Produced limestone, marl, and sandstone.
[5]Data may not add to totals shown because of independent rounding.

Table 4.—Exports of crushed stone, by destination

(Thousand short tons unless otherwise specified)

Destination	Quartzite		Limestone[1]		Other		Total[2]	
	1981	1982	1981	1982	1981	1982	1981	1982
North America:								
Canada	4	1	3,273	1,867	166	70	3,443	1,937
Mexico	(3)	(3)	1	(3)	32	9	33	10
Other	(3)	--	2	2	16	2	18	4
Total[2]	4	1	3,276	1,869	214	82	3,494	1,952
South America:								
Venezuela	(3)	(3)	31	43	1	1	32	44
Other	--	(3)	1	(3)	1	(3)	2	(3)
Total	(3)	(3)	32	43	2	1	34	44
Europe:								
France	3	2	--	--	15	7	18	9
Netherlands	3	40	--	--	(3)	(3)	3	40
United Kingdom	--	(3)	--	6	--	1	--	7
Other	1	1	1	(3)	13	2	15	3
Total[2]	7	43	1	7	28	10	36	60
Asia	2	3	(3)	(3)	3	4	5	6
Oceania	(3)	(3)	1	1	22	(3)	23	2
Middle East and Africa	(3)	(3)	1	(3)	5	1	6	1
Grand total[2]	13	47	3,311	1,921	274	97	3,598	2,065
Total value thousands	$2,494	$2,382	$15,982	$12,083	$7,473	$4,561	$25,949	$19,026

[1]Includes ground limestone.
[2]Data may not add to totals shown because of independent rounding.
[3]Less than 1/2 unit.

Table 5.—U.S. imports of crushed stone and stone fines, by type

(Thousand short tons and thousand dollars)

Type	1981 Quantity	1981 Customs value	1982 Quantity	1982 Customs value
Crushed stone and chips:				
Limestone	r1,772	r4,698	[1]1,383	8,356
Marble, breccia, onyx	9	482	4	318
Quartzite	71	r825	26	317
Slate	1	4	--	4
Other	1,183	2,887	250	1,575
Total	r3,036	r8,896	[2]1,664	10,570
Calcium carbonate fines:				
Chalk, natural	244	344	[3]175	953
Chalk, whiting	16	1,694	9	1,669
Precipitated	10	2,539	9	3,189
Total	270	4,577	[2]192	5,811
Grand total	r3,306	r13,473	1,856	[2]16,382

rRevised.
[1]99% from Canada.
[2]Data do not add to total shown because of independent rounding.
[3]90% from the Bahamas.

DIMENSION STONE[12]

DOMESTIC PRODUCTION

According to the preliminary production estimates, leading States, in order of dimension stone tonnage, were Georgia, Vermont, and Indiana, producing, together, 46% of the Nation's total. Notable in 1982 was a significant increase in output from New Hampshire. Of the total U.S. production, 51% was granite, 20% was limestone, 13% was sandstone, 10% was slate, and 4% was marble.

Compared with that of 1981, 1982 output of dimension granite decreased slightly in tonnage and 5% in value to about 681,000 tons and $78 million. Georgia continued to be the leading State, producing 37% of the U.S. total, followed by New Hampshire and Vermont. These three States together produced 65% of the U.S. total. Notable were a 8% production decrease in Vermont and a 20% increase in New Hampshire.

PRICES

The average preliminary 1982 price for dimension stone was $109 per ton, a decrease from $113 in 1981.

FOREIGN TRADE

Exports.—Exports of dimension stone in 1982, about one-half granite, decreased 10% in value to $19 million. The value of granite exports increased 8% whereas the value of all other materials decreased.

Imports.—Imports of dimension stone in 1982 increased by 28% in value to $170 million, primarily because of an increase in granite imports. Imports of dressed granite, primarily from Italy, increased by 114% to $72 million. Granite imports had risen significantly in 1981, and the 2-year increase for total granite from 1980 was 252%. Imports of slate decreased in value by 54% to $5 million. On a value basis, granite accounted for 47% of imports, followed by marble, 31%; travertine, 12%; and slate, 3%.

WORLD REVIEW

No significant change in world production of dimension stone was apparent in 1982. Italy probably produced about one-half of the world total. Other significant suppliers of dimension stone to the world included Brazil, Finland, India, the Republic of Korea, Portugal, Spain, and the United States.

Canada.—The Ontario Provincial Government offered a $90,000 grant to Fairmont Granite Ltd. to help it reopen its pink granite quarry near Beebe, Ontario. The quarry's plant was to produce monuments and modular building panels. The grant was through the Small Rural Mineral Development Program, a job-creation program, and awarded on the basis of competitive market potential.[13]

Italy.—Italy remained a major world buyer of rough dimension stone. It purchased 525,000 tons of rough granite in 1982, compared with 510,000 tons in 1981. The major sources in 1981 were Finland, 23%, and Spain, 22%. Italy purchased 140,000 tons of rough marble and travertine in 1982, compared with 135,000 tons in 1981. The major sources in 1981 were Yugoslavia, about 26%, and Portugal, about 21%. The United States was only a very minor source.

Italy remained the world's largest exporter of dimension stone in 1981, shipping 700,000 tons of polished and dressed marble and travertine, 600,000 tons of other dressed stone, and 390,000 tons of rough marble and travertine. It also exported 27,000 tons of rough granite, 71% to Western European countries.

An extensive illustrated article on the Carrara marble industry was published.[14]

Japan.—Japan remained one of the largest buyers of dimension stone, while producing little of its own. It purchased 505,000 tons of rough granite compared with 494,000 tons in 1981. The major sources in 1981 were India, about 32%; the Republic of Korea, about 28%; and China, about 12%. Japan purchased 32,000 tons of rough marble in 1982 compared with 22,000 tons in 1981. The major sources in 1981 were Italy, about 43%, and Portugal, about 15%. The United States was a minor source for both granite and marble.

Saudi Arabia.—The Saudi Arabian Government contracted with the Vermont Marble Co., a subsidiary of Omya Inc., for 1,800 tons of white marble to be delivered in 1982 for cladding the new Saudi Arabian Monetary Agency (central bank) headquarters building.

The Saudi Arabian Government was investigating its domestic dimension stone resources, including marble. Gray marble is most common, but promising deposits of pink, blue, black, and white also occur. Promising domestic deposits of carmine pink, red-gray, brown, gray, red-brown, black, and black-brown anorthositic granite have also been located.

Saudi Arabia has been a major market for dimension stone over the last 5 years.

Yugoslavia.—The Granit Enterprise at Jablanica was scheduled to produce 330,000 cubic feet of granite blocks and 1 million square feet of granite slabs in 1982. Production in 1985 was planned to be 50% more than in 1982.[15]

TECHNOLOGY

Research on a high-pressure water jet for use in cutting blocks of dimension stone in quarries was nearing success. Tests showed that a rotating double nozzle used on a 10-foot block of granite is two to three times more efficient in terms of time and cost than flame cutting.[16] Granite producers in Georgia were investigating the use of water jets in quarrying.

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[1]Physical scientist, Division of Industrial Minerals.

[2]Prepared by Valentin V. Tepordei.

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[12]Prepared by Harold A. Taylor, Jr.

[13]Industrial Minerals (London). Grant for Granite Operation. No. 183, December 1982, p. 11.

[14]Newman, C. Carrara Marble: Touchstone of Eternity. Nat. Geogr., v. 162, No. 1, July 1982, pp. 42-58.

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Table 6.—Dimension stone sold or used by producers in the United States, by State

State	1981			1982[P]		
	Quantity (short tons)	Cubic feet (thousands)	Value (thousands)	Quantity (short tons)	Cubic feet (thousands)	Value (thousands)
Alabama	7,425	94	$2,130	8,415	107	$2,341
Arizona	W	W	578	W	W	580
Arkansas	6,770	85	411	4,570	57	290
California	29,431	359	1,909	29,148	355	1,895
Colorado	761	9	64	761	9	64
Connecticut	19,440	225	910	19,786	229	1,046
Georgia	267,871	2,773	17,894	271,104	2,809	18,510
Hawaii	432	5	4	432	5	4
Illinois	1,712	20	85	1,500	17	98
Indiana	144,876	1,965	13,672	135,217	1,840	13,337
Kansas	14,067	187	605	10,771	144	395
Maryland	33,894	415	1,002	32,477	419	1,001
Massachusetts	49,659	710	8,616	51,315	733	9,158
Michigan	6,064	75	129	4,488	55	110
Minnesota	41,196	494	14,298	40,091	480	11,940
New Hampshire	88,902	1,050	6,889	107,000	1,266	7,500
New Mexico	26,230	361	173	17,541	241	138
New York	21,457	251	2,291	21,530	252	2,293
North Carolina	29,906	365	2,773	30,491	372	2,814
Oklahoma	18,233	220	738	17,825	215	968
Oregon	327	4	5	327	4	5
Pennsylvania	50,830	607	7,193	47,577	568	6,354
South Carolina	17,550	213	1,109	13,542	164	904
South Dakota	50,188	557	17,543	47,539	528	16,270
Tennessee	10,921	130	1,063	10,411	124	1,012
Texas	41,883	529	5,543	49,862	631	5,822
Utah	3,116	40	280	3,116	40	280
Vermont	206,819	2,209	30,756	202,131	2,162	29,446
Virginia	4,201	58	1,130	4,201	58	1,130
Washington	14,663	183	2,378	13,729	172	2,375
Wisconsin	40,343	498	4,259	36,505	456	2,644
Other[1]	81,940	1,081	4,030	96,374	1,257	4,389
Total[2]	1,331,107	15,773	150,463	1,329,776	15,769	145,113
Puerto Rico	104,628	1,395	2,040	--	--	--

[P]Preliminary. W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes Idaho, Iowa, Missouri, Montana, New Jersey, Ohio, Rhode Island, and items indicated by symbol W.
[2]Data may not add to totals shown because of independent rounding.

Table 7.—Dimension granite sold or used by producers in the United States, by State

State	1981		1982[P]	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Georgia	249,192	$11,217	249,000	$11,800
Massachusetts	48,557	8,504	49,000	8,600
Minnesota	29,450	11,540	24,500	9,500
New Hampshire	88,902	6,889	107,000	7,500
North Carolina	24,233	2,130	24,300	2,200
South Carolina	17,550	1,109	13,500	900
South Dakota	50,188	17,543	47,500	16,300
Vermont	91,371	13,420	84,000	11,700
Other[1]	82,107	10,520	82,000	10,000
Total	681,550	[2]82,870	680,800	78,500

[P]Preliminary.
[1]Includes California, Colorado, Connecticut, Maryland, New York, Oklahoma, Pennsylvania, Rhode Island, Virginia, Washington, and Wisconsin.
[2]Data do not add to total shown because of independent rounding.

Table 8.—U.S. exports of dimension stone, by type

(Thousand short tons and thousand dollars)

Type	1981		1982		Major destination in 1982, by percent[1]
	Quantity	Value	Quantity	Value	
Granite, rough	76.8	6,602	70.4	6,914	Japan 64%, Canada 16%.
Granite articles	NA	1,515	NA	1,822	Canada 39%, Italy 21%.
Limestone, crude, not for building or monumental	23.4	322	5.7	75	Chile 88%.
Limestone, dressed, for building or monumental	29.8	397	1.8	146	Canada 41%.
Limestone articles	25.3	463	6.0	250	Canada 46%.
Marble, breccia, onyx, rough or squared	11.4	421	10.4	811	United Arab Emirates 46%, Canada 31%.
Marble, breccia, onyx articles	NA	2,252	NA	1,867	Canada 43%, Bahamas 12%.
Quartzite, rough and dressed	13.4	2,494	47.2	2,382	France 31%, Netherlands 23%.
Slate building articles	NA	287	NA	133	Canada 35%.
Slate building articles, other	NA	1,993	NA	1,501	Canada 35%, Saudi Arabia 35%.
Stone, rough, not for building or monumental	7.2	426	3.4	267	Canada 18%.
Stone, rough, for building or monumental	12.9	1,362	9.4	1,151	Japan 46%, Canada 44%.
Stone, other, including alabaster or jet	NA	2,164	NA	1,359	Canada 17%, Saudi Arabia 15%.
Total	NA	20,698	NA	18,678	

NA Not available.
[1]By value.

Table 9.—U.S. imports for consumption of dimension granite, by country

(Thousand cubic feet and thousand dollars)

Country	Rough[1]		Dressed		Other n.s.p.f. undecorated[2] value[3]
	Quantity	Value	Quantity	Value	
1981:					
Brazil	1	40	47	1,397	183
Canada	226	4,186	128	4,809	3,723
India	(4)	2	3	148	6
Ireland	(4)	10	(4)	6	354
Italy	20	960	460	24,838	842
Japan	(4)	10	4	217	16
Portugal	--	--	3	124	--
South Africa, Republic of	4,722	1,145	24	663	--
Spain	2	12	12	266	--
Other	11	236	10	1,053	36
Total	4,982	6,601	691	33,521	5,160
1982:					
Brazil	352	65	97	2,395	33
Canada	341	3,030	204	11,085	1,988
India	9	146	19	462	18
Ireland	--	--	2	50	756
Italy	10	62	850	55,050	1,047
Japan	--	--	8	467	2
Portugal	--	--	3	108	27

See footnotes at end of table.

Table 9.—U.S. imports for consumption of dimension granite, by country —Continued

(Thousand cubic feet and thousand dollars)

Country	Rough[1] Quantity	Rough[1] Value	Dressed Quantity	Dressed Value	Other n.s.p.f. undecorated[2] value[3]
1982 —Continued					
South Africa, Republic of	4,351	784	12	204	--
Spain	--	--	7	456	--
Other	6	199	26	1,360	205
Total	5,069	4,286	1,228	71,637	4,076

[1]Does not include nonmanufactured nonmonumental granite.
[2]Does not include granite n.s.p.f. decorated.
[3]Quantity not reported.
[4]Less than 1/2 unit.

Table 10.—U.S. imports for consumption of dimension marble and travertine, by country

Country	Marble, breccia, or onyx, polished slabs: Quantity (thousand square feet)	Marble, breccia, or onyx, polished slabs: Value (thousands)	Marble, breccia, or onyx, other n.s.p.f.[1] value[2] (thousands)	Travertine, dressed[3]: Quantity (short tons)	Travertine, dressed[3]: Value (thousands)
1981:					
France	49	$151	$105	22	$32
Germany, Federal Republic of	181	279	495	59	36
Greece	112	260	133	--	--
Italy	9,412	24,938	12,419	42,561	16,005
Mexico	200	425	1,626	3,577	1,273
Pakistan	28	166	447	--	--
Philippines	230	479	143	--	--
Portugal	532	1,524	450	--	--
Spain	409	842	37	58	54
Taiwan	171	294	2,637	--	--
Other	229	593	799	173	154
Total	11,553	29,951	19,291	46,450	17,554
1982:					
France	236	663	221	15	18
Germany, Federal Republic of	107	163	270	42	38
Greece	238	614	168	--	--
Italy	8,957	26,072	11,582	165,116	19,612
Mexico	308	682	1,409	1,355	964
Pakistan	23	69	394	--	--
Philippines	193	478	139	--	--
Portugal	646	2,102	354	--	--
Spain	1,044	1,957	92	151	106
Taiwan	132	270	3,626	--	--
Other	2,065	1,141	910	76	49
Total	13,949	34,211	19,165	166,755	20,787

[1]Does not include certain special kinds of rough marble, breccia, and onyx.
[2]Quantity not reported.
[3]Suitable for use as monumental, paving, or building stone. Does not include travertine articles.

Table 11.—U.S. imports of other dimension stone, by type

Type	1981 Quantity	1981 Value (thousands)	1982 Quantity	1982 Value (thousands)	Major source for 1982, by percent[1]
Granite, unmanufactured, nonmonumental short tons	1,378	$95	1,102	$57	Spain 50%.
Granite, n.s.p.f., decorated	--	173		165	Italy 67%.
Alabaster and jet articles	--	1,179		1,120	Italy 74%.
Limestone, crude not for building or monuments short tons	320,207	1,517	272,770	1,359	Dominican Republic 50%, Canada 47%.
Limestone, dressed, hewn do	2,514	293	16,847	414	Italy 91%.
Marble and breccia, rough cubic feet	4,498	80	58,168	162	Italy 37%.
Onyx, rough do	13,392	188	6,585	67	Mexico 87%.
Marble, breccia, onyx, slab and tiles, unpolished square feet	371,626	1,051	339,599	1,227	Italy 72%.
Quartzite short tons	71,430	825	26,327	275	Republic of South Africa 46%.
Slate, roofing square feet	139,955	116	129,267	105	Spain 60%.
Slate, other, n.s.p.f.	--	10,672	--	4,871	Italy 78%.
Travertine articles, undecorated	--	980	--	1,747	Italy 80%.
Travertine articles, decorated	--	354	--	468	Italy 92%.
Stone, unmanufactured short tons	15,819	273	13,737	267	Mexico 41%.
Stone, dressed, building do	664	293	811	341	Mexico 31%.
Stone, other, n.s.p.f., undecorated	--	1,065	--	1,401	Mexico 41%, Italy 10%.
Stone, other, n.s.p.f., decorated	--	1,672	--	1,700	Mexico 19%, China 16%.

[1]By value.

Sulfur

By David E. Morse[1]

The economic recession of 1982 had a pronounced effect on the domestic sulfur industry. Sulfur production, shipments, apparent consumption, exports, and prices all declined. Production of sulfur in all forms was the lowest since 1971. Shipments were at the 1970 level; apparent consumption was the lowest since 1972; and exports were the lowest since 1978. The net shipment value, f.o.b. mine or plant, for sulfur in all forms was $1.0 billion in 1982, 23% less than the 1981 value. The average net shipment value for elemental sulfur, f.o.b. mine or plant, decreased about $3 to $108.27 per ton in 1982.

Frasch sulfur producers bore the brunt of the 1982 decrease in sulfur demand. Frasch output was the lowest since 1946; shipments reported by Frasch producers decreased 39% in quantity and value, or 2.3 million tons and $281 million below those of 1981. In sharp contrast to the performance of

Table 1.—Salient sulfur statistics

(Thousand metric tons, sulfur content, and thousand dollars unless otherwise specified)

	1978	1979	1980	1981	1982
United States:					
Production:					
Frasch	5,648	6,357	6,390	6,348	4,210
Recovered elemental	4,062	4,070	4,073	4,259	4,404
Other forms	1,465	1,674	1,403	1,538	1,173
Total	11,175	12,101	11,866	12,145	9,787
Shipments:					
Frasch	5,736	7,507	7,400	5,910	3,598
Recovered elemental	4,088	4,108	4,115	4,207	4,344
Other forms	1,465	1,674	1,403	1,538	1,173
Total	11,289	13,289	12,918	11,655	9,115
Imports, elemental	2,177	2,494	2,523	2,522	1,905
Exports, elemental[1]	827	1,963	1,673	1,392	961
Consumption, apparent, all forms[2]	12,600	13,739	13,659	12,785	10,059
Stocks, Dec. 31: Producer, Frasch and recovered elemental	5,345	4,239	3,094	3,634	4,202
Value:					
Shipments, f.o.b. mine or plant:					
Frasch	$279,918	$449,433	$720,511	$715,683	$434,660
Recovered elemental	163,799	198,137	305,046	412,115	425,217
Other forms	68,295	89,643	84,332	140,618	122,177
Total	512,012	737,213	1,109,889	1,268,416	982,054
Imports, elemental[3]	$75,671	$94,147	$138,852	$209,766	$164,885
Exports, elemental[3 4]	$34,667	$142,966	$185,866	$187,407	$122,143
Price, elemental, dollars per metric ton, f.o.b. mine or plant	$45.17	$55.75	$89.06	$111.48	$108.27
World: Production, all forms (including pyrites)	[r]52,138	[r]53,184	55,009	[p]53,563	[e]50,660

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Excludes exports from the Virgin Islands to foreign countries, except for 1981 and 1982.
[2]Measured by shipments, plus imports, minus exports.
[3]Declared customs valuation.
[4]Excludes value of exports from the Virgin Islands to foreign countries, except for 1981 and 1982.

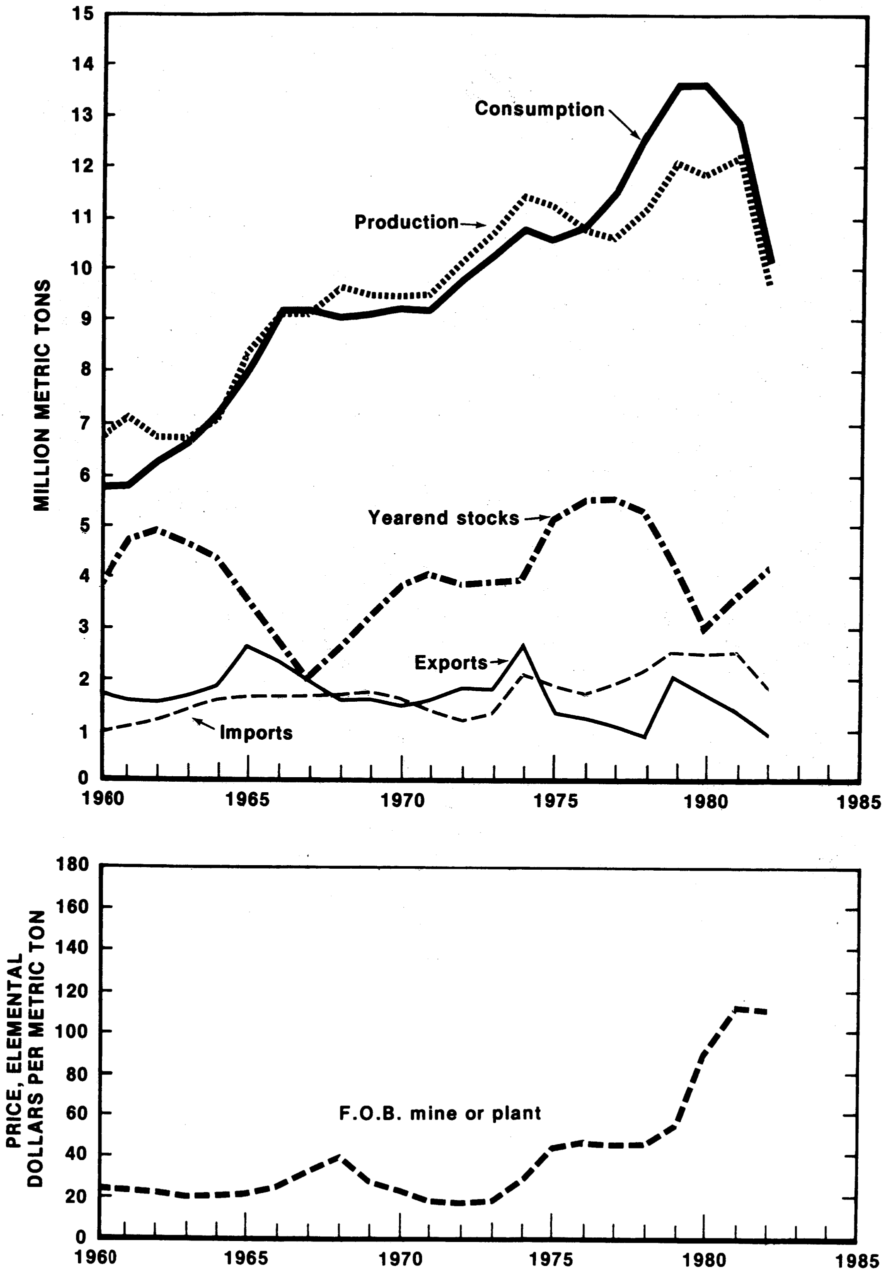

Figure 1.—Trends in the sulfur industry in the United States.

Frasch sulfur producers, the producers of recovered elemental sulfur set record high levels for both production and shipments. For the first time in U.S. history, recovered elemental sulfur production and shipments exceeded Frasch output and sales. Shipments of sulfur in all forms in 1982 were 7% less than the quantity produced; the United States was a net importer again in 1982.

Domestic Data Coverage.—Domestic production data for sulfur are developed by the Bureau of Mines from four separate, voluntary surveys of U.S. operations. Typical of these surveys is the Elemental Sulfur survey. Of the 207 operations to which a survey request was sent, 100% responded, representing the total production shown in tables 1 and 2.

DOMESTIC PRODUCTION

Frasch.—In January 1982, 10 Frasch mines operated in the United States, all in Louisiana and Texas. Mines in Louisiana were Freeport Minerals Co. at Garden Island Bay, Grand Isle, and Caillou Island. Mines in Texas were Farmland Industries, Inc., at Fort Stockton; Duval Corp. at Culberson and Phillips Ranch; Occidental Chemical Co. at Long Point Dome; and Texasgulf, Inc., at Boling Dome, Moss Bluff Dome, and Comanche Creek. However, three mines were closed during the year: Phillips Ranch, Long Point, and Moss Bluff; at yearend, the remaining seven mines were operating at an estimated 60% of capacity.

Frasch sulfur production decreased 2.14 million tons from the output in 1981. Shipments were also significantly lower by 2.31 million tons. Frasch sulfur accounted for 43% of domestic production of sulfur in all forms in 1982, compared with 52% in 1981. Approximately 80% of the total Frasch sulfur shipments was for domestic consumption, and 20%, for export. Reported yearend stocks after inventory adjustments increased by 422,000 tons. The total value of Frasch sulfur shipments decreased by $281 million, or 39%.

Recovered.—Production of recovered elemental sulfur, a nondiscretionary byproduct from natural gas and petroleum refineries, electric utilities, and coking plants, accounted for 45% of the total domestic output of sulfur in all forms, compared with 35% in 1981. Production and shipments reached alltime highs in 1982; both increased 3% over 1981 levels and surpassed Frasch output and shipments for the first time in U.S. history. This type of sulfur was produced by 58 companies at 161 plants in 29 States, 1 plant in the Virgin Islands, and 2 plants in Puerto Rico. Most of these plants were of relatively small size, with only seven reporting an annual production exceeding 100,000 tons. By source, 56% was produced by 43 companies at 90 refineries or satellite plants treating refinery gases, 3 coking plants, and 1 utility plant, and 44% was produced by 26 companies at 67 natural gas treatment plants. The five largest recovered elemental sulfur producers were Atlantic Richfield Co.; Chevron U.S.A., Inc.; Exxon Co., U.S.A.; Shell Oil Co.; and Standard Oil Co. of Indiana. These companies' 46 plants accounted for 56% of recovered elemental sulfur output in 1982.

The leading States in production of recovered elemental sulfur were Alabama, California, Louisiana, Mississippi, and Texas. These five States contributed 70% of the total output; shipments from Texas accounted for 30% of total shipments. The total value of shipments of recovered elemental sulfur in 1982 was an alltime high of $425 million.

Table 2.—Production of sulfur and sulfur-containing raw materials in the United States

(Thousand metric tons)

	1981		1982	
	Gross weight	Sulfur content	Gross weight	Sulfur content
Frasch sulfur	6,348	6,348	4,210	4,210
Recovered elemental sulfur	4,259	4,259	4,404	4,404
Byproduct sulfuric acid (100% basis) produced at copper, lead, molybdenum, and zinc plants	3,546	1,159	2,532	828
Pyrites	797	307	676	265
Other forms[1]	119	72	131	80
Total	XX	12,145	XX	9,787

XX Not applicable.
[1]Hydrogen sulfide and liquid sulfur dioxide.

Table 3.—Sulfur produced and shipped from Frasch mines in the United States

(Thousand metric tons and thousand dollars)

Year	Production			Shipments	
	Texas	Louisiana	Total	Quantity	Value[1]
1978	3,720	1,928	5,648	5,736	279,918
1979	3,897	2,460	6,357	7,507	449,433
1980	4,081	2,309	6,390	7,400	720,511
1981	3,908	2,440	6,348	5,910	715,683
1982	2,898	1,312	4,210	3,598	434,660

[1]F.o.b. mine.

Table 4.—Recovered sulfur produced and shipped in the United States

(Thousand metric tons and thousand dollars)

Year	Production			Shipments	
	Natural gas plants	Petroleum refineries[1]	Total	Quantity	Value[2]
1978	1,753	2,309	4,062	4,088	163,799
1979	1,760	2,310	4,070	4,108	198,137
1980	1,757	2,316	4,073	4,115	305,046
1981	1,971	2,288	4,259	4,207	412,115
1982	1,960	2,444	4,404	4,344	425,217

[1]Includes a small quantity from coking operations and utility plants.
[2]F.o.b. plant.

Table 5.—Recovered sulfur produced and shipped in the United States, by State

(Thousand metric tons and thousand dollars)

State	1981			1982		
	Production (quantity)	Shipments		Production (quantity)	Shipments	
		Quantity	Value		Quantity	Value
Alabama	403	404	41,224	441	440	46,067
California	477	465	31,393	494	486	31,859
Florida	243	243	W	190	190	W
Illinois	216	216	19,739	214	214	21,006
Kansas	20	20	1,716	W	W	W
Louisiana	239	239	26,606	232	232	25,247
Michigan and Minnesota	77	77	5,600	97	97	7,175
Mississippi	698	677	78,871	623	602	71,722
New Jersey	119	120	13,581	113	103	12,040
New Mexico	69	69	5,991	62	63	5,337
North Dakota	W	W	W	77	76	4,400
Ohio	31	31	2,155	28	27	3,106
Pennsylvania	56	56	4,654	58	57	4,818
Texas	1,144	1,136	115,252	1,298	1,297	129,454
Wisconsin	(1)	(1)	19	1	1	55
Wyoming	46	47	2,568	69	63	3,327
Other[2]	418	405	62,745	407	394	59,604
Total[3]	4,259	4,207	412,115	4,404	4,344	425,217

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Less than 1/2 unit.
[2]Arkansas, Colorado, Delaware, Indiana, Kentucky, Missouri, Montana, New York, Oklahoma, Utah, Virginia, Washington, Puerto Rico, and the Virgin Islands combined to avoid disclosing company proprietary data and data indicated by symbol W.
[3]Data may not add to totals shown because of independent rounding.

Byproduct Sulfuric Acid.—Sulfur contained in byproduct sulfuric acid produced at copper, lead, molybdenum, and zinc roasters and smelters amounted to 8% of the total domestic production of sulfur in all forms. Output was 29% less than that of 1981 because of the adverse effect of the economic recession on demand for copper, molybdenum, and zinc. Twelve acid plants operated in conjunction with copper smelters, and 12 plants were accessories to lead, molybdenum, and zinc roasting and smelting operations. The five largest acid plants accounted for 57% of the output, and production in five States amounted to 82% of the total. The five largest producers of byproduct sulfuric acid were ASARCO Incorporated, Kennecott Copper Corp., Magma Copper Co., Phelps Dodge Corp., and AMAX Inc. These companies' 18 plants produced 84% of the 1982 total.

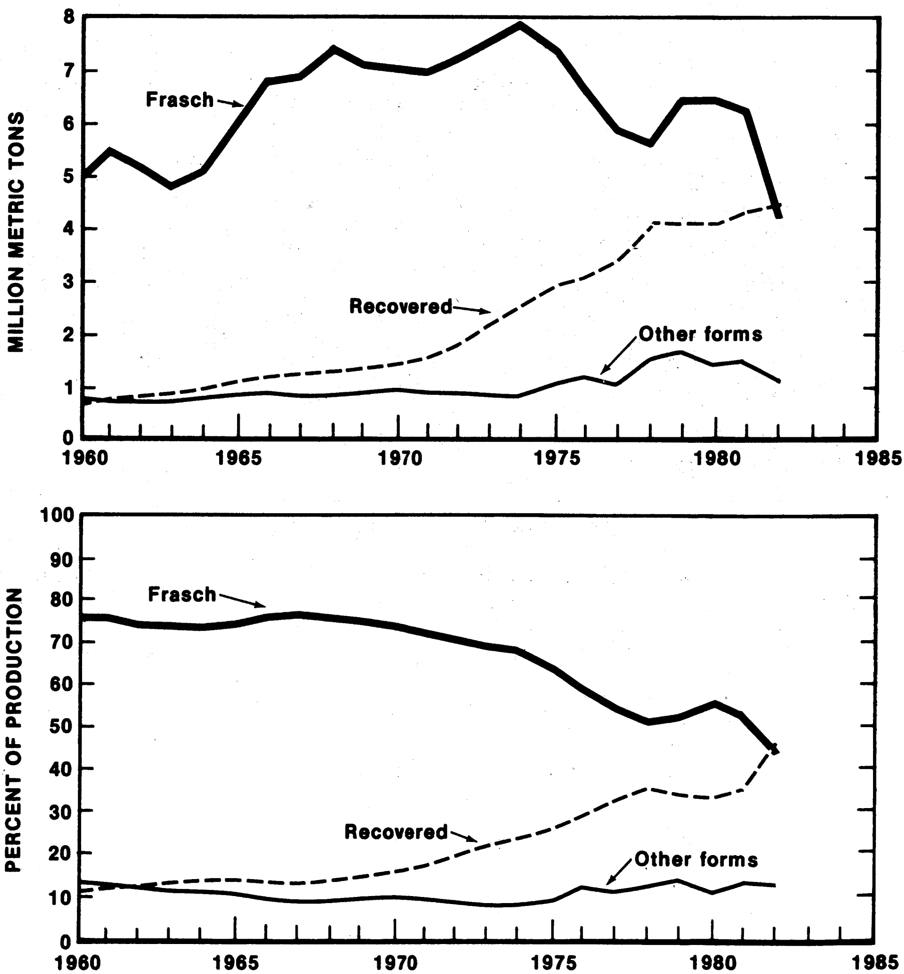

Figure 2.—Trends in the production of sulfur in the United States.

Table 6.—Byproduct sulfuric acid[1] (sulfur content) produced in the United States

(Thousand metric tons and thousand dollars)

Year	Copper plants[2]	Lead and zinc plants[3]	Zinc plants[3]	Lead and molybdenum plants[3]	Total	Value
1978	812	291	--	--	1,103	49,848
1979	821	346	--	--	1,167	51,815
1980	686	--	183	134	1,003	55,897
1981	848	--	179	132	1,159	75,657
1982	615	--	112	101	828	63,674

[1]Includes acid from foreign materials.
[2]Excludes acid made from pyrites concentrates.
[3]Excludes acid made from native sulfur.

Pyrites, Hydrogen Sulfide, and Sulfur Dioxide.—Contained sulfur in pyrites, hydrogen sulfide, and sulfur dioxide amounted to 4% of the total domestic production of sulfur in all forms during 1982, compared with 3% in 1981. The total sulfur content in these products was 9% less than that of 1981. Pyrites was produced by three companies at three mines in three States; hydrogen sulfide, by three companies at four plants in three States; and sulfur dioxide, by three companies at five plants in five States. The three largest producers of these products were Shell Oil, hydrogen sulfide; Stauffer Chemical Co., sulfur dioxide; and Tennessee Chemical Co., pyrites and sulfur dioxide. These companies' one mine and five plants accounted for 91% of the total contained sulfur produced in the form of these products.

Table 7.—Pyrites, hydrogen sulfide, and sulfur dioxide sold or used in the United States

(Thousand metric tons, sulfur content, and thousand dollars)

Year	Pyrites	Hydrogen sulfide	Sulfur dioxide	Total	Value
1978	301	61	(1)	362	18,447
1979	400	35	72	507	37,828
1980	322	36	42	400	28,435
1981	307	28	44	379	64,961
1982	265	32	48	345	58,503

[1]Included with "Hydrogen sulfide."

CONSUMPTION AND USES

Apparent domestic consumption of sulfur in all forms declined for the third consecutive year, as shown in table 8. In 1982, 81% of the sulfur consumed was obtained from domestic sources. The sources of supply were domestic recovered elemental sulfur, 41%; domestic Frasch sulfur, 28%; combined domestic byproduct sulfuric acid, pyrites, hydrogen sulfide, and sulfur dioxide, 12%; the remaining 19% was supplied by imports of Frasch and recovered elemental sulfur.

The Bureau of Mines collected end-use data on sulfur and sulfuric acid according to the Standard Industrial Classification of industrial activities. Table 9 shows shipments by end use of elemental sulfur reported by 65 companies, and table 10 shows shipments by end use of sulfuric acid reported by 67 companies. Sixteen companies reported shipments of both elemental sulfur and sulfuric acid.

The largest sulfur end use, sulfuric acid production, represented 83% of shipments for domestic consumption. Some identified end uses were tabulated in the "Unidentified" category because these data were proprietary. Data collected from companies that did not identify shipments by end use were also tabulated as "Unidentified."

Shipments of 100% sulfuric acid decreased 18% from shipments reported in 1981. Shipments of sulfuric acid for phosphatic fertilizer production, the largest end use, declined 17% in 1982. Shipments of sulfuric acid for petroleum refining and other petroleum and coal products, the second largest end use, declined 17%. Usage of sulfuric acid for copper ore leaching decreased 18%.

According to the 1982 canvass reports, company receipts of spent sulfuric acid for reclaiming totaled 2.8 million tons. The largest source of spent acid, from petroleum refining and coal products, accounted for 56% of the total returned. The petroleum refining industry was a net user of about 728,000 tons of sulfuric acid. The remaining reclaimed acid was returned from manufacturers of phosphatic fertilizers, soap and detergents, explosives, steel, paints and pigments, organic chemicals, inorganic chemicals, and some unidentified sources.

Table 11 shows the domestic uses of sulfur, including sulfur contained in sulfuric acid. The largest end use for sulfur was sulfuric acid for phosphatic fertilizer production, which accounted for 55% of the 1982 total.

Table 8.—Apparent consumption of sulfur in the United States[1]

(Thousand metric tons)

	1978	1979	1980	1981	1982
Frasch:					
Shipments	5,736	7,507	7,400	5,910	3,598
Imports	993	1,229	990	856	690
Exports	827	1,963	1,673	[r]1,216	731
Total	5,902	6,773	6,717	[r]5,550	3,557
Recovered:					
Shipments	4,088	4,108	4,115	4,207	4,344
Imports	1,185	1,265	1,533	1,666	1,215
Exports	39	81	109	[r]176	230
Total	5,234	5,292	5,539	[r]5,697	5,329
Pyrites, shipments	301	400	322	307	265
Byproduct sulfuric acid, shipments	1,103	1,167	1,003	1,159	828
Other forms, shipments[2]	61	107	78	72	80
Total, all forms	[3]12,600	13,739	13,659	12,785	10,059

[r]Revised.
[1]Crude sulfur or sulfur content.
[2]Includes consumption of hydrogen sulfide and liquid sulfur dioxide.
[3]Data do not add to total shown because of independent rounding.

Table 9.—Elemental sulfur sold or used in the United States, by end use

(Thousand metric tons)

SIC	Use	1981	1982
20	Food and kindred products	W	W
26, 261	Pulp and paper products	30	20
282, 2822	Synthetic rubber and other plastic products	W	W
287	Agricultural chemicals	348	376
28, 285, 286	Paints and allied products, industrial organic chemicals, and other chemical products	77	64
284	Soaps and detergents	W	45
29, 291	Petroleum refining and petroleum and coal products	193	180
295	Paving and roofing materials	3	W
281	Other industrial inorganic chemicals	157	80
30	Rubber and miscellaneous plastic products	W	W
	Sulfuric acid:		
	Domestic sulfur	7,733	5,906
	Imported sulfur	1,460	1,071
	Total	9,193	6,977
	Unidentified	820	677
	Total domestic uses	10,821	8,419
	Exports	856	657
	Grand total	11,677	9,076

W Withheld to avoid disclosing company proprietary data; included with "Unidentified."

Table 10.—Sulfuric acid sold or used in the United States, by end use

(Thousand metric tons of 100% H_2SO_4)

SIC	Use	Quantity 1981	Quantity 1982
102	Copper ores	942	776
1094	Uranium and vanadium ores	652	369
10	Other ores	165	158
261	Pulpmills	739	661
26	Other paper products	94	96
285, 2816	Inorganic pigments and paints and allied products	449	539
281	Other inorganic chemicals	839	774
282, 2822	Synthetic rubber and other plastic materials and synthetics	590	661
2823	Cellulosic fibers including rayon	193	263
283	Drugs	54	43
284	Soaps and detergents	392	295
286	Industrial organic chemicals	1,725	1,003
2873	Nitrogenous fertilizers	634	231
2874	Phosphatic fertilizers	23,700	19,624
2879	Pesticides	113	127
287	Other agricultural chemicals	204	224
2892	Explosives	42	46
2899	Water-treating compounds	461	443
28	Other chemical products	199	225
29, 291	Petroleum refining and other petroleum and coal products	3,171	2,311
30	Rubber and miscellaneous plastic products	29	17
331	Steel pickling	268	262
333	Nonferrous metals	75	50
33	Other primary metals	81	16
3691	Storage batteries/acid	173	161
	Unidentified	1,418	1,023
	Total domestic	37,402	30,398
	Exports	210	239
	Grand total	37,612	30,637

Table 11.—Sulfur and sulfuric acid sold or used in the United States, by end use

(Thousand metric tons, sulfur content)

SIC	Use	Elemental sulfur[1] 1981	Elemental sulfur[1] 1982	Sulfuric acid (sulfur equivalent) 1981	Sulfuric acid (sulfur equivalent) 1982	Total 1981	Total 1982
102	Copper ores	--	--	308	254	308	254
1094	Uranium and vanadium ores	--	--	213	121	213	121
10	Other ores	--	--	54	52	54	52
20	Food and kindred products	W	W	--	--	W	W
261, 26	Pulpmills and paper products	30	20	272	247	302	267
2816, 285, 28, 286	Inorganic pigments, paints and allied products, industrial organic chemicals, other chemical products	77	64	146	176	223	240
281	Other inorganic chemicals	157	80	274	253	431	333
2822, 282,	Synthetic rubber, and other plastic materials and synthetics	W	W	192	216	192	216
2823	Cellulosic fibers, including rayon	--	--	63	86	63	86
283	Drugs	--	--	18	14	18	14
284	Soaps and detergents	W	45	128	97	128	142
286	Industrial organic chemicals	--	--	564	328	564	328
2873	Nitrogenous fertilizers	--	--	207	75	207	75
2874	Phosphatic fertilizers	--	--	7,748	6,415	7,748	6,415
2879	Pesticides	--	--	37	42	37	42
287	Other agricultural chemicals	348	376	67	73	415	449
2892	Explosives	--	--	14	15	14	15
2899	Water-treating compounds	--	--	151	145	151	145
28	Other chemical products	--	--	65	73	65	73
291, 29	Petroleum refining and other petroleum and coal products	193	180	1,037	755	1,230	935
295	Paving and roofing materials	3	W	--	--	3	W
30	Rubber and miscellaneous plastic products	W	W	9	6	9	6
331	Steel pickling	--	--	88	86	88	86
333	Nonferrous metals	--	--	25	16	25	16
33	Other primary metals	--	--	26	5	26	5
3691	Storage batteries/acid	--	--	57	53	57	53
	Exported sulfuric acid	--	--	68	78	68	78
	Total identified	808	765	11,831	9,681	12,639	10,446
	Unidentified	820	677	464	334	1,284	1,011
	Grand total	1,628	1,442	12,295	10,015	13,923	11,457

W Withheld to avoid disclosing company proprietary data; included with "Unidentified."

[1]Does not include elemental sulfur used for production of sulfuric acid.

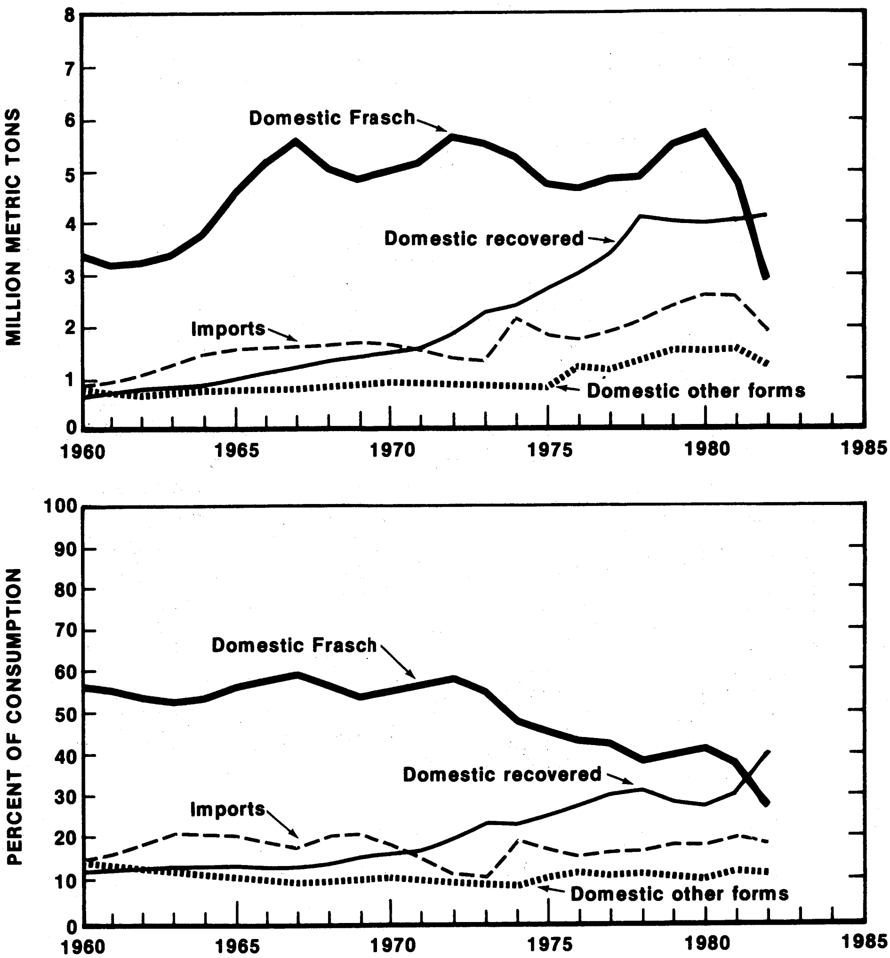

Figure 3.—Trends in the consumption of sulfur in the United States.

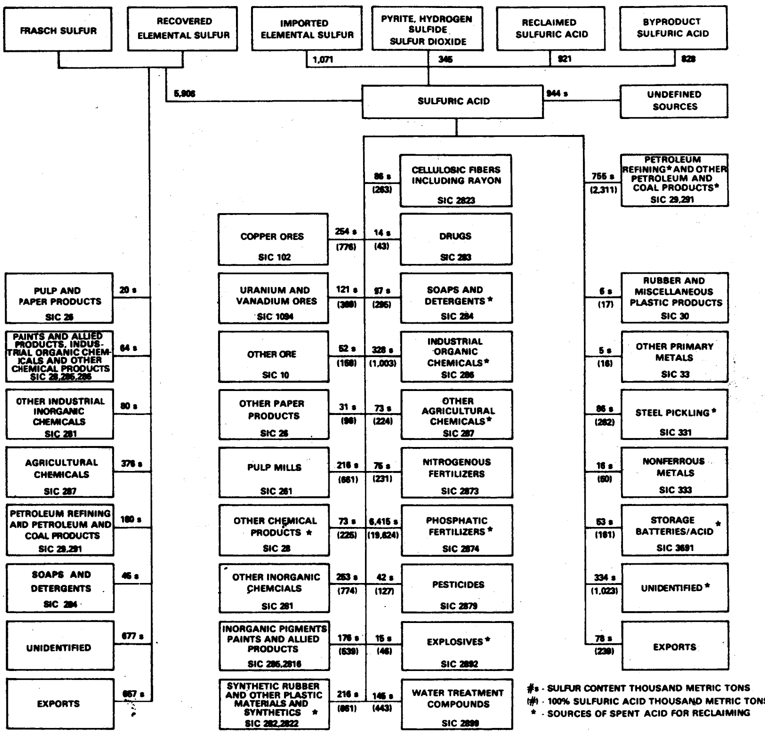

Figure 4.—Sulfur-sulfuric acid supply and end-use relationship in 1982.

STOCKS

Inventories of Frasch sulfur increased to 4.02 million tons during the first half of 1982, then decreased slightly during the second half as production and shipment volumes came into balance. Combined yearend stocks in 1982 amounted to approximately a 6-month supply, compared with a 4-month supply in 1981, based on domestic and export demands for Frasch and recovered elemental sulfur.

Table 12.—Producers' yearend stocks

(Thousand metric tons)

Year	Frasch	Recovered	Total
1978	5,123	222	5,345
1979	4,058	181	4,239
1980	2,954	140	3,094
1981	3,442	192	3,634
1982	3,964	238	4,202

PRICES

At yearend 1982, the quoted prices for liquid sulfur were $126.48 per ton, Texas and Louisiana gulf ports, and $132.87 per ton, ex-terminal Tampa, Fla., which was approximately $12.30 less than the quoted 1981 yearend prices.

On the basis of total shipments and value reported to the Bureau of Mines, the average value of shipments of Frasch sulfur, f.o.b. mine, for domestic consumption and exports combined decreased slightly during 1982. Shipment values for recovered elemental sulfur varied widely in different regions: lowest in the West, somewhat higher in the midcontinent, and near the values for Frasch sulfur in the East and South. The average value per ton of sulfur contained in byproduct sulfuric acid increased from $65 in 1981 to $77 in 1982. The average unit value for sulfur contained in pyrites, hydrogen sulfide, and sulfur dioxide, combined, decreased from $171 to $170 per ton.

Table 13.—Reported sales values of shipments of elemental sulfur, f.o.b. mine or plant

(Dollars per metric ton)

Year	Frasch	Recovered	Total
1978	48.80	40.07	45.17
1979	59.87	48.23	55.75
1980	97.36	74.13	89.06
1981	121.11	97.97	111.48
1982	120.79	97.89	108.27

FOREIGN TRADE

The United States was a net importer of sulfur for the eighth consecutive year. Exports of elemental sulfur from the United States, including the Virgin Islands, decreased to the lowest level since 1978. The total reported value of sulfur exports decreased $65 million or 35% compared with that of 1981. The average export value was $127.10 per ton in 1982, a 6% decrease from that of 1981.

Frasch sulfur from Mexico and recovered elemental sulfur from Canada continued to supply nearly all U.S. sulfur import requirements. In 1982, U.S. sulfur imports declined 24% in quantity and 21% in value. Sulfur imports from Canada decreased 27%, and imports from Mexico decreased 19% from the quantities reported in 1981.

The United States also had significant international trade in sulfuric acid in 1982. Sulfuric acid exports declined slightly, while imports increased 18%.

Table 14.—U.S. exports of elemental sulfur, by country

(Thousand metric tons and thousand dollars)

Country	1981		1982	
	Quantity	Value	Quantity	Value
Algeria	--	--	21	2,263
Argentina	7	1,063	8	1,235
Australia	1	500	1	434
Belgium-Luxembourg	453	67,028	375	52,760
Brazil	51	7,267	80	10,646
Bulgaria	14	1,775	11	1,229
Canada	11	796	7	493
Chile	16	1,699	2	606
Egypt	54	7,400	42	4,640
Finland	29	4,061	--	--
Germany, Federal Republic of	4	2,533	2	1,584
Greece	15	1,962	29	3,621
India	161	20,726	71	6,098
Italy	(1)	4	39	4,702
Mexico	56	3,235	51	2,819
Morocco	--	--	52	6,043
Netherlands	261	29,820	(1)	8
Nigeria	16	1,438	--	--
Romania	169	22,069	50	7,336
South Africa, Republic of	16	1,710	(1)	10
Spain	6	630	(1)	4
Tunisia	--	--	68	7,349
Turkey	14	1,778	14	2,169
U.S.S.R	--	--	28	3,523
United Kingdom	1	28	1	74
Uruguay	9	1,171	3	398
Other	r32	r8,714	6	2,100
Total[2]	1,392	187,407	961	122,143

rRevised.
[1]Less than 1/2 unit.
[2]Data may not add to totals shown because of independent rounding.

Table 15.—U.S. exports of sulfuric acid (100% H_2SO_4), by country

Country	1981		1982	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Canada	31,611	$1,212	68,297	$2,989
Colombia	45	43	1,366	110
Honduras	63	17	1,672	7
Jamaica	3,254	224	1,954	159
Mexico	141,235	7,807	116,787	5,024
Netherlands Antilles	24,503	1,469	9,059	667
Panama	256	21	1,381	60
Saudi Arabia	2,201	273	1,317	144
Venezuela	16,342	1,330	21,181	1,779
Other	20,657	1,723	13,605	2,427
Total	240,167	14,119	236,619	13,366

Table 16.—U.S. imports of elemental sulfur, by country

(Thousand metric tons and thousand dollars)

Country	1981		1982	
	Quantity	Value	Quantity	Value
Canada	1,666	101,518	1,215	77,357
Germany, Federal Republic of	(1)	27	(1)	18
Mexico	856	108,221	690	87,494
Other[2]	(1)	1	(1)	16
Total	2,522	[3]209,766	1,905	164,885

[1]Less than 1/2 unit.
[2]1981—the United Kingdom; 1982—Taiwan and the United Kingdom.
[3]Data do not add to total shown because of independent rounding.

Table 17.—U.S. imports of sulfuric acid (100% H_2SO_4), by country

Country	1981		1982	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Canada	345,386	$8,134	307,375	$8,722
Germany, Federal Republic of	6,016	350	10,918	492
Japan	11,213	135	81,931	3,699
Mexico	--	--	1,990	124
Netherlands	1,056	117	--	--
Norway	--	--	19,692	1,254
Peru	--	--	6,130	229
Other	2	21	96	142
Total	363,673	8,757	428,132	14,662

WORLD REVIEW

The economic recession in Western Europe and North America, coupled with reduced consumption by fertilizer manufacturers, resulted in a significant decline in world sulfur demand and, consequently, production. Frasch producers in the United States and Mexico suffered most from the reduced demand; remelt activities in Canada declined, especially during the second half of 1982. Sulfur shipments from Iraq and Iran were negligible; however, sulfur from Saudi Arabia reached world markets for the first time. The United States continued as the world's foremost sulfur importer, followed by the U.S.S.R., Morocco, Brazil, and India.

Canada.—Shipments of sulfur in all forms were about 7.8 million tons in 1982, a decrease of 14% compared with shipments of nearly 9.0 million tons in 1981. Recovered elemental sulfur was produced at 48 sour natural gas plants, 45 in Alberta and 3 in British Columbia, and at 14 petroleum refineries. Byproduct production from smelter gases decreased 21% to approximately 625,000 tons of contained sulfur.

Canadian sulfur exports declined from the record high level of 7.3 million tons in 1981 to 6.2 million tons in 1982. Sulfur exported through the Port of Vancouver declined 13% to 4.83 million tons, the lowest level in the past 3 years.

The Port of Vancouver was closed because of a lockout on October 19. After a week of deadlock, the Federal Minister of Labour intervened by introducing legislation requiring the resumption of port operations. The lockout was withdrawn, and following a tentative agreement, work resumed on November 4.

In Alberta Province, production of sulfur was about 5.3 million tons; nearly 260,000 tons was from tar sands. Of total shipments from Alberta of 6.1 million tons, 4.8 million tons was shipped to overseas markets, 1.2 million tons was exported to the United States, and 650,000 tons was shipped to domestic consumers. Alberta producer stocks, which were 16.7 million tons in January, were reduced to 15.2 million tons in July, but declined only slightly to 15.09 million tons by yearend.

Germany, Federal Republic of.—The Federal Republic of Germany was the second largest producer of elemental sulfur in Western Europe and an important exporter of liquid and solid sulfur. The bulk of elemental sulfur was recovered from sour natural gas fields in the Lower Saxony region of northern Germany. Sulfur from petroleum refineries was produced by 15 companies having a total sulfur capacity of approximately 800,000 tons per year.[2]

Iran.—Recovered elemental sulfur was not produced from the Bandar Khomeini (formerly Shahpur) and Kharg chemical complexes in 1981-82, because of the ongoing war with neighboring Iraq. Recovered elemental sulfur from the Isfahan and Shiraq petroleum refineries amounted to only 6,000 tons in 1981.

Iraq.—Production of sulfur from the Misraq operation continued at a reduced rate in 1982. Iranian military activities damaged export facilities at Khor al Zubair, thereby reducing exports to nearly zero. In 1981, Iraqi sulfur exports had declined to 45,000 tons from 569,000 tons in 1980. The Iraqi State Organization for Minerals' (SOM) Al-Qain phosphate fertilizer complex was completed in 1982. The facility in northern Iraq, near the Syrian border, included three 500,000-ton-per-year sulfuric acid plants. SOM planned to bring a 500,000-ton-per-year sulfur recovery plant into operation at the KirKūk Oilfield in 1983. Sulfur production from associated sour natural gas would depend upon Iraq's capability to produce and export crude oil.

Mexico.—Frasch sulfur production declined 16% because of reduced sulfur demand in the United States and Western Europe. Total exports decreased 21% to nearly 953,000 tons. Domestic sales increased only 1% to 868,000 tons. Recovered elemental sulfur production from Petróleos Mexicanos operations remained unchanged.

Poland.—Sulfur exports from Poland increased to 3.97 million tons in 1982 from 3.82 million tons in 1981. Exports to Western Europe declined 9% to 1.18 million tons; exports to Eastern Europe increased 5% to 1.95 million tons, of which 818,000 tons was shipped to the Soviet Union. Morocco increased its imports of Polish sulfur by 195,000 tons to 461,000 tons in 1982. Polish Frasch sulfur production apparently exceeded U.S. production of Frasch sulfur in 1982.

Saudi Arabia.—In April, 23,000 tons of prilled sulfur was loaded at the Jubail industrial port onto a vessel bound for Tunisia, thereby marking the entry of Saudi Arabia as a new, major sulfur supplier to the world market. Total sulfur exports from Saudi Arabia were over 600,000 tons. An article was published that, for the first time, gave a comprehensive description of sulfur-producing facilities, examined the three marketing companies formed to export sulfur, and also discussed the likely markets for Saudi Arabian sulfur.[3]

U.S.S.R.—Construction was begun in 1982 on the first stage of a new industrial center based on the natural gas reserves near Astrakhan. The gas reportedly contains 25% hydrogen sulfide. According to plan, the first stage had a completion target to produce 2 million tons of sulfur in 1986. A second stage, which would double capacity, was under consideration. No target date for the second stage had been established.[4]

Table 18.—Sulfur: World production in all forms, by country and source[1]

(Thousand metric tons)

Country[2] and source[3]	1978	1979	1980	1981[p]	1982[e]
Algeria: Byproduct, petroleum and natural gas	15	15	14	15	10
Argentina:					
Native (from caliche)	18	--	--	10	10
Byproduct, all sources[e]	20	20	NA	NA	NA
Total	38	20	NA	10	10
Australia:[4]					
Pyrites[5]	93	29	29	30	30
Byproduct:					
Metallurgy[e 6]	140	140	140	140	145
Petroleum	10	11	11	11	12
Total	243	180	180	181	187
Austria:					
Byproduct:					
Metallurgy	9	10	9	9	9
Petroleum and natural gas	22	24	19	28	25
Gypsum	27	27	24	25	25
Total	58	61	52	62	59
Bahamas: Byproduct, petroleum[e]	5	5	5	5	5
Bahrain: Byproduct, petroleum	26	25	33	36	40
Belgium: Byproduct, all sources[e]	267	270	270	270	270
Bolivia:[7] Native	[8]14	[8]15	11	10	6
Brazil:[9] Byproduct, petroleum	57	92	131	102	100
Bulgaria:					
Pyrites[e]	310	315	300	300	300
Byproduct, all sources[e]	70	75	70	70	70
Total[e]	380	390	370	370	370
Canada:					
Pyrites[10]	5	12	12	10	20
Byproduct:					
Metallurgy	676	667	903	783	625
Natural gas	6,248	5,935	5,899	5,599	5,200
Petroleum[e]	200	200	160	160	160
Tar sands	118	213	286	247	259
Total	7,247	7,027	7,260	6,799	6,264
Chile:[7]					
Native:					
Refined	14	12	14	5	4
From caliche	18	65	74	110	105
Byproduct, metallurgy	[r]21	27	[e]27	[e]28	26
Total	[r]53	104	115	143	135
China:					
Native[e]	200	200	200	200	200
Pyrites[e]	[r]1,500	[r]1,500	1,700	1,800	1,800
Byproduct, all sources[e]	[r]200	[r]300	300	300	300
Total[e]	[r]1,900	[r]2,000	2,200	2,300	2,300
Colombia:					
Native	35	16	26	26	26
Byproduct, petroleum	3	2	1	2	2
Total	38	18	27	28	28
Cuba:					
Pyrites	[r]21	12	22	21	20
Byproduct, petroleum[e]	8	8	8	8	8
Total[e]	[r]29	20	30	29	28

See footnotes at end of table.

Table 18.—Sulfur: World production in all forms, by country and source[1] —Continued

(Thousand metric tons)

Country[2] and source[3]	1978	1979	1980	1981[p]	1982[e]
Cyprus:[11] Pyrites	55	21	25	7	5
Czechoslovakia:					
Native[e]	5	5	5	5	5
Pyrites[e]	60	60	60	60	60
Byproduct, all sources[e]	10	10	10	10	10
Total[e]	75	75	75	75	75
Denmark: Byproduct, petroleum	14	8	8	6	6
Ecuador:					
Native[e]	5	5	5	4	5
Byproduct:					
Natural gas[e]	5	5	5	5	5
Petroleum[e]	5	5	5	5	5
Total[e]	15	15	15	14	15
Egypt:[9] Byproduct, petroleum and natural gas	3	3	3	24	30
Finland:					
Pyrites	87	151	144	184	184
Byproduct:					
Metallurgy	232	263	247	234	234
Petroleum[e]	30	30	30	30	30
Total[e]	349	444	421	448	448
France:					
Byproduct:					
Natural gas[12]	1,900	1,940	[2]1,840	1,701	[13]1,668
Petroleum[12]	[2] [r]163	[r]188	226	221	283
Unspecified[14]	[e]160	[e]160	150	[e]120	150
Total	[r]2,223	[r]2,288	2,216	2,042	2,101
German Democratic Republic:					
Pyrites[e]	10	10	10	10	10
Byproduct, all sources[e]	350	350	350	350	350
Total[e]	360	360	360	360	360
Germany, Federal Republic of:					
Pyrites	221	203	222	213	200
Byproduct:					
Metallurgy[15]	380	450	450	[e]400	400
Natural gas[12]	650	690	814	834	900
Petroleum[12]	190	214	220	[e]200	185
Unspecified[14]	160	93	[e]93	[e]95	100
Total	1,601	1,650	1,799	1,742	1,785
Greece:					
Pyrites	61	63	61	60	60
Byproduct, petroleum[e]	3	3	4	7	8
Total[e]	64	66	65	67	68
Hungary:					
Pyrites[e]	3	3	3	3	3
Byproduct, all sources	9	9	9	9	9
Total[e]	12	12	12	12	12
India:					
Pyrites	26	[r]27	34	23	25
Byproduct:					
Metallurgy[e]	115	115	115	92	100
Petroleum	[r]8	[r]4	5	4	5
Total[e]	[r]149	[r]146	154	119	130

See footnotes at end of table.

Table 18.—Sulfur: World production in all forms, by country and source[1] —Continued

(Thousand metric tons)

Country[2] and source[3]	1978	1979	1980	1981[p]	1982[e]
Indonesia:[11] Native	(19)	(19)	(19)	1	1
Iran:					
Native[e]	150	75	70	50	50
Byproduct, petroleum and natural gas[e]	300	200	150	6	10
Total[e]	450	275	220	56	60
Iraq:					
Frasch	600	550	700	145	100
Byproduct, petroleum and natural gas[e]	40	r40	40	40	40
Total[e]	640	r590	740	185	140
Ireland: Pyrites	19	13	11	11	11
Israel: Byproduct, petroleum and natural gas[e]	10	10	10	10	10
Italy:					
Native	104	19	23	20	18
Pyrites	330	302	331	261	250
Byproduct, all sources[e 16]	250	250	250	263	220
Total	684	571	604	544	488
Japan:					
Pyrites	327	300	311	293	13276
Byproduct:					
Metallurgy[17]	1,296	1,350	1,300	1,200	1,200
Petroleum[18]	1,105	1,241	1,173	1,080	1,000
Total	2,728	2,891	2,784	2,573	2,476
Korea, North:					
Pyrites[e]	255	255	250	225	200
Byproduct, metallurgy[e]	10	10	10	10	10
Total[e]	265	265	260	235	210
Korea, Republic of:					
Byproduct:					
Metallurgy[e]	47	54	54	54	54
Petroleum[e]	34	36	36	36	36
Total[e]	81	90	90	90	90
Kuwait: Byproduct, petroleum and natural gas[e]	100	100	120	110	70
Libya: Byproduct, petroleum and natural gas[e]	19	20	22	16	20
Mexico:					
Frasch	1,650	1,773	1,700	1,652	131,391
Byproduct:					
Metallurgy[e]	100	100	115	100	100
Petroleum and natural gas	168	252	402	426	13425
Total[e]	1,918	2,125	2,217	2,178	1,916
Morocco: Pyrites	61	63	36	38	15
Namibia: Pyrites	3	4	4	8	58
Netherlands:					
Byproduct:					
Metallurgy[e]	60	r88	90	90	75
Petroleum[e]	r65	r70	52	55	50
Total[e]	r125	r158	142	145	125
Netherlands Antilles: Byproduct, petroleum	95	91	91	90	90
New Zealand: Byproduct, all sources[e]	1	1	(19)	(19)	(19)
Norway:					
Pyrites	150	119	193	e190	190
Byproduct:					
Metallurgy[e]	36	40	40	40	40
Petroleum[e]	7	6	6	6	6
Total[e]	193	165	239	236	236

See footnotes at end of table.

Table 18.—Sulfur: World production in all forms, by country and source[1] —Continued

(Thousand metric tons)

Country[2] and source[3]	1978	1979	1980	1981[p]	1982[e]
Pakistan:					
Native	1	1	1	([19])	1
Byproduct, all sources[e]	14	14	14	15	15
Total	15	15	15	15	16
Peru:					
Native	([19])	([19])	--	--	--
Byproduct, all sources	18	[e]20	[e]20	[e]20	20
Total	18	20	20	20	20
Philippines: Pyrites	52	41	54	46	30
Poland:[20]					
Frasch[e]	4,546	4,310	4,667	4,295	4,428
Native[e]	505	520	518	478	492
Byproduct:					
Metallurgy[e 21]	315	310	300	300	300
Petroleum[e 21]	35	35	30	30	30
Gypsum[e]	20	20	20	20	20
Total[e]	5,421	5,195	5,535	5,123	5,270
Portugal:					
Pyrites	136	151	155	135	130
Byproduct, all sources	1	1	2	2	2
Total	137	152	157	137	132
Romania:					
Pyrites[e]	400	400	400	400	400
Byproduct, all sources[e]	120	130	140	150	150
Total[e]	520	530	540	550	550
Saudi Arabia:					
Native[e]	1	1	1	NA	--
Byproduct: Petroleum and natural gas[e]	14	125	460	600	700
Total	15	126	461	600	700
Singapore: Byproduct, petroleum	[r]20	[r]20	20	10	10
South Africa, Republic of:					
Pyrites	219	243	493	502	500
Byproduct:					
Metallurgy[e]	100	100	100	100	80
Petroleum[e]	25	25	25	27	20
Total	344	368	618	629	[9]600
Spain:					
Pyrites	1,046	1,091	1,096	1,118	1,100
Byproduct:					
Metallurgy	117	120	125	135	125
Petroleum	10	10	12	12	10
Coal (lignite) gasification[e]	3	3	3	3	3
Total[e]	1,176	1,224	1,236	1,268	1,238
Sweden:					
Pyrites	233	282	249	249	249
Byproduct:					
Metallurgy[e]	130	130	130	130	130
Unspecified	[e]18	36	[e]40	[e]40	40
Total	381	448	419	419	419
Switzerland: Byproduct, petroleum	3	3	3	3	3
Syria: Byproduct, petroleum and natural gas	[e]6	[e]6	[e]5	8	8

See footnotes at end of table.

Table 18.—Sulfur: World production in all forms, by country and source[1] —Continued

(Thousand metric tons)

Country[2] and source[3]	1978	1979	1980	1981[p]	1982[e]
Taiwan:					
Pyrites	([19])	([19])	([19])	([19])	([19])
Byproduct, all sources	10	9	8	9	20
Total	10	9	8	9	20
Trinidad and Tobago: Byproduct, petroleum[4]	54	77	57	44	40
Turkey:					
Native	28	[e]30	30	30	30
Pyrites	[e]14	[e]14	21	24	25
Byproduct, all sources[e]	80	70	70	65	70
Total[e]	122	114	121	119	125
U.S.S.R.:					
Frasch[e]	800	800	800	800	800
Native[e]	[r]1,900	[r]1,900	2,000	2,050	2,050
Pyrites[e]	3,500	3,500	3,550	3,600	3,700
Byproduct:[e]					
Coal	40	40	40	40	40
Metallurgy	[r]1,700	[r]1,700	1,800	1,850	1,900
Natural gas	1,100	1,100	1,200	1,250	1,300
Petroleum	200	200	200	200	200
Total[e]	[r]9,240	[r]9,240	9,590	9,790	9,990
United Kingdom:					
Byproduct:					
Metallurgy	[r]44	[r]56	[e]50	[e]50	50
Spent oxides	5	[r]4	4	[e]4	4
Of petroleum refinery	[r]56	[r]53	[e]80	75	85
Total	[r]105	[r]113	[e]134	[e]129	139
United States:					
Frasch	5,648	6,357	6,390	6,348	[13]4,210
Pyrites	301	400	322	307	[13]265
Byproduct:					
Metallurgy	1,103	1,167	1,003	1,159	[13]828
Natural gas	1,753	1,760	1,757	1,971	[13]1,960
Petroleum	2,309	2,310	2,316	2,288	[13]2,444
Unspecified	61	107	78	72	[13]80
Total	11,175	12,101	11,866	12,145	[13]9,787
Uruguay: Byproduct, petroleum[e]	2	2	2	2	2
Venezuela: Byproduct, petroleum and natural gas	95	85	85	85	85
Yugoslavia:					
Pyrites and pyrrhotite	171	190	261	286	290
Byproduct:					
Metallurgy[e]	200	200	200	170	170
Petroleum[e]	5	5	5	4	3
Total	376	395	466	460	463
Zaire: Byproduct, metallurgy[e]	30	30	30	30	30
Zambia:					
Pyrites	1	1	([19])	([19])	([19])
Byproduct, all sources	109	74	92	90	90
Total	110	75	92	90	90
Zimbabwe:					
Pyrites	24	28	29	25	25
Byproduct, all sources[e]	5	5	5	5	5
Total[e]	29	33	34	30	30
Grand total	[r]52,138	[r]53,184	55,009	53,563	50,660

See footnotes at end of table.

Table 18.—Sulfur: World production in all forms, by country and source[1]—Continued

(Thousand metric tons)

Country[2] and source[3]	1978	1979	1980	1981[p]	1982[e]
Grand total—Continued					
Of which:					
Frasch	13,244	13,790	14,257	13,240	10,929
Native	[r]2,998	[r]2,864	2,978	2,999	3,003
Pyrites	[r]9,694	[r]9,803	10,388	10,439	10,431
Byproduct:					
Coal and coal gasification	43	43	43	43	43
Metallurgy	[r]6,861	[r]7,127	7,238	7,104	6,631
Natural gas	11,656	11,430	11,515	11,360	11,033
Petroleum	[r]4,747	[r]4,979	4,955	4,759	4,878
Petroleum and natural gas, undifferentiated	792	[r]880	1,330	1,368	1,433
Spent oxides	5	4	4	4	4
Tar sands	118	213	286	247	259
Unspecified sources	[r]1,933	[r]2,004	1,971	1,955	1,971
Gypsum	47	47	44	45	45

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.

[1]Table includes data available through May 25, 1983.

[2]In addition to the countries listed, a number of nations may produce limited quantities of either elemental sulfur or compounds (chiefly H_2S or SO_2) as a byproduct of petroleum, natural gas, and/or metallurgical operations, but output, if any, is not quantitatively reported, and no basis is available for the formulation of reliable estimates of output. Countries not listed in this table that may recover byproduct sulfur from oil refining include Albania, Bangladesh, Brunei, Burma, Costa Rica, Guatemala, Honduras, Jamaica, Malaysia, Nicaragua, Paraguay, and the People's Democratic Republic of Yemen. Albania and Burma may also produce byproduct sulfur from crude oil and natural gas extraction. No complete listing of other nations that may produce byproduct sulfur from metallurgical operations (including processing of coal for metallurgical use) can be compiled, but the total of such output is considered as small. Nations listed in this table that may have production from sources other than those listed are identified by individual footnotes.

[3]The term "source" reflects both the means of collecting sulfur and the type of raw material. Sources listed include the following: (1) Frasch recovery; (2) native, comprising all production of elemental sulfur by traditional mining methods (thereby excluding Frasch); (3) pyrites (whether or not the sulfur is recovered in the elemental form or as acid); (4) byproduct recovery, either as elemental sulfur or as sulfur compounds from coal gasification, metallurgical operations including associated coal processing, crude oil and natural gas extraction, petroleum refining, tar sand cleaning, and processing of spent oxide from stack-gas scrubbers; and (5) recovery from the processing of mined gypsum. Recovery of sulfur in the form of sulfuric acid from artificial gypsum produced as a byproduct of phosphatic fertilizer production is excluded because to include it would result in double counting. It should be noted that production of Frasch sulfur, other native sulfur, pyrites-derived sulfur, mined gypsum-derived sulfur, byproduct sulfur from extraction of crude oil and natural gas, and recovery from tar sands are all credited to the country of origin of the extracted raw material; in contrast, byproduct recovery from metallurgical operations, petroleum refineries, and spent oxides is credited to the nation where the recovery takes place, which in some instances is not the original source country of the crude product from which the sulfur is extracted.

[4]In addition, may produce limited quantities of byproduct sulfur from natural gas.

[5]Excluding sulfur content of auriferous pyrites, for which data are not available.

[6]Excluding sulfur recovered, if any, from processing copper concentrates.

[7]In addition, may produce limited quantities of byproduct sulfur from crude oil and natural gas and/or from petroleum refining.

[8]Exports; regarded as tantamount to production owing to minimal domestic consumption levels.

[9]In addition, may produce limited quantities of byproduct sulfur from metallurgical operations and/or coal processing.

[10]Byproduct pyrite and pyrrhotite from the processing of metallic sulfide ores.

[11]In addition, may produce limited quantities of byproduct sulfur from oil refining.

[12]Elemental byproduct recovered sulfur only; sulfur recovered as SO_2, H_2S, and/or other compounds is included under "Unspecified."

[13]Reported figure.

[14]Comprises all byproduct sulfur recovered in the form of compounds including that, if any, recovered from petroleum and natural gas operations, as well as total recovery from metallurgical operations.

[15]Includes only the elemental sulfur equivalent of sulfuric acid produced as byproduct from metallurgical furnaces; additional output may be included under "Unspecified."

[16]Includes recovery from gypsum, if any.

[17]Includes sulfur recovered from ore concentrates of pyrrhotite, copper, lead, and zinc from domestic and foreign sources by metallurgical facilities.

[18]Includes sulfur recovered from petroleum refining only.

[19]Less than 1/2 unit.

[20]Official Polish sources report total mined elemental sulfur output annually; this figure has been divided between Frasch and other native sulfur on the basis of information obtained from supplementary sources. Therefore, although both numbers are estimates, the total is not an estimate. Estimates for production of byproduct and gypsum-derived sulfur are based on officially published data on sulfuric acid production and additional information from unofficial sources.

[21]Estimates reported under "Metallurgy" represent byproduct recovery in the form of compounds (principally sulfuric acid) from all sources (including coal and fertilizer plants); estimates reported under "Petroleum" represent only elemental sulfur recovery from petroleum, with any recovery in the form of compounds included under "Metallurgy."

TECHNOLOGY

Presentation of 66 papers at an international conference included a review of worldwide and regional supply and markets for sulfur; descriptions of sulfur handling, forming, and transportation; descriptions of recent developments in treating tail gas from natural gas processing plants; agricultural uses and response of crops to sulfur additions to soils; and uses of sulfur concretes.[5]

An article discussing new processes to enhance sulfur removal from sour natural gas was published.[6] Chemical reactions in the troposphere and photochemical reactions of major and trace elements were discussed, including the sulfur cycle.[7]

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[1]Physical scientist, Division of Industrial Minerals.

[2]Sulphur (London). West Germany as a Brimstone Supplier. No. 161, July-August 1982, pp. 18-21.

[3]———. The Market for Saudi Arabian Sulphur. No. 159, March-April 1982, pp. 20-25.

[4]———. No. 162, September-October 1982, pp. 14, 16.

[5]More, A. I. (ed.). Conference Proceedings. Sulphur '82. The British Sulphur Corp. Ltd., London, p. 586.

[6]Hyne, J. B. Getting Sulfur Out of Gas. Chem. Tech., v. 12, No. 10, October 1982, pp. 628-637.

[7]Chamliders, W. L., and D. D. Davis. Special Report. Chem. and Eng. News, v. 66, No. 46, Oct. 4, 1982, pp. 39-52.

Talc and Pyrophyllite

By Robert A. Clifton[1]

Total domestic production of talc and pyrophyllite combined declined by 15% in 1982 because of decreased demand in all end-use categories except roofing. Exports of talc decreased by 25% from that of 1981.

Domestic Data Coverage.—Domestic production data for talc and pyrophyllite were developed by the Bureau of Mines from a voluntary survey of 41 known operating mines in 1982. All 41 mines responded, and the production figures shown in table 1 represented 100% of U.S. production.

Table 1.—Salient talc and pyrophyllite statistics

(Thousand short tons and thousand dollars)

	1978	1979	1980	1981	1982
United States:					
Mine production, crude:					
Talc	1,268	1,268	1,127	1,236	1,049
Pyrophyllite	116	185	113	107	87
Total	1,384	1,453	1,240	1,343	[1]1,135
Value:					
Talc	$14,956	$19,365	$25,247	$30,660	$26,105
Pyrophyllite	811	998	837	837	1,131
Total	15,767	[1]20,364	26,084	31,497	27,236
Sold by producers, crude and processed:					
Talc	1,155	1,119	1,173	1,115	915
Pyrophyllite	116	195	158	106	110
Total	1,271	1,314	1,331	1,221	1,025
Value:					
Talc	$68,781	$80,529	$84,523	$95,354	$82,104
Pyrophyllite	2,804	4,413	4,254	3,454	3,557
Total	71,585	84,942	88,777	98,808	85,661
Exports[2] (talc)	267	316	275	311	232
Value	$12,359	$15,210	$14,963	$15,095	$12,957
Imports for consumption (talc)	19	22	21	[3]27	[3]27
Value	$1,946	$2,822	$3,720	[3]$4,562	[3]$5,215
Apparent consumption	1,023	1,020	1,077	937	820
World: Production	7,051	[r]7,579	8,300	[p]7,955	[e]7,595

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Data do not add to total shown because of independent rounding.
[2]Excludes powders—talcum (in package), face, and compact.
[3]Does not include imported pyrophyllite.

Legislation and Government Programs.—The national stockpile inventory of steatite, block or lump, remained at a reported 1,092 short tons at the end of 1982. This still far exceeded the goal of 28 tons. The inventory of ground steatite, with a goal of zero, remained at 1,089 tons.

The allowable depletion rates established under the Tax Reform Act of 1969 remained at 22% for domestic block steatite and 14% for foreign through 1982.

U.S. import duties on talc minerals from most favored nations follow: crude and unground, 0.02 cent per pound; ground, washed, powdered, and/or pulverized, 4.2% ad valorem; cut, sawed, or in blanks, crayons, cubes, disks, or other forms, 0.1 cent per pound; other not specifically provided for, 6% ad volorem.

Mining regulations promulgated by the National Park Service under the Mining in the Parks Act, which expired in 1980, were the object of a petition by four interested mining companies. The industry petition asked for a number of rule changes, among which were the following:

1. Allow claimholders to establish "mineral resource areas" in Death Valley that would "allow claimholders operating within these designated mineral resource areas to conduct surface operations outside the boundaries of their claim, providing certain conditions are met."

2. Limit application of the rules to Federal lands, allowing unrestricted mining activity on State and private inholdings within national parks. At present, the rules apply to inholdings as well as the public land portions of parks.

3. Eliminate separate standards for operations associated with unpatented claims or claims patented with surface-use restrictions where the surface has not been disturbed.

4. Knock out the requirement to "restore" the area to "a condition equivalent to its pristine beauty." The prospector would simply have to "reclaim" the area.

The National Park Service asked for comments on the petition in the June 1, 1982, Federal Register but had taken no action by yearend. Two of the petitioning companies affected by the rules were talc producers in Death Valley.

DOMESTIC PRODUCTION

Talc.—U.S. mine production of crude talc decreased 15% in tonnage and 15% in value from that of 1981. Talc, including soapstone, was produced at 35 mines in 11 States in 1982. California's 13 mines were by far the largest number for any State. Mines in Montana, New York, Texas, and Vermont produced about 88% of domestic talc in 1982. Montana led all States in value of talc produced.

The seven largest domestic producers of talc in 1982, listed alphabetically, were Cyprus Industrial Mineral Co., with mines in California, Montana, and Texas; Eastern Magnesia Talc Co. in Vermont; Pfizer, Inc., Minerals, Pigments & Metals Div., in California and Montana; Southern Clay Products, Inc., in Texas; Texas Talc Co., in Texas; R. T. Vanderbilt Co., Inc., in New York; and Windsor Minerals, Inc., in Vermont.

Pyrophyllite.—The pyrophyllite-producing mines were in North Carolina and California in 1982. Total production decreased 19% during 1982. Four companies operated six mines during the year.

Table 2.—Crude talc and pyrophyllite produced in the United States, by State

(Thousand short tons and thousand dollars)

State	1981 Quantity	1981 Value	1982 Quantity	1982 Value
California	111	5,867	85	1,699
Georgia (talc)	26	182	20	141
Montana (talc)	324	13,383	W	W
North Carolina	104	825	83	1,266
Texas (talc)	282	4,127	205	3,024
Other[1] (talc)	496	7,113	742	21,106
Total	1,343	31,497	1,135	27,236

W Withheld to avoid disclosing company proprietary data, included with "Other."

[1]Includes Arkansas, New York, Oregon, Vermont, Virginia, and Washington.

CONSUMPTION AND USES

Apparent domestic consumption of crude and processed talc and pyrophyllite decreased by 12% in 1982. Sales of talc and pyrophyllite declined in tonnage and value.

The 1982 end-use distribution showed 34% of the ground talc in ceramics, 20% in paint, 11% in roofing, 9% in paper, 6% in plastics, 5% in cosmetics, 2% in rubber, 1% in insecticides, with the remainder going to other uses.

The largest portion, 26%, of domestically produced ground pyrophyllite was used in refractories, 24% was used in ceramics, 22% in insecticides, 12% in roofing, and the remainder in other uses. A significant amount of imported pyrophyllite was ground for use in the ceramics industry.

Table 3.—End uses for ground talc and pyrophyllite

(Thousand short tons)

Use	1981			1982		
	Talc	Pyrophyllite	Total	Talc	Pyrophyllite	Total
Ceramics	375	12	387	292	20	312
Cosmetics[1]	75	--	75	45	--	45
Insecticides	13	29	42	7	19	26
Paint	206	1	207	170	1	171
Paper	88	--	88	79	--	79
Plastics	111	--	111	54	1	55
Refractories	2	39	41	2	22	24
Roofing	26	9	35	94	10	104
Rubber	36	--	36	21	1	22
Other[2]	50	17	67	83	11	94
Total	982	107	1,089	847	85	932

[1]Incomplete data. Some cosmetic talc known to be included in "Other."

[2]Includes art sculpture, asphalt filler and coatings, crayons, floor tile, foundry facings, rice polishing, stucco, and other uses not specified.

PRICES

Talc prices varied over a wide range depending on the quality and degree and method of processing. In general, prices remained steady during 1982, except for foreign exchange fluctuation. Engineering & Mining Journal, December 1982, quoted prices for domestic talc per short ton as follows:

New Jersey:	
Mineral pulp, bags extra	$18.50- $20.50
Vermont:	
98% through 325 mesh, bulk	64.00
99.99% through 325 mesh, bags:	
Dry processed	136.00
Water beneficiated	213.00-228.00
New York:	
96% through 200 mesh	58.00- 64.00
98% to 99.25% through 325 mesh	73.00- 75.00
100% through 325 mesh, fluid-energy ground	150.00
California:	
Standard	69.50
Fractionated	37.00- 71.00
Micronized	62.00-104.00
Cosmetic steatite	44.00- 65.00
Georgia:	
98% through 200 mesh	40.00
99% through 325 mesh	50.00
100% through 325 mesh, fluid-energy ground	100.00

American Paint & Coatings Journal, December 20, 1982, listed the following prices per short ton for paint-grade talc in carload lots:

California:	
Bags, mill:	
White, Hegman No. 3-3-1/2	$103.00
Hegman No. 4-5	129.00
Montana: Ultrafine grind, f.o.b. mill	145.00
New York:	
Nonfibrous, bags, mill:	
98% through 325 mesh	78.00
99.6% through 325 mesh	91.00
Trace retained on 325 mesh	146.00

The approximate equivalents, in dollars per short ton, of the price ranges quoted in Industrial Minerals (London), December 1982, for steatite talc, c.i.f. main European ports, were as follows:

Australian, cosmetic (ex store)	$160-$174
Norwegian:	
Ground (ex store)	109- 116
Micronized (ex store)	145- 203
French, fine-ground	121- 298
Italian, cosmetic-grade	239
Chinese, normal (ex store):	
UK 200 mesh	174- 177
UK 300 mesh	181- 189

FOREIGN TRADE

Exports.—Talc exports decreased 25% during 1982. The total value of exported talc decreased 14%, and the average price was $56 per ton. The value received for talc exported in 1982 varied between $30 per ton for material shipped to Mexico and a reported $500 per ton for material sent to Costa Rica.

Mexico remained the major importer of U.S. talc, accounting for 44% of the tonnage in 1982, followed by Canada, 27%; Belgium-Luxembourg, 8%; and Japan, 4%. Canada, however, continued to lead in value with 32% of the total compared with Mexico's 24%. A total of 53 countries imported U.S. talc in 1982.

Imports.—U.S. imports of talc decreased 2% in 1982. The average value of these imports was $197 per ton. Cosmetic grades accounted for the high prices. Imports from Canada increased by 50%. Canada, with 40% of the total, became the leading source of imported talc, followed closely by Italy with 35%. Imports from France decreased by 93%.

Table 4.—U.S. exports of talc[1]

(Thousand short tons and thousand dollars)

Year	Belgium-Luxembourg		Canada		Japan		Mexico		Other		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1978	20	1,106	55	3,734	19	1,304	133	2,274	40	3,941	267	12,359
1979	18	1,043	60	4,485	19	1,145	164	3,539	55	4,998	316	15,210
1980	24	1,412	68	4,960	13	957	161	3,648	9	3,986	275	14,963
1981	17	1,364	79	4,632	9	500	164	4,256	42	4,343	311	15,095
1982	18	1,263	63	4,208	9	439	102	3,083	40	3,964	232	12,957

[1]Excludes powders—talcum (in package), face, and compact.

Table 5.—U.S. imports for consumption of talc, by class and country

Year and country	Crude and unground		Ground, washed, powdered, or pulverized		Cut and sawed		Total unmanufactured	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value[1] (thousands)
1980	14,045	$1,818	5,383	$717	1,172	$1,185	20,600	$3,720
1981:								
Canada	--	--	6,922	882	87	96	7,009	978
France	5,678	472	403	73	--	--	6,081	545
Italy	2,921	543	7,393	728	--		10,314	1,271
Japan	--	--	19	17	693	899	712	916
Korea, Republic of	1,718	216	326	62	189	109	2,233	387
Other[2]	76	23	91	56	487	386	654	465
Total	10,393	1,254	15,154	1,818	1,456	1,490	[3]27,003	[3]4,562
1982:								
Canada	22	5	10,374	1,508	131	187	10,527	1,700
France	--	--	408	70	--	--	408	70
Italy	9,039	1,722	139	43	2	3	9,180	1,768
Japan	--	--	23	42	270	352	293	394
Korea, Republic of	--	--	1,426	312	164	94	1,590	406
Other[4]	42	7	3,799	520	664	350	4,505	877
Total	9,103	1,734	16,169	2,495	1,231	986	[3]26,503	[3]5,215

[1]Does not include talc, n.s.p.f.; 1980—$1,292,902; 1981—$1,271,884; and 1982—$1,049,090.
[2]Includes Austria, China, Costa Rica, the Federal Republic of Germany, Hong Kong, India, Kenya, and Taiwan.
[3]Does not include imported pyrophyllite.
[4]Includes Australia, Brazil, China, India, Israel, Switzerland, and Taiwan.

WORLD REVIEW

The United States remained the world's largest talc producer, and Japan remained the largest pyrophyllite producer during 1982. They still shared 36% of the world's talc and pyrophyllite production. A survey of the world's talc supply and demand was reported in a trade magazine,[2] which reported good growth in the industry for the 10-year period 1972-81, particularly during the second half of this period.

Table 6.—Talc and pyrophyllite: World production, by country[1]

(Short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Afghanistan[3]	1,957	551	--	--	--
Argentina (talc, steatite, pyrophyllite)	51,601	38,390	36,080	39,925	[4]43,270
Australia	161,989	[r]173,586	188,455	96,721	94,000
Austria (unground talc)	117,780	[r]128,331	128,648	128,336	128,000
Botswana	345	115	([5])	([5])	([5])
Brazil (talc and pyrophyllite)[6]	287,174	402,870	455,316	[e]501,000	423,000
Burma	431	434	263	153	154
Canada (shipments)	67,970	99,572	95,901	98,100	79,000
Chile	476	937	1,256	733	700
China[e]	165,000	165,000	1,010,000	990,000	990,000
Colombia	4,762	6,708	[e]6,700	[e]6,700	6,700
Egypt	6,509	4,857	4,417	[e]4,410	4,960
Finland	215,126	294,515	350,425	339,418	330,700
France (ground talc)	322,646	333,416	332,435	340,911	336,000
Germany, Federal Republic of (marketable)	17,026	16,519	17,085	17,021	17,000
Greece (steatite)	[r]2,019	[r]5,635	1,609	[e]1,540	1,650
Hungary[e]	19,300	19,300	19,300	19,300	18,700
India	371,349	426,272	407,366	405,175	386,000
Italy (talc and steatite)	184,901	173,484	182,879	180,457	176,000
Japan[7]	1,868,333	1,883,698	1,927,718	1,703,125	[4]1,638,136
Korea, North[e]	165,000	175,000	185,000	185,000	185,000
Korea, Republic of (talc and pyrophyllite)	733,128	857,825	792,752	622,383	660,000
Mexico	2,909	8,637	11,120	12,312	11,000
Nepal[8]	562	358	1,609	78	110
Norway	106,611	[r]96,436	96,601	[e]94,000	94,000
Pakistan (pyrophyllite)	27,877	29,983	33,069	27,554	27,600
Paraguay	176	231	276	165	220
Peru (talc and pyrophyllite)	9,820	17,604	[e]16,200	[e]16,200	16,200
Philippines	4,476	3,935	951	492	550
Portugal	1,884	3,006	2,864	3,871	3,300
Romania[e]	72,800	66,100	66,100	66,100	66,100
South Africa, Republic of[9]	13,940	16,806	15,836	16,674	[4]15,226
Spain (steatite)	68,224	78,316	81,515	76,134	72,000
Sweden	23,503	19,562	3,307	4,400	4,400
Taiwan	10,964	12,339	10,925	27,309	33,000
Thailand (talc and pyrophyllite)	16,411	14,927	12,926	13,266	13,200
U.S.S.R.[e]	520,000	530,000	540,000	550,000	560,000
United Kingdom	19,842	18,298	19,000	19,800	19,800
United States (talc and pyrophyllite)	1,383,752	1,452,733	1,240,427	1,342,916	[4]1,135,415
Uruguay	1,900	[e]1,980	2,432	[e]1,870	2,200
Zambia	[e]110	--	284	1,015	990
Zimbabwe	836	1,179	503	425	380
Total	[r]7,051,419	[r]7,579,445	8,299,550	7,954,989	7,594,661

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through May 11, 1983.
[2]In addition to the countries listed, Czechoslovakia produces talc, but available information is inadequate to make reliable estimates of output levels.
[3]Data are for calendar year beginning Mar. 20 of that stated.
[4]Reported figure.
[5]Revised to zero.
[6]Total of beneficiated and salable direct shipping production of talc and pyrophyllite.
[7]Includes talc, pyrophyllite, and pyrophyllite clay.
[8]Data based on Nepalese fiscal year, beginning mid-July of year stated.
[9]Includes talc and wonderstone.

Canada.—Two articles in 1982 stressed the Ontario Government's willingness to aid its talc industry.[3] The first reported that Canada Talc Industries Ltd. was to receive up to Can$657,000 to expand production facilities at Madoc, Ontario. The second reported that Steetley Talc, Ltd., had been offered up to Can$940,000 to improve and expand its operation at Timmins, Ontario.

China.—By selective mining, rigid quality control, and analytical proof of purity, Chinese talc had been upgraded and was reportedly reentering the European cosmetic talc market.[4] Haichen Cosmetic Talc Ltd., was the merchandising firm in London.

Finland.—An article in an industry publication described the Finnish talc industry in detail.[5] In the 13 years 1968-80, the industry grew more than tenfold in an effort to reduce dependence upon foreign fillers for its paper industry. The Lahnaslampi Mine was opened in 1969 by Suomen Talkki Oy in central Finland and has produced as much as 180,000 tons per year. The Vuonos plant of Oy Lohja has a capacity of 150,000 tons per year and was opened in 1977. The last of Finland's three larger producers began production in 1979. The Luikonlahti Mine of Myllykoski Oy has a capacity of 50,000 tons per year, but this is being doubled.

Italy.—Società Talco e Grafite Val Chisone procured ownership, through a subsidiary Talcosarda, of the Sardinian talc mining concession closed by Società Industriale e Mineraria in 1978-79. Talcosarda planned to produce 65,000 tons per year of talc at the site.

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[1]Physical scientist, Division of Industrial Minerals.
[2]Industrial Minerals (London). No. 183, December 1982, pp. 59-78.
[3]———. No. 178, July 1982, p. 10.
———. No. 182, November 1982, p. 10.
[4]———. No. 175, April 1982, p. 19.
[5]Watson, I. The Industrial Minerals of Finland. Ind. Miner. (London), No. 173, February 1982, pp. 23-27.

Thorium

By James B. Hedrick[1]

Domestic mine production of monazite, the principal source of thorium, increased in 1982. Associated Minerals Ltd., Inc., was the only domestic monazite producer. Most of the thorium products used by the domestic industry during 1982 were imported or produced in the United States from imported materials or from existing company and Government stocks. W. R. Grace & Co. and Rhône-Poulenc Inc. were the principal processors of thorium in the United States.

Major nonenergy end uses were in aerospace, mantles for incandescent gaslamps, welding rods, electronics, and refractory applications. The only commercial thorium-fueled nuclear reactor in the United States, located at Fort St. Vrain, Colo., operated at 37% of its electrical power capacity in 1982. The experimental thorium-fueled, light-water breeder reactor at Shippingport, Pa., ceased operation in October 1982 and was being decommissioned. Spent fuel from the reactor was to be examined to determine breeding performance.

Domestic Data Coverage.—Domestic mine production data for thorium are developed by the Bureau of Mines from one voluntary survey of U.S. operations. This is the Rare Earths and Thorium survey. Of the one mine to which a survey request was sent, response was 100%, representing an estimated 100% of total production. The production data are withheld to avoid disclosing company proprietary data.

Table 1.—Companies with thorium processing and fabricating capacity

Company	Plant location	Operations and products
Atomergic Chemetals Corp	Plainview, N.Y	Produces oxide, fluoride, metal.
Bettis Atomic Power Laboratory	West Mifflin, Pa	Nuclear fuels, Government research and development.
Cerac, Inc	Milwaukee, Wis	Produces ceramics.
Ceradyne, Inc	Santa Ana, Calif	Produces advanced technical ceramics.
Chicago Magnesium Casting Corp	Blue Island, Ill	Magnesium-thorium alloys.
Coleman Company Inc	Wichita, Kans	Produces thoriated mantles.
Consolidated Aluminum Corp	Madison, Ill	Magnesium-thorium alloys.
Controlled Castings Corp	Plainview, N.Y	Do.
General Atomic Co	San Diego, Calif	Nuclear fuels.
W. R. Grace & Co	Chattanooga, Tenn	Produces thorium-containing residues from monazite.
GTE Sylvania	Towanda, Pa	Produces thoriated welding rods.
Hitchcock Industries, Inc	South Bloomington, Minn	Magnesium-thorium alloys.
NLO Inc	Cincinnati, Ohio	Produces compounds and metals; manages DOE thorium stocks.
Phillips Elmet	Lewistown, Maine	Produces thoriated welding rods.

Table 1.—Companies with thorium processing and fabricating capacity —Continued

Company	Plant location	Operations and products
Rhône-Poulenc Inc	Freeport, Tex	Produces thorium nitrate from an intermediate compound of monazite.
Teledyne Cast Products	Pomona, Calif	Magnesium-thorium alloys.
Teledyne Wah Chang	Huntsville, Ala	Produces thoriated welding rods.
Union Carbide Corp., Nuclear Div	Oak Ridge, Tenn	Nuclear fuels, test quantities.
Wellman Dynamics Corp	Creston, Iowa	Magnesium-thorium alloys.
Westinghouse Electric Corp	Bloomfield, N.J	Produces thorium-containing lighting and metallic thorium.

Legislation and Government Programs.—Government stocks of thorium nitrate in the National Defense Stockpile were unchanged during 1982 at 3,234,936 kilograms.[2] There were no acquisitions, sales, or shipments from the stockpile during the year. The stockpile goal of 272,155 kilograms was unchanged.

DOMESTIC PRODUCTION

Associated Minerals, a subsidiary of the Australian-owned firm Associated Minerals Consolidated Ltd. (AMC), produced monazite from a minerals sands dredging operation at Green Cove Springs, Fla. Associated Minerals was the only company in the United States to produce monazite in 1982.

Rhône-Poulenc and W. R. Grace, Davison Chemical Div., were the only domestic processors of monazite or the intermediate concentrate, a rare earth-thorium hydroxide compound. Other processing firms listed in table 1 processed imported and domestic finished compounds and metals.

W. R. Grace processed monazite at its Chattanooga, Tenn., facilities to produce rare-earth catalysts and compounds. Although thorium was extracted from monazite, no thorium compounds were produced for sale. W. R. Grace's thorium residues, stored at its plantsite, contained about 5,316 metric tons of thorium oxide equivalent at yearend 1982.

Rhône-Poulenc, a subsidiary of the French-owned Rhône-Poulenc Group, separated rare earth-thorium hydroxides derived from imported monazite at its Freeport, Tex., plant to produce rare-earth products. Thorium nitrate was produced as a byproduct.

CONSUMPTION AND USES

Domestic thorium processors consumed an estimated 77 tons of equivalent thorium oxide in 1982 in energy and nonenergy uses.

The distribution of nonenergy uses for thorium was estimated as follows: refractory applications and associated research, 51%; aerospace alloys, 22%; lamp mantles, 20%; welding rods, 3%; and other applications and research, 4%.

Thorium used in metallurgical applications was primarily alloyed with magnesium. Adding thorium to magnesium imparts high strength and excellent creep resistance at elevated temperatures, properties that are useful in aircraft and aerospace applications. Small quantities were used in dispersion-hardened alloys for high-strength, high-temperature applications.

Thorium oxide (thoria) has the highest melting point of all the oxides, 3,300° C, and is used in several refractory applications, including high-technology ceramics, investment molds, crucibles, and experimental stage core-retention beds for nuclear reactors.

Mantles for incandescent gaslamps are coated with thorium nitrate. The nitrate is converted to an oxide when burned and produces an intense white light when heated in a gas flame.

Thorium nitrate is also used to produce thoriated tungsten welding electrodes. The addition of thorium improves the flow of electrons through the welding rod.

Other nonenergy uses for thorium were in electron tubes, special-use lighting, catalysts, and high-refractive glass.

An energy-related use for thorium is as a nuclear fuel using the thorium-uranium-233 fuel cycle. In the reactor process, fission of uranium-233 produces neutrons that are absorbed by thorium-232 creating additional uranium-233. If more uranium-233 exists after operation of the reactor than was initially loaded, it becomes a breeder reactor.

STOCKS

On December 31, 1982, the stockpile of the General Services Administration contained 1,547,043 kilograms of thorium oxide equivalent contained in thorium nitrate, the same as at the end of 1981. The thorium nitrate stockpile goal was 130,153 kilograms of thorium oxide equivalent.

The U.S. Department of Energy (DOE) inventory at the end of fiscal year 1982[3] was 1,234,622 kilograms of thorium oxide equivalent contained in various forms. The inventory consists of 512,055 kilograms of equivalent thorium oxide in several high-grade usable forms and 722,567 kilograms of equivalent thorium oxide in low-grade residues that would require further processing.

According to DOE, the total amount of thorium stored in the United States at the end of 1982 was 4,264,372 kilograms, expressed as equivalent thorium oxide.

PRICES

The average declared value of imported monazite increased slightly during 1982 to $426 per ton, $3 per ton more than the 1981 value. The price of Australian monazite (minimum 60% rare-earth oxide including thoria, f.o.b.-f.i.d.),[4] as quoted in Metal Bulletin (London), increased from $A380 to $A430 (US$429 to US$485)[5] per ton at yearend 1981 to $A400 to $A440 (US$392 to US$432)[6] per ton by yearend 1982. Although the Australian yearend price quoted for monazite increased in 1982, fluctuations in the foreign exchange rate caused the U.S. dollar price to decrease. The 1982 yearend price for monazite based on its thorium oxide content was approximately $5.60 to $6.17 per kilogram of thorium oxide contained.

Rhône-Poulenc quoted thorium product prices, per kilogram, net 30 days, f.o.b. New Brunswick, N.J., or duty paid at point of entry, effective January 1, 1982, as follows: thorium oxide—99% purity, $24.50; 99.99% purity, $43.00; catalyst grade, $44.60; and lamp grade, $53.20. Mantle-grade thorium nitrate was quoted at $10.60 per kilogram of thorium oxide equivalent of the contained thorium.

FOREIGN TRADE

For the third consecutive year, France received all of the domestic shipments of thorium ore.

Exports of thorium metal including wrought, unwrought, waste, and scrap increased 54% compared with 1981 shipments. For the years 1980, 1981, and 1982, major destinations for the thorium metal and alloys were Canada (28%), Israel (24%), and the United Kingdom (13%).

Imports of thorium ore in 1982 decreased 4% from the 1981 level. Monazite from Australia typically contained about 7% thorium oxide, and the slightly richer Malaysian ore contained about 8%.

Table 2.—U.S. foreign trade in thorium and thorium-bearing materials

(Quantity in kilograms unless otherwise specified)

	1980		1981		1982		Principal sources and destinations, 1982
	Quantity	Value	Quantity	Value	Quantity	Value	
EXPORTS							
Thorium ore, monazite	3,129	$17,226	129,403	$146,421	91,508	$103,356	France 91,508.
Metals[1]	1,203	61,321	195	10,639	301	17,690	United Kingdom 217; Japan 45; Other 39.
IMPORTS							
Ore and concentrate:							
Thorium ore, monazite ___ metric tons	5,147	1,849,767	[r]7,469	[r]3,158,167	7,203	3,070,006	Australia 6,600; Malaysia 603.
ThO_2 content	[r]362,510	XX	[r]522,830	XX	510,240	XX	
Compounds:							
Nitrate	27,198	210,219	28,192	258,327	15,202	160,243	France 14,449; Canada 753.
Oxide	9,324	144,038	18,348	377,164	13,787	307,058	France 9,385; Netherlands 3,703; Canada 699.
Oxide equivalent, in gas mantles[e 2]	1,684	677,642	1,200	556,894	1,846	731,233	Malta 1,664; Brazil 98; China 56; Other 28.
Other	227	65,478	302	106,538	326	75,593	United Kingdom 204; Switzerland 122.
Metals and alloys	2,130	248,835	2,135	225,888	4,082	NA	United Kingdom 4,082.

[e]Estimated. [r]Revised. NA Not available. XX Not applicable.
[1]Unwrought, wrought, waste, and scrap.
[2]Based on the manufacture of 2,205 gas mantles per kilogram ThO_2.

WORLD REVIEW

The principal source of the world's thorium is monazite, a byproduct of minerals sands mined for titanium and zirconium in many countries and for tin in Malaysia and Thailand. Monazite was also recovered as a byproduct of fluorspar mining in the Republic of South Africa. Australia, India, Brazil, and Malaysia were the leading producers among the market economy countries in 1982. Government restrictions requiring the removal of thorium from monazite before export continued in India and Brazil. Australia was the only major producer without domestic processing capabilities beyond the concentrating stage at the mine. Monazite production quantities do not reflect world demand for thorium because monazite is processed almost entirely for its rare-earth content.

Australia.—Australia's largest minerals sands production, including monazite, came from the State of Western Australia. The States of Queensland and New South Wales also produced monazite. Production of monazite for the first half of 1982 was 4,991 tons.

Legislation enacted because of environmental concerns by the government of New South Wales curtailed minerals sands mining in newly created parks at yearend. The only exception was the Bridge Hall deposit, which was scheduled to close by mid-1983.[7]

The Minerals Sands Producers Association considered the increasing restrictions excessive in view of improved environmental controls and land rehabilitation programs.

Australia's Bureau of Mineral Resources reported that 70% of Australia's demonstrated economic resources would be depleted by the turn of the century, based on known deposits and projected output.[8] Minerals sands reserves may be depleted sooner because substantial reserves have been withdrawn from mining based on environmental and other considerations.[9] Australia has produced 102,000 tons of monazite since 1950. The latest estimate by the Bureau of Mineral Resources for demonstrated economic resources of Australian monazite was 334,000 tons.

The U.S. Department of State denied assistance to Dillingham Corp., a U.S. company, in its claim for compensation from the Australian Government for halting minerals sands mining on Fraser Island, Queensland, stating that it was a private matter between Dillingham and the Australian Government. Dillingham indicated that it is prepared to take its case to the International Court of Justice if necessary.[10]

The Australian Railways Union banned the handling of monazite, which contains slightly radioactive thorium, because of what the union considered to be insufficient safeguards on its use, specifically in France and the Federal Republic of Germany.[11] Employees at the Transport Workers Union have agreed to move the monazite by road based on health assurances by Allied Eneabba Ltd., which mines the minerals sands at Yeelirrie, Western Australia.

The Australian Waterside Workers Federation also refused to handle monazite. Their ban, however, was lifted and shipments resumed after safeguards were initiated. Union workers were instructed to wear badges to monitor radiation levels during transport.[12]

Mineral Deposits Ltd. reportedly relinquished prospecting rights over a large area of Moreton Island, Queensland, despite indications of the existence of a minerals sands ore body. More than one-half of the total area of the island is available for declaration as a national park.[13]

AMC, a subsidiary of Renison Goldfields Consolidated Ltd. (RGC), was undergoing a major reorganization, reportedly because of weak markets and escalating costs in minerals sands production. According to RGC's annual report, production has been cut back at Capel, Western Australia, and North Stradbroke Island, Queensland. In addition, mining operations at Medowie and Jerusalem Creek, New South Wales, and processing operations at Hexham, New South Wales, and Southport, Queensland, were closed. Capital for improvements was planned for facilities at Eneabba, Western Australia, and Green Cove Springs, Fla. (United States). AMC's head office was moved to new facilities in Perth, Western Australia.

Brazil.—According to Anuário Mineral Brasileiro 1981, measured reserves of monazite in Brazil total 30,212 tons. The largest reserves, 22,295 tons, are located in the São João de Barra region in the State of Rio de Janeiro. Monazite production in 1980 was 2,082 tons from the State of Rio de Janeiro and 450 tons from the State of Espírito Santo.

China.—Monazite was reportedly being mined in Jiangxi Province. Concentrates were produced at plants at Longnan and Xunwu. Monazite deposits were also reported in Guangdong Province.[14]

India.—Indian Rare Earths Ltd. produced monazite from 429,500 tons of raw sand mined in 1981-82.[15] Construction work at the company's new Orissa Sands Complex in Orissa was in an advanced phase. Annual monazite capacity at Orissa will reportedly be 4,000 tons. Problems with the fabrication contractors were cited as the cause for delayed completion of the complex.[16]

Malaysia.—The Malaysia Mining Corp. (MMC) reportedly has the capacity to produce 1,500 tons of monazite per year from its operations in Perak and Selangor States in West Malaysia.[17] The Berjuntai Tin Dredging Bhd. mine in the State of Selangor is owned by MMC. Dredged concentrate at the mine had an average monazite content of 2.0% by weight.[18]

Table 3.—Monazite concentrate: World production, by country[1]

(Metric tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Australia	14,992	16,340	14,079	13,251	13,100
Brazil	[r]2,541	[r]1,900	2,532	2,200	2,000
India[3]	3,303	3,254	3,395	3,704	4,000
Malaysia[4]	[r]1,254	[r]542	347	320	450
Sri Lanka	213	213	63	[e]60	60
Thailand	--	32	152	[e]150	100
United States	W	W	W	W	W
Zaire	77	90	51	50	50
Total	[r]22,380	[r]22,371	20,619	19,735	19,760

[e]Estimated. [p]Preliminary. [r]Revised. W Withheld to avoid disclosing company proprietary data; not included in total.

[1]Table includes data available through Mar. 28, 1983.

[2]In addition to the countries listed, China, Indonesia, Nigeria, the Republic of Korea, and North Korea may produce monazite, but output, if any, is not reported quantitatively, and available general information is inadequate for formulation of reliable estimates of output levels.

[3]Data are for years beginning Apr. 1 of that stated.

[4]Exports.

TECHNOLOGY

Researchers at Sandia National Laboratories developed a concept to use thorium oxide to contain a nuclear reactor fuel if it has accidentally melted. A layered bed of thorium oxide particles on top of a layer of aluminum oxide particles was proposed for core retention. Thorium oxide, with the highest melting point of all the oxides, was expected to protect the bottom of a reactor vessel for an extended time with only passive cooling.[19]

Thorium oxide and other nuclear fuels with a four-layer spherical coating of pyrolytic carbon and silicon carbide were studied under simulated core heat-up conditions to evaluate performance. Testing showed that fuel failures were very low compared with previous models and were independent of the type of fuel used. Data indicated fuel failures were due to thermal decomposition of the silicon carbide layer and not the inner fuel itself.[20] An improved coating for fuel structural design may make future thorium oxide and other nuclear fuels more failure resistant or failure proof.

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[1]Physical scientist, Division of Nonferrous Metals.

[2]All measurements are metric units unless otherwise specified.

[3]Fiscal year 1982 ended Sept. 30, 1982.

[4]Free on board-free into container depot.

[5]Values have been converted from Australian dollars ($A) to U.S. dollars (US$) at the rate of $A0.88648=US$1.00 based on yearend 1981 foreign exchange rates from the Wall Street Journal.

[6]Values have been converted from Australian dollars ($A) to U.S. dollars (US$) at the rate of $A1.019=US$1.00 based on yearend 1982 foreign exchange rates from the Wall Street Journal.

[7]Mining Journal. Australia—Beach Sand Miners See Better Times. Feb. 26, 1982, p. 157.

[8]Maryborough—Hervey Bay Chronicle (Australia) Aust. Mineral Sands "Low." May 5, 1982, p. 5.

[9]Ward, J. Mineral Sands—a Dwindling Resource? Pres. at 11th Bureau of Miner. Resour. Symp. Australian Acad. Sci.

[10]Industrial Minerals. Company News and Mineral Notes. No. 175, April 1982, p. 134.

[11]Mining Journal. Labour—Union Ban on Mineral Sands. Jan. 21, 1983, p. 44.

[12]Industrial Minerals. Company News and Mineral Notes. No. 138, August 1982, p. 65.

[13]Mining Journal. Industry in Action. Mineral Deposits Drops Moreton Authority. Oct. 1, 1982, p. 237.

[14]Couch, J. A. Rare Earths From China—Set to Make an Impact. Pres. at 5th Ind. Miner. Internat. Cong., Madrid, Spain, Apr. 25-28, 1982, p. 6.

[15]Data for Apr. 1, 1981—Mar. 31, 1982.

[16]Indian Rare Earths Ltd. 32d Annual Report 1981-82, p. 17.

[17]Coope, B. Titanium Minerals—Focus on Production. Indust. Miner., No. 178, July 1982, pp. 27-35.

[18]Mining Magazine. Tin Dredging at Berjuntai, Malaysia. March 1982, pp. 200-209.

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[19]Fish, J. D., M. Pilch, and F. E. Arellano. Demonstration of Passively-Cooled Particle-Bed Core Retention. Sandia National Laboratories, Albuquerque, N. Mex. Pres. at Internat. Topical Meeting on Liquid Metal Fast Breeder Reactor Safety and Related Design and Operational Aspects, Lyon, France, July 19-23, 1982, p. 10.

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[20]Gooding, D. T. Accident Condition Performance of Fuels for High-Temperature Gas-Cooled Reactors. Pres. at 83d Ann. Meeting, Am. Ceram. Soc., Washington, D.C., May 5, 1981.

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Tin

By James F. Carlin, Jr.[1]

World tin mine production declined in response to continuing world oversupply and low prices. The 1982 average Metals Week composite price of Straits (Malaysian) tin was $6.54 per pound, a decline of almost $1 from the average price of 1981. The continuing economic slowdown caused a decline in tin consumption that contributed to the oversupply situation. The Sixth International Tin Agreement (ITA) came into force on July 1, without the United States as a participant.

Domestic Data Coverage.—Domestic production data for tin are developed by the Bureau of Mines from a voluntary survey of U.S. mines. All five mines to which a survey request was sent responded.

Table 1.—Salient tin statistics

(Metric tons unless otherwise specified)

	1978	1979	1980	1981	1982
United States:					
Production:					
Mine	W	W	W	W	W
Smelter	5,900	4,600	3,000	2,000	3,500
Secondary	21,100	21,493	18,638	15,438	14,283
Exports[1]	498	569	595	2,361	5,769
Imports for consumption:					
Metal	46,776	48,355	45,982	45,874	27,939
Ore (tin content)	3,873	4,529	840	232	1,961
Consumption:					
Primary	48,403	49,496	44,342	40,229	36,194
Secondary	13,128	12,969	12,020	14,144	13,276
U.S. industry yearend stocks	17,217	16,567	15,745	11,675	14,588
Prices, average cents per pound:					
New York market	587.03	711.45	773.44	648.40	586.85
New York composite	629.58	753.89	846.00	733.05	653.91
London	583.83	700.93	761.99	649.53	580.50
Penang	567.65	672.33	745.56	637.85	587.29
World production:					
Mine	r241,108	r245,307	247,264	p252,575	e241,114
Smelter	r244,128	r249,242	249,916	p247,260	e241,164

eEstimated. pPreliminary. rRevised. W Withheld to avoid disclosing company proprietary data.
[1]Exports (excluding reexports)

Legislation and Government Programs.—The General Services Administration (GSA) continued its daily fixed-price tin sale program throughout the year. The tempo of sales was especially brisk during the initial months of the year in the wake of the GSA's late 1981 decision to allow stockpile tin to be sold to foreign users. A total of 4,172 metric tons was sold in 1982. The GSA sales program continued to cause opposition from major tin mining countries, who objected that the sales were harming their economies by depressing the price of tin during a year of weak demand.

The depletion allowance for tin remained 22% for domestic deposits and 14% for foreign deposits.

DOMESTIC PRODUCTION

PRIMARY TIN

Mine Production.—Some tin ore was produced as a byproduct of molybdenum mining in Colorado, and some tin concentrates were produced in placer mining in Alaska. Domestic mine production data were withheld to avoid disclosing company proprietary data, but total output amounted to only a small fraction of domestic tin requirements.

Smelter Production.—The lone domestic tin smelter, Gulf Chemical & Metallurgical Corp., a subsidiary of Associated Metals and Minerals Corp., located in Texas City, Tex., increased its tin metal output to an estimated 3,500 tons. The smelter used a substantially increased amount of imported tin concentrates in addition to domestic concentrates, secondary tin-bearing materials, and its own stockpile of tin residues and slags.

SECONDARY TIN

The United States continued to be the world's largest producer of secondary tin. Secondary tin production declined as consumption requirements decreased. During the year, Proler International Corp.'s detinning plant in San Francisco, Calif., closed.

Table 2.—Secondary tin recovered from scrap processed at detinning plants in the United States

	1981[e]	1982
Tinplate scrap treated metric tons	667,952	456,574
Tin recovered in the form of:		
Metal do	1,328	810
Compounds (tin content) do	265	282
Total[1] do	1,593	1,092
Weight of tin compounds produced do	1,220	1,754
Average quantity of tin recovered per metric ton of tinplate scrap used kilograms	2.38	2.39
Average delivered cost of tinplate scrap per metric ton	$102.42	$56.08

[e]Estimated; four detinning plants closed during 1981.
[1]Recovery from tinplate scrap treated only. In addition, detinners recovered 244 metric tons of tin as metal and in compounds from tin-base scrap and residues in 1982.

Table 3.—Tin recovered from scrap processed in the United States, by form of recovery

(Metric tons)

Form of recovery	1981	1982
Tin metal:		
At detinning plants	1,569	1,054
At other plants	18	13
Total	1,587	1,067
Bronze and brass:		
From copper-base scrap	8,864	6,897
From lead- and tin-base scrap	30	74
Total	8,894	6,971
Solder	3,035	2,723
Type metal	576	222
Babbitt	261	237
Antimonial lead	791	1,015
Chemical compounds	265	282
Miscellaneous[1]	29	27
Total	4,957	4,506
Grand total	15,438	12,544
Value (thousands)	$220,547	$82,027

[1]Includes foil and terne metal.

Table 4.—Stocks, receipts, and consumption of new and old scrap and tin recovered in the United States in 1982

(Metric tons)

Type of scrap and class of consumer	Gross weight of scrap						Tin recovered[e]		
	Stocks Jan. 1	Receipts	Consumption			Stocks Dec. 31			
			New	Old	Total		New	Old	Total
Copper-base scrap:									
Secondary smelters:									
Auto radiators (unsweated)	2,223	56,288	--	55,846	55,846	2,665	--	2,401	2,401
Brass, composition or red	4,076	41,555	8,171	34,483	42,654	2,977	276	1,245	1,521
Brass, low (silicon bronze)	449	1,263	521	871	1,392	320	--	--	--
Brass, yellow	4,023	39,724	9,641	29,993	39,634	4,113	2	172	174
Bronze	1,709	13,983	2,193	11,486	13,679	2,013	172	903	1,075
Low-grade scrap and residues	12,951	158,764	126,710	35,835	162,545	9,170	9	--	9
Nickel silver	684	2,408	290	2,178	2,468	624	3	19	22
Railroad-car boxes	236	1,747	--	1,626	1,626	357	--	77	77
Total	26,351	315,732	147,526	172,318	319,844	22,239	462	4,817	5,279
Brass mills:[1]									
Brass, low (silicon bronze)	2,142	41,522	41,522	--	41,522	3,120	--	--	--
Brass, yellow	17,788	196,985	196,984	1	196,985	18,416	--	--	--
Bronze	543	4,024	4,024	--	4,024	882	191	--	191
Nickel silver	3,020	15,020	14,721	299	15,020	4,182	--	--	--
Total	23,493	257,551	257,251	300	257,551	26,600	191	--	191
Foundries and other plants:[2]									
Auto radiators (unsweated)	1,912	2,396	22	3,074	3,096	1,212	1	138	139
Brass, composition or red	705	12,871	1,698	11,319	13,017	559	81	538	619
Brass, low (silicon bronze)	40	726	721	23	744	22	--	--	--
Brass, yellow	942	7,304	4,321	3,538	7,859	387	13	17	30
Bronze	861	469	288	204	492	838	22	16	38
Low-grade scrap and residues	--	1	--	1	1	--	--	--	--
Nickel silver	12	86	--	76	76	22	--	--	--
Railroad-car boxes	1,080	3,578	--	3,967	3,967	691	--	188	188
Total	5,552	27,431	7,050	22,202	29,252	3,731	117	897	1,014
Total tin from copper-base scrap	XX	XX	XX	XX	XX	XX	770	5,714	6,484
Lead-base scrap:									
Smelters, refiners, and others:									
Babbitt	165	3,875	--	3,905	3,905	135	--	189	189
Battery lead plates	38,498	653,545	--	664,169	664,169	27,874	--	1,374	1,374
Drosses and residues	11,585	67,068	66,953	--	66,953	11,700	1,757	--	1,757
Solder and tinny lead	1,707	15,292	--	16,766	16,766	233	--	2,683	2,683
Type metal	1,662	6,375	--	6,807	6,807	1,230	--	291	291
Total	53,617	746,155	66,953	691,647	758,600	41,172	1,757	4,537	6,294
Tin-base scrap:									
Smelters, refiners, and others:									
Babbitt	11	66	--	67	67	10	--	56	56
Block-tin pipe	5	54	--	55	55	5	--	54	54
Drosses and residues	30	469	482	--	482	17	58	--	58
Pewter	--	1	--	1	1	--	--	1	1
Total	46	590	482	123	605	32	58	111	169
Tinplate and other scrap: Detinning plants	--	--	456,574	--	456,574	--	1,336	--	1,336
Grand total	XX	XX	XX	XX	XX	XX	3,921	10,362	14,283

[e]Estimated; tin recovered new and old from copper-base scrap, brass mills, and foundries. XX Not applicable.

[1]Brass-mill stocks include home scrap, and purchased-scrap consumption is assumed equal to receipts; therefore, lines and total in brass-mill section do not balance.

[2]Omits "machine-shop scrap."

CONSUMPTION AND USES

Tin consumption declined because of the continuing general economic slowdown that affected most usage categories. Solder, which also used substantial quantities of secondary tin, was the largest application of tin. Tinplate was the largest use of primary tin.

Tinplate continued to lose ground to aluminum in the container market. Out of 89.3 billion metal cans shipped in 1982, steel (tinplate and tin-free steel) accounted for 41% and aluminum accounted for 59%; this compared with 88.3 billion metal cans shipped in 1981, with steel accounting for 45% and aluminum accounting for 55%.[2]

Brass mills consumed 475 tons of primary tin and 220 tons of secondary tin, compared with 815 and 500 tons, respectively, in 1981.

Table 5.—Consumption of primary and secondary tin in the United States

(Metric tons)

	1978	1979	1980	1981	1982
Stocks Jan. 1[1]	16,858	13,584	12,938	9,456	9,261
Net receipts during year:					
Primary	46,821	50,126	43,545	41,162	35,843
Secondary	2,541	2,636	2,461	5,692	6,507
Scrap	10,499	10,659	7,709	8,050	7,830
Total receipts	59,861	63,421	53,715	54,904	50,180
Total available	76,719	77,005	66,653	64,360	59,441
Tin consumed in manufactured products:					
Primary	48,403	49,496	44,342	40,229	36,194
Secondary	13,128	12,969	12,020	14,144	13,276
Total	61,531	62,465	56,362	54,373	49,470
Intercompany transactions in scrap	1,604	1,602	835	726	274
Total processed	63,135	64,067	57,197	55,099	49,744
Stocks Dec. 31 (total available less total processed)	13,584	12,938	9,456	9,261	9,697

[1]Includes tin in transit in the United States.

Table 6.—Tin content of tinplate produced in the United States

(Metric tons)

Year	Tinplate waste (waste, strips, cobbles, etc., gross weight)	Tinplate (all forms)		
		Gross weight	Tin content[1]	Tin per metric ton of plate (kilograms)
1978	338,351	4,022,524	17,280	4.3
1979	360,852	4,236,578	17,929	4.2
1980	311,770	3,699,920	16,346	4.4
1981	284,505	3,288,662	13,306	4.0
1982	208,074	2,712,678	10,969	4.0

[1]Includes small tonnage of secondary tin and tin acquired in chemicals.

Table 7.—Consumption of tin in the United States, by finished product

(Metric tons of contained tin)

Product	1981 Primary	1981 Secondary	1981 Total	1982 Primary	1982 Secondary	1982 Total
Alloys (miscellaneous)	1,900	535	2,435	1,769	519	2,288
Babbitt	1,412	2,432	3,844	1,088	827	1,915
Bar tin	455	W	455	509	W	509
Bronze and brass	2,205	4,836	7,041	1,466	2,934	4,400
Chemicals	4,417	W	4,417	3,503	W	3,503
Collapsible tubes and foil	561	W	561	3,572	W	3,572
Solder	11,210	4,589	15,799	9,250	3,892	13,142
Terne metal	(1)	(1)	(1)	(1)	(1)	(1)
Tinning	2,491	W	2,491	1,887	W	1,887
Tinplate[2]	13,306	--	13,306	10,969	165	11,134
Tin powder	983	W	983	906	W	906
Type metal	19	33	52	10	47	57
White metal[3]	1,027	174	1,201	1,054	123	1,177
Other	243	1,545	1,788	184	4,769	4,953
Total	40,229	14,144	54,373	36,167	13,276	49,443

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Included with "Alloys (miscellaneous)."
[2]Includes secondary pig tin and tin acquired in chemicals.
[3]Includes pewter, britannia metal, and jewelers' metal.

Table 8.—U.S. industry yearend tin stocks

(Metric tons)

	1978	1979	1980	1981	1982
Plant raw materials:					
Pig tin:					
Virgin[1]	4,129	4,073	10,423	7,034	6,312
Secondary	694	219	268	447	280
In process[2]	8,761	8,646	1,788	1,780	6,485
Total	13,584	12,938	12,479	9,261	13,077
Additional pig tin:					
Jobbers-importers	275	258	564	1,943	1,316
Afloat to United States	3,358	3,371	2,702	471	195
Total	3,633	3,629	3,266	2,414	1,511
Grand total	17,217	16,567	15,745	11,675	14,588

[1]Includes tin in transit in the United States.
[2]Tin content, including scrap. In 1982, data represent scrap only.

PRICES

The price of tin metal generally declined throughout the year, with most of the decline occurring in the first few months. The sharp decrease in the initial part of the year was attributed to the ending of the massive price support buying program that had begun in mid-1981 and was allegedly undertaken by one or more major tin mining countries.

The average price for the year was almost $1 per pound lower than in 1981. Prices were mainly influenced by the world oversupply of tin relative to demand.

Table 9.—Monthly composite price of Straits tin for delivery in New York

(Cents per pound)

Month	1981 High	1981 Low	1981 Average	1982 High	1982 Low	1982 Average
January	785.46	719.15	748.76	786.82	770.16	775.90
February	723.15	700.73	713.49	773.54	657.16	745.19
March	718.65	688.79	700.26	679.41	654.76	669.17
April	708.56	652.37	683.58	666.66	651.09	655.99
May	666.60	643.82	658.06	671.46	646.86	662.84
June	666.76	645.80	658.39	640.85	565.61	608.25
July	742.99	650.15	689.81	627.97	595.19	612.55
August	786.81	731.08	753.39	647.84	608.17	625.49
September	792.95	769.53	780.22	664.08	620.99	639.04
October	810.63	786.04	795.61	632.00	621.35	624.74
November	832.28	803.27	821.47	625.45	601.73	613.47
December	809.56	778.18	793.52	619.57	608.54	614.33
Average	XX	XX	733.05	XX	XX	653.91

XX Not applicable.

Source: Metals Week.

FOREIGN TRADE

Imports of tin concentrates increased to the highest level in 3 years but remained well below longer range historical levels in past years.

Thailand, long an important supplier, emerged as the dominant source of tin metal. Imports of tin from Malaysia dropped significantly, reportedly because Malaysia diverted increased amounts of its tin sales to the International Tin Council (ITC) buffer stockpile acquisition program.

Imports of tin in all forms (ore and concentrate, metal, and waste and scrap) remained free of U.S. duty.

Table 10.—U.S. imports for consumption and exports of miscellaneous tin, tin manufactures, and tin compounds

Year	Miscellaneous tin and manufactures: Imports: Tinfoil, tin powder, flitters, metallics, tin and manufactures, n.s.p.f.: Value (thousands)	Imports: Dross, skimmings, scrap, residues, and tin alloys, n.s.p.f.: Quantity (metric tons)	Imports: Dross, skimmings, scrap, residues, and tin alloys, n.s.p.f.: Value (thousands)	Exports: Tin scrap and other tin-bearing material, except tinplate scrap: Value (thousands)	Tin compounds: Imports: Quantity (metric tons)	Tin compounds: Imports: Value (thousands)
1980	$9,154	1,312	$4,215	$13,819	171	$2,285
1981	8,666	2,583	3,387	16,357	170	2,098
1982	12,288	3,068	4,364	13,566	321	2,667

Table 11.—U.S. exports and imports for consumption of tin, tinplate, and terneplate in various forms

Year	Ingots, pigs, and bars				Tinplate and terneplate				Tinplate circles, strips, and cobbles		Tinplate scrap	
	Exports		Reexports		Exports		Imports		Exports		Imports	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
1980	595	$10,194	3,699	$62,382	641,401	$440,671	NA	NA	([1])	([1])	6,497	$405
1981	2,361	31,053	3,719	55,505	345,718	220,993	NA	NA	([1])	([1])	5,080	414
1982	5,769	84,454	3,311	47,896	217,841	118,870	NA	NA	([1])	([1])	5,530	454

NA Not available.
[1]Included with exports of tinplate and terneplate.

Table 12.—U.S. imports for consumption of tin, by country

Country	1981		1982	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Concentrates (tin content):				
Bolivia	--	--	192	$1,817
Canada	--	--	187	845
Peru	232	$2,975	1,416	17,473
South Africa, Republic of	--	--	144	1,183
Zaire	--	--	22	226
Total	232	2,975	1,961	21,544
Metal:[1]				
Australia	552	8,121	334	4,083
Belgium-Luxembourg	--	--	10	119
Bolivia	8,277	110,520	4,340	54,388
Brazil	1,129	15,463	2,409	31,675
Canada	22	384	2	49
Chile	5	59	116	1,589
China	2,033	22,263	2,632	35,495
Germany, Federal Republic of	--	--	(2)	14
Hong Kong	50	631	5	75
India	1	16	20	309
Indonesia	7,096	99,791	5,744	75,278
Malaysia	13,163	193,432	2,364	30,981
Mexico	70	666	--	--
Nigeria	520	6,935	124	1,383
Peru	99	1,490	--	--
Singapore	656	9,516	600	7,848
South Africa, Republic of	34	466	38	473
Thailand	11,967	163,331	9,116	118,463
United Kingdom	46	665	55	737
Zimbabwe	154	2,131	30	370
Total	45,874	635,880	27,939	363,329

[1]Bars, blocks, pigs, or granulated.
[2]Less than 1/2 unit.

WORLD REVIEW

International Tin Agreement.—Negotiations for the Sixth ITA, originally due to take effect on July 1, 1981, continued into 1982. Since the differences between consumer country and producer country positions on such central issues as the ITC buffer stockpile and export controls proved to be considerable, the Fifth ITA was extended an additional year to July 1, 1982, to permit extra time for discussions.

On July 1, 1982, the Sixth ITA went into effect. The new pact contained fewer producer and fewer consumer countries than the prior 5-year agreement. In an attempt to bring world supply and demand into balance during the last half of the year, the ITC imposed on member producer countries a reduction of 36% on tin exports compared to the same period in 1981.

Table 13.—ITC buffer stock price range in 1982

(Malaysian dollars per kilogram)

Floor price	29.15
Lower sector	29.15-32.06
Middle sector	32.06-34.98
Upper sector	34.98-37.89
Ceiling price	37.89

Australia.—Tin ore was mined principally in Queensland, New South Wales, and Tasmania. The island State of Tasmania was the largest producing area. The Renison underground mine, of Renison Ltd. in Tasmania, and the Ardlethan Mine, of Aberfoyle Ltd. in New South Wales, were the two largest mines. Ranking third was the Cleveland Mine of Aberfoyle in Tasmania. Production in Queensland came from a number of small mines.

Two smelters operated in 1982. The larger one was the Alexandria smelter of Associated Tin Smelter Pty. Ltd. (ATS) on the east coast. It had an annual capacity to produce 7,000 tons of tin metal. The smelter of Greenbushes Tin NL, at Greenbushes, Western Australia, had a capacity to produce 1,000 tons of tin metal.

Australia exported some tin concentrate, primarily to Malaysia. Major destinations for tin metal were the United Kingdom and the Netherlands. Australia's domestic tin consumption amounted to about one-fourth of its mine output. Tinplate and solder were the major usage categories.

Management of a feasibility study on the Mount Bischoff prospect in Tasmania was taken over by Conzinc Riotinto of Australia Ltd. Drilling and sampling work carried out by Metals Exploration Ltd. reportedly indicated reserves of 6.1 million tons of ore, grading 0.49% tin.

Otter Exploration N.L. reported progress in developing a metallurgical process to recover tin from a complex deposit at Gillian, Queensland.

The joint venture of Southern Ventures N.L. and its partners International Gold and Minerals Ltd. and Coolawin Resources Ltd. announced that exploration work at China Camp, North Queensland, had disclosed significant reserves.

Oakbridge Ltd. reported that exploration at the Baal Gammon prospect near Herberton, Queensland, resulted in establishing reserves of 6.5 million tons grading 0.1% tin. The firm's exploration in northern Queensland delineated substantial low-grade alluvial deposits in the Robertson's Creek and Mount Garnet areas which would be further tested.

Bolivia.—Tin mine output was hindered by miner strikes and declining ore grades. Workers at the tin mines of Corpacíon Minera de Bolivia (COMIBOL) struck for several weeks, demanding higher wages.

The tin volatilization plant at La Palca, claimed to be the largest of its type in the world, reportedly encountered continuing operational difficulties.

ASARCO Incorporated, through its subsidiary, Bolivian Lead Corp. S.A., started a joint venture tin project with the Estalsa Group, the largest private mining company in Bolivia, to develop the Kelluani lode deposit near La Palca. Reportedly, the deposit could be mined by open pit methods.

Teams of geologists from the Bolivian Geological Survey began exploring for tin in the volcanic zones of Oruro and Potosí. Reports indicated the preliminary investigations suggested deposits at depths of 20 to 200 meters.

With Bolivia's domestic tin ore production declining in recent years, the state-owned smelting company Empresa Nacional de Fundiciones (ENAF) became hard pressed to keep its two tin smelters at Vinto and Oruro operating near capacity. The two smelters had a collective installed capacity of 30,000 tons per year.

Brazil.—While not a member of the ITA, Brazil ranked as the eighth largest producer of tin concentrate in the world and the seventh largest tin metal producer. The private sector was totally responsible for concentrate production, with the Paranapenema S.A., Mineração, Indústria e Construção, Brascan, and Brumadinho Groups collectively accounting for 80% of mined output. The majority of mines were in Rondonia state, with smaller mines in Goias, southern Para, and Amazonas.

The major tin producer, Paranapenema, based in São Paulo, produced 3,600 tons of tin-in-concentrate. To complement its three mines in Rondonia and one in Para, the firm started a fifth mine in 1982 at Pitinga in Amazonas state. The Brumadinho Group acquired 70% control of Bera do Brasil, which had been jointly owned by Paul Bergsoe & Son Ltd. and the East Asiatic Co. Reportedly, the output of Bera do Brasil's tin smelting plant in São Paulo was to be doubled.

St. Joe Minerals Corp. conducted studies on its Mocambo high-grade alluvial tin deposit near the Xingu River in the southern part of the Amazon River Basin.

Brazil consumed domestically more than one-half of its tin metal production. The major use was for tinplate, and the largest producer was Cia. Siderúrgica Nacional, with an additional two new tinplate lines planned for 1982, at its Volta Redonda plant.

Burma.—The Tenasserim district, a historically important tin mining area, was designated to be the subject of fresh development work after the approval of a $16 million loan from the Asian Development Bank. The loan was to assist startup of five alluvial tin mines at Ahtwin Bokypin, Zadiwin Kyaukmedaung Onzin Chaung, Shanthe, and Thithladaw. The mines were to be developed by gravel pump operations, and the goal was to increase tin-in-concentrate output by Burma by 60% annually.

A new tin smelting plant in Syriam, near

Rangoon, was opened. It was a joint venture project between Burma and the Republic of Korea.

Canada.—Shell Canada Ltd. sold its tin prospect in East Kemptville, Nova Scotia, to Rio Algom Ltd. of Toronto. Rio Algom's Canadian exploration operation continued to evaluate the property.

The Kidd Creek Mine near Timmins, Ontario, a producer of tin as a byproduct of base metal production, was acquired from Texasgulf Inc. by Canada Development Corp.

Five exploration projects were carried out in the Swift River-Rancheria area near the Yukon-British Columbia boundary. Canada Tungsten Mining Corp. Ltd. started dredging operations for recovery of gold, tungsten, and tin at Dublin Gulch, Yukon Territory.

China.—The two main mining areas were Gejiu in Yunnan Province and Hechi in Guangxi Province. There were also important mines in Guangdong, Hunan, and Jiangxi.

China's seven tin smelters had an estimated collective capacity of about 15,000 tons per year of tin metal.

France.—Société National Elf Aquitaine was awarded a 3-year permit to prospect for tin and other minerals over a 20-square-kilometer area in central France.

India.—The Geological Survey of India (GSI) reported the discovery of a 40-square-kilometer area of prospective tin ore in the Bastar district in Madhya Pradesh. Reportedly, GSI exploration in the Koraput district in Orissa was also promising.

Indonesia.—This country was the world's third largest mined tin producer, with two-thirds of its deposits located offshore. The major tin miner, P. T. Tambang Timah, a national mining organization, had a dredging fleet of 13 land dredges and 19 sea dredges. P. T. Tambang had under construction a new dredge, the *Singkep I*, which was scheduled to be used in the Karimun Kundur Sea area near Singkep. With the new dredge, P. T. Tambang will have three modern dredges capable of dredging to a depth of 50 meters below sea level. That capability was essential as newly discovered tin reserves in the Kundur-Laut area, the area near Sungai Liat, and the Klapa Kampit area were located at 50 meters below sea level. P. T. Tambang, which traditionally spends about 7% of its annual budget on exploration, sought new tin deposits in the Kalimantan region.

The Indonesian Government awarded a contract to a consortium of firms from the Federal Republic of Germany and Japan to construct a 130,000-ton-per-year electrolytic tinplate line, due for 1985 completion.

The Banka Tin Mining unit introduced a U.S.-built amphibious dredge with a digging depth of 6 meters, which was stationed at Air Anyer, Sungai Liat.

Japan.—The Metal Mining Agency reported that test drilling disclosed rich veins of tin at the Kuga Mine in Yamaguchi Prefecture on Honshu Island. An average grade of 0.48% tin at a depth of 50 meters was claimed.

Korea, Republic of.—The 3,000-ton-per-year-capacity Pyro tin smelter, inactive since mid-1981, was acquired in a joint takeover by Kimetal Pty. Ltd., of Singapore and Hwa Sun Industries Co. Ltd. of Seoul. The new firm, Kimetal Korea Ltd., planned to start production in 1983. It was anticipated that most concentrates would be imported and that two-thirds of the tin metal produced would be used domestically.

Malaysia.—Lowered world tin demand and the ITC's export control sanctions caused a marked decline in Malaysia's tin mining activity. At yearend 43 dredges, 521 gravel pump mines, and 62 opencast, underground, and other miscellaneous mines were operating, about 80 fewer than the number of total active mines at yearend 1981. The labor force reportedly declined sharply to about 28,000.

Malaysia Mining Corp. (MMC) reported completion of a feasibility study of tin deposits in the Kuala Langat district. MMC expected commercial production there by 1985, with development expected to cost over $200 million. Production eventually could be 9,000 tons per year. The deposit reportedly had established reserves of 181,000 tons of tin.

Reports indicated a marked increase in tin smuggling, which some authorities attributed to the ITC's prolonged export restrictions.

Rwanda.—Société des Mines du Rwanda and La Générale des Carrières et Des Mines commenced operation of a 4,000-ton-per-year tin smelter at Kigali.

South Africa, Republic of.— Tin mining was performed at three separate fields, with one mining company operating in each field. Rooiberg Tin Ltd., owned by Goldfields of South Africa Ltd., was the largest tin producer, accounting for about 70% of the national total. Owing to the addition of its tin smelter in 1979, Rooiberg's output was almost entirely in the form of tin metal. The second leading producer was Union Tin Mines Ltd., owned primarily by Zinchem. Industrial Mineral Resources Pty. Ltd., a subsidiary of the Anglo American Corp. Ltd., mined tin from four locations: Zaaiplaats, Western Area, Roodepoort, and Groenfontein.

Tanzania.—The State Mining Corporation (STAMICO) announced that it would begin mining from tin deposits found in the Kyerwa Karagwe district of the Kagera region. STAMICO anticipated shipping the concentrates to Rwanda for smelting.

Thailand.—Tin mine output declined sharply as declining tin prices forced high-cost producers out of business and easily worked deposits became exhausted. Uncontrolled mining activities by individual miners or small firms reportedly continued to dissipate high-grade ore, leaving large amounts of lower grade ore that could only be mined using capital-intensive methods. The number of operating suction boats, traditionally a major component of Thailand's production, declined markedly.

The Thai Government began to seek ways to explore for new tin deposits. The International Finance Corp., an International Bank for Reconstruction and Development (World Bank) affiliate, reported it would commence to finance a program of exploratory drilling in the Andaman Sea near Takuapa. The project would be managed by Sea Minerals Ltd. and would be done in waters up to 65 meters deep.

Table 14.—Tin: World mine production, by country[1]

(Metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Argentina	[2]362	386	351	[r] [e]462	340
Australia	11,864	[r]12,571	11,588	12,267	[3]12,700
Bolivia	30,881	27,648	27,291	29,830	[3]26,773
Brazil	6,341	7,005	6,930	8,297	9,500
Burma	757	1,233	1,290	1,415	[3]1,654
Burundi	[e]20	8	--	--	--
Cameroon	14	8	13	14	14
Canada	360	337	264	239	153
China[e]	14,000	14,000	14,600	15,000	15,000
Czechoslovakia[e]	[2]180	[2]180	322	433	400
German Democratic Republic[e]	1,600	1,600	1,800	1,900	1,900
Indonesia	[r]27,437	[r]29,434	32,529	35,238	36,500
Japan	603	660	549	561	[3]533
Korea, Republic of	19	31	8	([4])	--
Laos[e]	[2]400	300	350	400	400
Malaysia	62,650	62,995	61,404	59,938	[3]52,330
Mexico	73	23	[e]20	[e]20	20
Namibia	1,250	1,042	[e]1,000	[e]1,000	1,000
Niger	125	73	78	69	70
Nigeria	2,935	2,750	2,569	2,300	2,700
Peru	458	870	1,077	1,519	[3]1,672
Portugal	282	225	274	506	500
Rwanda	1,502	1,910	2,069	1,790	1,800
Spain	711	496	437	564	550
South Africa, Republic of	2,886	2,697	2,913	2,811	[3]3,035
Swaziland	1	--	--	--	--
Tanzania	9	10	12	11	10
Thailand	30,186	33,962	33,685	31,474	26,000
Uganda[e]	[2]120	60	30	30	30
U.S.S.R.[e]	34,000	35,000	36,000	36,000	37,000
United Kingdom	3,132	[r]2,373	2,982	3,869	4,000
United States	W	W	W	W	W
Vietnam	[e]250	[e]200	370	550	580
Zaire	4,390	3,879	3,159	2,468	2,240
Zambia[e]	([5])	1	([5])	--	10
Zimbabwe[e]	1,310	1,340	1,300	1,600	1,700
Total	[r]241,108	[r]245,307	247,264	252,575	241,114

[e]Estimated. [p]Preliminary. [r]Revised. W Withheld to avoid disclosing company proprietary data.

[1]Contained-tin basis. Data derived in part from the Monthly Statistical Bulletin of the International Tin Council, London, England. Table includes data available through May 19, 1983.

[2]Estimate by the International Tin Council.

[3]Reported figure.

[4]Revised to zero.

[5]Less than 1/2 unit.

Table 15.—Tin: World smelter production, by country[1]

(Metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Argentina[e]	100	100	300	600	500
Australia	5,129	5,423	4,819	4,286	[2]3,114
Belgium	3,295	[r]2,240	2,822	65	--
Bolivia	16,254	14,950	18,191	20,005	[2]19,032
Brazil	[r]9,329	10,133	8,792	7,639	[2]9,298
China[e]	14,000	14,000	14,600	15,000	15,000
German Democratic Republic[e]	1,750	2,000	2,200	2,300	2,300
Germany, Federal Republic of	4,767	4,096	2,262	1,815	1,800
Indonesia	25,829	27,790	30,465	32,519	33,000
Japan	1,141	1,251	1,319	1,315	[2]1,296
Malaysia[3]	71,953	73,068	71,318	70,326	68,000
Mexico[4]	1,000	1,268	1,382	866	800
Netherlands	1,600	1,445	1,370	2,500	2,520
Nigeria	2,984	2,858	2,678	2,486	[2]2,754
Portugal	854	1,121	938	400	400
Spain	4,575	4,412	4,100	[e]3,400	3,500
South Africa, Republic of	637	819	1,100	2,056	2,800
Thailand	28,945	33,058	34,689	32,636	26,700
U.S.S.R.[e]	34,000	35,000	36,000	36,000	37,000
United Kingdom	8,445	8,025	5,829	6,839	5,600
United States[5]	5,900	4,600	3,000	2,000	3,500
Vietnam[e]	200	160	350	500	500
Zaire	496	458	458	[e]550	550
Zimbabwe	945	967	934	1,157	1,200
Total	[r]244,128	[r]249,242	249,916	247,260	241,164

[e]Estimated. [p]Preliminary. [r]Revised.

[1]Data derived in part from the Monthly Statistical Bulletin of the International Tin Council, London, England. Output reported throughout is primary tin only unless otherwise specified. Table includes data available through June 6, 1982.

[2]Reported figure.

[3]Includes small production of tin from smelter in Singapore.

[4]Primarily from imported tin concentrate; minor amounts of refined tin from domestic ores were as follows, in metric tons: 1978—73; 1979—23; 1980—20 (estimated); 1981—20 (estimated); and 1982—20 (estimated).

[5]Includes tin content of alloys made directly from ores.

The Government-owned Offshore Mining Organization (OMO) announced a program to search for new tin deposits off the coast of the island of Phuket in the Andaman Sea in southern Thailand. OMO also planned a tin exploration project along the eastern coast of the Gulf of Thailand, an area extending from north of the Chao Phya River down to the Kampuchean border.

OMO began operations of its own Bor Dan bucket ladder dredge of 300,000-cubic-meter-per-month capacity. OMO also decided to extend existing contracts with the private dredge operators who worked as contractors under production sharing agreements on OMO's leases. The first such contract to be extended was that of Billiton Thailand Ltd., first signed in 1977, which was renewed for 3 more years.

Euro-Thai Mining Co. Ltd. began operations at its mine in Yala. The Thai Pioneer Enterprise Co. Ltd.'s 3,600-ton-per-year tin smelter at Phathum Thani closed down in May, reportedly because of financial problems and a lack of concentrate feed.

Tin smuggling continued to be an important factor requiring considerable Government effort and expense to control. Government sources estimated the extent of such smuggling at 5,000 tons per year of tin, primarily to evade taxes and to circumvent the ITC's export controls.

U.S.S.R.—The U.S.S.R. ranked as the world's second leading tin mine producer. However, its tin output was inadequate to meet domestic needs, and considerable tin metal was imported. The major Soviet tin producing areas were the Soviet Far East, Yakutia, and Transbaykal. About 25% of total output was from placers, mostly located in the Soviet North East. The Solnechnyy mining and concentration complex in Khabarovsk Kray in the Soviet Far East was being expanded. The complex contained four underground mines and two concentration plants. The Pereval'nyy Mine at the complex was under development.

At the Karaganda steelworks complex, the first stage of a tin mill was placed in operation with a design capacity of 445,000 tons of tinplate per year. Final capacity of the tin mill was to be 750,000 tons per year.

Reports indicated the U.S.S.R. was assisting tin development in Vietnam and also importing tin from that country.

United Kingdom.—South Crofty Ltd. was the major producer of tin. The Marine Mining Consortium Ltd. started a project to recover alluvial tin off the north coast of Cornwall at St. Ives Bay by 1985.

Zaire.—Tin mine production continued the pattern of decline evident for several years. Société Minière et Industrielle de Kivu in Kivu produced about 80% of the country's tin. A feasibility study was started at the Manono Mine in the east, which reportedly had reserves of 23,000 tons. Société Zairetain, the local subsidiary of the Belgian-based Geomines Internationale, submitted an investment program to the Government to increase Zairetain's tin output to 2,000 tons annually. Compagnie Française des Mines (COFRAMINES) started development of the Kania alluvial tin deposits, located in the north of Shaba Province. Estimated production of 500 tons per year was scheduled to commence in 1983.

TECHNOLOGY

Sirosmelt, the new tin smelting process developed by Australia's Commonwealth Scientific & Industrial Research Organization (CSIRO) and under evaluation at the Alexandria, New South Wales, plant of ATS, reportedly continued to yield good results in production-scale trials. According to CSIRO and ATS metallurgists, the process could significantly enhance the viability of low-grade hard rock deposits such as those at the Taronga project in New South Wales. The submerged combustion process, which treated the ore and slag in one continuous process, was claimed to save time, energy, and smelting costs while achieving a greater recovery of tin from slag.[3]

The Australian company Jason Mining Ltd. reported successful trials on the Emmaville deep tin deposits in New South Wales, using a new extraction technique based on a combination of mining and oilfield technology. The method involved sinking a borehole to the top of the mineral-bearing alluvial horizon and then inserting a 1.65-meter-long tool comprised of a standard oil well tricone drilling bit, a Venturi-type suction chamber, and a high-pressure water jet which converted the alluvium to a slurry. From the suction chamber, the slurry was drawn through the central column of a double-columned casing to the surface, where it was dried to produce a concentrate.[4]

In the Soviet Union, a basically new technology was reportedly developed for purification of tin and tin alloys, based upon centrifugal filtration. The new procedure was introduced at the Novosibirsk Tin Combine for purification of tin and removal of iron and arsenic and at the Ryaztsvetmet plant for purification of tin-lead alloys and removal of copper. The continuous process of tin purification reportedly allowed tin with a high content of impurities to be refined at reduced cost, with less tin loss and increased extraction of accompanying metals such as bismuth, antimony, copper, lead, and indium.[5]

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[1]Physical scientist, Division of Nonferrous Metals.
[2]Can Manufacturers Institute. Metal Can Shipments Report 1982. Washington, D.C., 1983, p. 5.
[3]Tin International. February 1983, p. 52.
[4]Mining Journal. Oct. 8, 1982, p. 247.
[5]Tsvetnyye Metally (Moscow). No. 9, September 1982, pp. 11-12.

Titanium

By Langtry E. Lynd[1] and Ruth A. Hough[2]

Domestic production and consumption of titanium concentrates, titanium dioxide pigments, and titanium metal were all lower in 1982 than in 1981. The particularly severe decline in titanium metal output was attributed mainly to a collapse of the commercial aircraft market, the major consumer of titanium in the previous 3 years. U.S. mine production of ilmenite was at the lowest level since 1943 because of closure of a mine in New Jersey and lower output in New York. Production of natural rutile was about one-third higher than in 1981, and the only domestic synthetic rutile plant was operated at about two-thirds of its 110,000-ton-per-year capacity.[3] Domestic production of titanium dioxide pigments decreased, partly because of closure of a sulfate-process plant in New Jersey as domestic consumption of titanium dioxide pigments dropped, reflecting the continuing economic recession.

Price quotations for ilmenite and titanium slag in U.S. markets increased, while rutile prices decreased. Titanium sponge metal published prices decreased 27% to $5.55 per pound. Titanium dioxide pigment list prices remained unchanged.

Domestic Data Coverage.—Consumption data for titanium raw materials are developed by the Bureau of Mines from a voluntary domestic survey. Out of 40 operations to which a survey request was sent, 90% responded, representing an estimated 90% of the total consumption shown in tables 1 and 7. Consumption by the four nonrespondents was estimated using reported prior-year consumption levels.

Table 1.—Salient titanium statistics

	1978	1979	1980	1981	1982
United States:					
Ilmenite concentrate:					
Mine shipments ____short tons__	580,878	646,399	593,704	523,681	233,063
Value ____thousands__	$25,628	$32,965	$32,041	$37,013	$19,093
Imports for consumption ____short tons__	308,671	184,478	357,488	236,217	348,366
Consumption ____do____	792,289	791,063	848,607	856,116	583,250
Titanium slag:					
Imports for consumption ____do____	149,172	111,210	194,994	268,825	247,845
Consumption ____do____	128,826	144,708	181,582	252,826	225,541
Rutile concentrate, natural and synthetic:					
Imports for consumption ____do____	289,617	283,479	281,605	202,373	163,325
Consumption ____do____	263,184	313,761	297,582	285,371	238,937
Sponge metal:					
Imports for consumption ____do____	1,476	2,488	4,777	6,490	1,354
Consumption ____do____	19,854	23,937	26,943	31,599	17,328
Price, Dec. 31, per pound ____	$3.28	$3.98	$7.02	$7.65	$5.55
Titanium dioxide pigments:					
Production ____short tons__	700,755	742,081	727,245	r761,190	635,061
Imports for consumption ____do____	117,708	104,968	97,590	124,906	138,922
Apparent consumption ____do____	801,728	837,042	753,480	e806,040	716,416
Price, Dec. 31, cents per pound:					
Anatase ____	46.0	53.0	57.0	69.0	69.0
Rutile ____	51.0	59.0	63.0	75.0	75.0
World: Production:					
Ilmenite concentrate ____short tons__	r3,874,661	r3,874,586	4,015,772	p4,009,737	e3,371,090
Titaniferous slag ____do____	1,037,193	r842,038	1,343,200	p1,245,000	e1,170,000
Rutile concentrate, natural ____do____	[1]332,690	r [1]393,807	[1]459,634	p [1]409,220	e [1]381,253

eEstimated. pPreliminary. rRevised.
[1]Excludes U.S. production data to avoid disclosing company proprietary data.

Legislation and Government Programs.—The Government stockpile goal for titanium sponge metal remained at 195,000 tons in 1982. The Government stockpile in December 1982 contained 21,465 tons of specification sponge metal and 10,866 tons of nonspecification material.

The Government stockpile goal for rutile was unchanged at 106,000 tons in 1982. The total rutile stockpile inventory in December 1982 was 39,186 tons.

The sale by the General Services Administration (GSA) of an Air Force forging facility, including a 50,000-ton forge, in North Grafton, Mass., to Wyman-Gordon Co., Worcester, Mass., was completed on May 28, 1982, for $34.4 million cash.[4] A titanium sponge barter arrangement that had been proposed by GSA was abandoned because of opposition from three major sponge producers.

DOMESTIC PRODUCTION

Concentrates.—Production of ilmenite in 1982 was the lowest since 1943. The 1982 decline in domestic output resulted mainly from closure of the ASARCO Incorporated heavy mineral sands facility at Manchester, N.J., in March 1982, because of escalating costs, and from reduced production at the hard rock mining and milling operations of NL Industries, Inc., at Tahawus, N.Y., because of the shutdown of NL Industries' titanium dioxide pigment plant at Sayreville, N.J., in September 1982.[5] Production of ilmenite by E. I. du Pont de Nemours & Co., Inc., at Starke and Highland, Fla., was somewhat lower in 1982 than in 1981. Associated Minerals (U.S.A.) Inc., Ltd., was the only U.S. producer of natural rutile concentrate and increased its rutile production about 40% in 1982. Kerr-McGee Chemical Corp. continued production of synthetic rutile at Mobile, Ala., using Australian ilmenite feed, at a rate somewhat in excess of the needs of its 56,000-ton-per-year pigment plant in Hamilton, Miss.

Ferrotitanium.—Ferrotitanium was produced by A. Johnson & Co., Inc., Lionville, Pa.; The Pesses Co., Solon, Ohio; Reactive Metals and Alloys Corp., West Pittsburg, Pa., and Shieldalloy Corp., Newfield, N.J. Most of the production of ferrotitanium consisted of the 70% titanium grades.

Metal.—Production of titanium sponge metal in 1982 was about 40% less than in 1981. Total U.S. sponge capacity reached about 33,000 tons per year in 1982, up about 8% from that of 1981. However, because of low demand, capacity utilization began to drop in the first quarter and was about 35% at yearend. Sponge- and ingot-producing companies and their annual capacities in 1982 are shown in table 3. International Titanium, Inc., installed one-half of its planned 5,000-ton-per-year sponge capacity and began production in the first quarter of 1982. Titanium Metals Corp. of America's TIMET division was continuing its $50 million modernization program, to be completed in 1983, which will include increasing its sponge production capacity to 16,000 tons per year.

Wyman-Gordon, Worcester, Mass., announced it would spend about $24 million in the next 2 years to build a new 1,500-ton-per-year ingot facility and install an ingot-forging operation at its Grafton, Mass., plant.[6] In April 1982, Wyman-Gordon purchased a 42.5% share of International Titanium.

A. Johnson installed at Morgantown, Pa., a $4 million facility that included an electron-beam furnace with an annual melting capacity of 1,500 tons of titanium ingot. This facility will also produce commercially pure cast titanium slab, eliminating the conventional step of remelting ingot and forging it into slab.[7]

Westinghouse Electric Corp. reportedly proposed to Mitsubishi Metal Corp. of Japan a joint venture to produce 6,600 tons per year of titanium sponge in the United States. The new sponge plant would be built on a plantsite at Ogden, Utah, used for zirconium production by a Westinghouse subsidiary, Western Zirconium Co.

Cabot Corp.'s High Technology Materials Div., Kokomo, Ind., was using part of its recently tripled mill capacity to produce titanium flat-rolled products. The expansion involved installation of a $58 million, 84-inch-wide, four-high-two-high plate-hot strip-blooming mill and associated finishing facilities.[8] Cabot also planned to add eventually about 7.5 million pounds per year of melting capacity at Kokomo at an estimated cost of $12 million. Plans for a joint manufacturing venture between Cabot and IMI Titanium Ltd. were reportedly well advanced.

Table 2.—Production and mine shipments of ilmenite concentrates[1] from domestic ores in the United States

Year	Production gross weight (short tons)	Shipments: Gross weight (short tons)	Shipments: TiO_2 content (short tons)	Shipments: Value (thousands)
1978	589,751	580,878	352,842	$25,628
1979	639,292	646,399	389,535	32,965
1980	548,882	593,704	358,181	32,041
1981	509,342	523,681	310,854	37,013
1982	227,844	233,063	145,725	19,093

[1]Includes a mixed product containing rutile, leucoxene, and altered ilmenite.

Table 3.—U.S. producers of titanium metal in 1982

Company	Ownership	Plant location	Capacity (short tons): Sponge	Capacity (short tons): Ingot
Howmet Corp., Alloy Div	Pechiney Ugine Kuhlmann, France	Whitehall, Mich	--	5,000
International Titanium, Inc	Wyman-Gordon Co., 42.5%; Ishizuka Research Institute and Mitsui & Co. Ltd., Japan; and other U.S. and Japanese interests.	Moses Lake, Wash	2,500	--
Lawrence Aviation Industries, Inc.	Self	Port Jefferson, N.Y	--	1,000
Martin Marietta Aluminum, Inc	do	Torrance, Calif	--	4,000
Oregon Metallurgical Corp	Armco, Inc., 80%; public, 20%	Albany, Oreg	4,500	8,000
RMI Co	United States Steel Corp, 50%; National Distillers & Chemical Corp., 50%.	Ashtabula, Ohio	9,500	--
Do	do	Niles, Ohio	--	12,000
Teledyne Allvac	Teledyne, Inc	Monroe, N.C	--	4,000
Teledyne Wah Chang Albany	do	Albany, Oreg	1,500	1,000
Titanium Metals Corp. of America.	NL Industries, Inc., 50%; Allegheny International, Inc., 50%.	Henderson, Nev	15,000	17,000
Western Zirconium Co	Westinghouse Electric Corp	Ogden, Utah	500	500
Total			33,500	52,500

Oregon Metallurgical Corp. completed construction of a new 50,000-square-foot mill products plant in Albany, Oreg. The plant produces plate, bar, and billet, and includes a 2,500-ton hydraulic forge press, gas-fired forging furnaces, and a gyratory forging machine.[9]

Allegheny Ludlum Steel Corp. announced on December 13 the formation of a partnership with Sumitomo Metal Industries Ltd., Sumitomo Corp., and Sumitomo Corp. of America for the manufacture and marketing, initially for industrial application, of commercially pure titanium, sheet, strip, plate, and welded tubing in the United States and Canada. The Sumitomo Group was to supply semifinished titanium to the partnership, and Allegheny Ludlum Steel was to process the semifinished material, using presently underutilized facilities at its specialty steel plants in Brackenridge and Leechburg, Pa., as well as its tubing facilities at Wallingford, Conn. The headquarters of the partnership, to be known as ALS Metals Co., was planned to be in Pittsburgh, Pa.[10]

Dow Chemical Co. and Howmet Turbine Components Corp. agreed at yearend to dissolve their partnership organization, known as the D-H Titanium Co., which since 1979 had attempted commercialization of an electrolytic cell process for the production of titanium. The semicommercial production plant that was built and operated for that purpose at Freeport, Tex., was to be deactivated, with Dow becoming sole owner of both the production facilities and the process technology. Dow planned to continue research and development on the process at a reduced level. Low demand and greatly increased worldwide sponge capacity, rather than technical problems, were cited as the major reasons for ending the joint venture.[11]

Pigment.—Production of titanium dioxide pigment decreased about 17% in 1982, on a titanium dioxide content basis. Rutile pigment accounted for 78% of total output and was produced by five manufacturers. Six companies produced titanium dioxide

Table 4.—Components of U.S. titanium metal supply and demand

(Short tons)

Component	1978	1979	1980	1981	1982
Production: Ingot	31,385	37,414	42,864	45,923	25,236
Exports:					
Sponge	97	180	113	58	36
Other unwrought	210	155	344	257	173
Scrap	5,453	4,967	3,300	3,280	4,287
Ingot, slab, sheet bar, etc	1,340	1,984	3,278	4,203	2,196
Other wrought	689	1,316	1,845	1,846	1,404
Total	7,789	8,602	8,880	9,644	8,096
Imports:					
Sponge	1,476	2,488	4,777	6,490	1,354
Scrap	3,789	6,140	4,138	3,787	1,277
Ingot and billet	561	338	191	244	212
Mill products	1,125	942	946	1,116	870
Total	6,951	9,908	10,052	11,637	3,713
Stocks, end of period:					
Government: Sponge (total inventory)	32,331	32,331	32,331	32,331	32,331
Industry:					
Sponge	2,642	2,155	2,381	e3,720	e3,350
Scrap	6,447	6,733	8,641	e10,484	e11,073
Ingot	2,569	2,366	1,860	3,592	2,488
Other	73	200	2	7	3
Total industry	11,731	11,454	12,884	e17,803	e16,914
Reported consumption:					
Sponge	19,854	23,937	26,943	e31,599	e17,328
Scrap	12,318	13,986	15,406	e14,795	e8,528
Ingot	30,746	37,868	43,360	e43,525	26,727
Mill products (net shipments)[1]	17,648	23,113	27,133	25,492	18,204
Castings (shipments)[1]	180	186	191	209	267

eEstimated.
[1]U.S. Bureau of the Census, Current Industrial Reports, Ser. DIB-991 and ITA-991.

pigment in 1982. Plant locations and estimated yearend capacities are listed in table 5.

American Cyanamid Co. completed the 10,000-ton-per-year expansion that it began in 1981 of its chloride-sulfate process pigment plant in Savannah, Ga.

NL Chemicals, a division of NL Industries, in September 1982 ceased all production of titanium dioxide pigment at its 100,000-ton-per-year sulfate process plant in Sayreville, N.J. Some finishing, warehousing, and shipping facilities, including pigment-slurry equipment, were to continue in operation, employing about 50 workers out of a previous total of about 460. NL Chemicals said that current world economic conditions and deteriorated end-use markets were making full pigment production unprofitable at the Sayreville plant, which operated at a loss in recent years. The company's other U.S. titanium dioxide pigment plant, at St. Louis, Mo., was closed in 1979. NL Chemicals planned to continue to supply its customers with pigments produced at its plants in Belgium, Canada, the Federal Republic of Germany, and Norway.[12]

Table 5.—Capacities of U.S. titanium dioxide pigment plants on December 31, 1982

Company and plant location	Pigment capacity (tons per year) Sulfate process	Chloride process
American Cyanamid Co., Savannah, Ga	64,000	46,000
E. I. du Pont de Nemours & Co., Inc.:		
Antioch, Calif	--	35,000
De Lisle, Miss	--	150,000
Edge Moor, Del	--	110,000
New Johnsonville, Tenn	--	228,000
Gulf + Western Natural Resources Group, Chemicals Div.:		
Ashtabula, Ohio	--	35,000
Gloucester City, N.J	44,000	--
Kerr-McGee Chemical Corp., Hamilton, Miss	--	56,000
SCM Corp., Glidden Pigments Group:		
Ashtabula, Ohio	--	42,000
Baltimore, Md	66,000	42,000
Total	174,000	744,000

Table 6.—Components of U.S. titanium dioxide pigment supply and demand

(Short tons)

Component	1978 (gross weight)	1979 (gross weight)	1980 Gross weight	1980 TiO_2 content	1981 Gross weight	1981 TiO_2 content	1982 Gross weight	1982 TiO_2 content
Production	700,755	742,081	727,245	665,209	761,190	700,648	635,061	607,113
Shipments:[1]								
Quantity	714,547	756,941	731,546	681,264	778,116	727,854	707,075	662,487
Value (thousands)	$621,909	$720,265	$795,734	$795,734	$947,881	$947,881	$927,517	$927,517
Imports for consumption	117,708	104,968	97,590	[e]90,915	124,906	[e]117,412	138,922	[e]130,309
Exports	37,812	49,369	42,126	41,992	61,104	57,440	72,823	66,280
Stocks, end of period	93,370	54,008	83,237	[e]77,518	102,189	[e]96,058	86,933	[e]81,543
Apparent consumption[2]	801,728	837,042	753,480	[e]686,911	[e]806,040	[e]742,080	716,416	[e]685,657

[e]Estimated.
[1]Includes interplant transfers.
[2]Apparent consumption = production plus imports minus exports minus stock increase.

Sources: U.S. Bureau of the Census and U.S. Bureau of Mines. 1980 is the 1st year for which actual TiO_2 content data are available for total production.

CONSUMPTION AND USES

Concentrates.—The total amount of titanium in concentrates consumed domestically decreased in 1982, along with the decrease in TiO_2 pigment production and titanium metal production. Most of the decrease in consumption was in the form of ilmenite.

Metal.—Demand for titanium sponge, ingot, and mill products declined sharply in 1982, mainly because of continued decline in orders for commercial aircraft. Demand for titanium in the nonaerospace industrial market also slackened, as both power generation and chemical processing industries trimmed capital investment plans. New orders for metal were also kept low because of extensive inventory accumulation in all product forms during 1980-81.[13]

In 1982, mill product shipments were 41% in the form of billet; 44% sheet, strip, plate, tubing, pipe, and extrusions; 13% rod and bar; and 2% fastener stock and wire. Castings amounted to about 1.5% of mill product shipments. As in 1981, bar and billet were the major forms used for aerospace gas turbine engines and airframe forgings, while the other forms were used mainly for nonaerospace industrial applications. Mill product usage in 1982 was estimated to be about 77% for aerospace and 23% for other industrial uses. Allowing for the portion of titanium scrap that was used in steel and other alloys, overall consumption of titanium was estimated at about 67% for aerospace, 20% for other industrial uses, and 13% for alloying purposes.

Table 7.—Consumption of titanium concentrates in the United States

(Short tons)

Year	Ilmenite[1]		Titanium slag		Rutile (natural and synthetic)	
	Gross weight	TiO_2 content[e]	Gross weight	TiO_2 content[e]	Gross weight	TiO_2 content[e]
1978	792,289	475,448	128,826	91,490	263,184	245,184
1979	791,063	487,228	144,708	106,346	313,761	292,912
1980	848,607	513,315	181,582	133,933	297,582	277,882
1981:						
Alloys and carbide	(2)	(2)	(3)	(3)	--	--
Pigments	843,055	501,301	252,826	186,020	[4]206,257	[4]192,779
Welding-rod coatings and fluxes	(2)	(2)	--	--	7,389	6,944
Miscellaneous[5]	13,061	9,721	--	--	71,725	66,873
Total	856,116	511,022	252,826	186,020	[4]285,371	[4]266,596
1982:						
Alloys and carbide	(2)	(2)	(3)	(3)	--	--
Pigments	574,634	345,618	225,541	168,433	[4]194,994	[4]184,403
Welding-rod coatings and fluxes	(2)	(2)	--	--	5,607	5,275
Miscellaneous[5]	8,616	6,775	--	--	38,336	35,435
Total	583,250	352,393	225,541	168,433	[4]238,937	[4]225,113

[e]Estimated.
[1]Includes a mixed product containing rutile, leucoxene, and altered ilmenite.
[2]Included with "Miscellaneous" to avoid disclosing company proprietary data.
[3]Included with "Pigments" to avoid disclosing company proprietary data.
[4]Includes synthetic rutile made in the United States.
[5]Includes ceramics, chemicals, glass fibers, and titanium metal.

Table 8.—U.S. distribution of titanium-pigment shipments, titanium dioxide content, by industry

(Percent)

Industry	1978	1979	1980	1981	1982
Paints, varnishes, lacquers	47.9	47.4	44.1	43.4	43.3
Paper	20.8	21.8	24.3	23.8	24.6
Plastics (except floor covering and vinyl-coated fabrics and textiles)	11.6	11.8	10.6	11.4	11.4
Rubber	2.8	2.9	2.1	2.2	2.3
Printing ink	2.0	1.9	2.8	1.3	.9
Ceramics	2.1	1.9	1.7	1.4	1.1
Other	6.7	7.1	8.2	8.6	6.4
Exports	6.1	5.2	6.2	7.9	10.0
Total	100.0	100.0	100.0	100.0	100.0

Table 9.—U.S. consumption of titanium products[1] in steel and other alloys

(Short tons)

	1978	1979	1980	1981	1982
Carbon steel	601	529	423	641	420
Stainless and heat-resisting steel	2,394	2,368	1,620	1,552	1,289
Other alloy steel (includes HSLA)	936	959	848	903	664
Tool steel	W	W	W	W	W
Total steel[2]	3,931	3,856	2,891	3,096	2,373
Cast irons	144	129	102	63	47
Superalloys	743	1,197	1,053	645	409
Alloys, other than above	255	234	272	254	200
Miscellaneous and unspecified	9	9	13	26	10
Total consumption	5,082	5,425	4,331	4,084	3,039

W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous and unspecified."
[1]Includes ferrotitanium containing 20% to 70% titanium and titanium metal scrap.
[2]Excludes data withheld and unspecified included under "Miscellaneous and unspecified."

The largest use of titanium was for compressor blades and wheels, stator blades, rotors, and other parts in aircraft gas turbine engines. The second largest use was in airframe structures of both military and commercial aircraft, such as wing-support structures, landing gears, ducting, and structures where resistance to heat is required. The most rapid growth in titanium use has been for those industrial uses requiring superior resistance to corrosion, such as surface condensers in powerplants, heat exchangers, and chemical industry equipment.

Pigment.—Consumption of TiO_2 in pigments decreased 8% in 1982 as a result of the general economic recession.

Ferrotitanium.—Consumption of ferrotitanium and titanium metal scrap in steel and other alloys decreased 26% in 1982, mainly because of lower steel production.

STOCKS

Stocks of titanium materials in the United States held by producers, consumers, and dealers are shown in table 10. The total TiO_2 content of stocks of concentrates decreased about 16%, mainly because of an 18% reduction in ilmenite stocks.

Table 10.—Stocks of titanium concentrates and pigment in the United States, December 31

(Short tons)

	Gross weight	TiO_2 content[e]
Ilmenite:[1]		
1980	931,541	584,280
1981[r]	813,656	515,431
1982	666,018	421,863
Titanium slag:[1]		
1980	171,898	127,981
1981	203,692	150,706
1982	135,765	103,667
Rutile:[1]		
1980	156,888	147,670
1981[r]	163,054	153,770
1982	176,079	165,762
Titanium pigment:[2]		
1980	NA	83,237
1981	NA	102,189
1982	NA	86,933

[e]Estimated. [r]Revised. NA Not available.
[1]Producer, consumer, and dealer stocks.
[2]U.S. Bureau of the Census. Producer stocks only.

PRICES

Published yearend prices of titanium concentrates and products in 1981 and 1982 are shown in table 11.

Concentrates.—U.S. prices of concentrates were stable or increased slightly in 1982, except for that of Florida rutile, which was reduced about 10%. Australian ilmenite prices increased somewhat, but Australian rutile prices declined 18% to 26%.

Metal.—Domestic metal prices were reportedly being discounted up to about 20% by yearend. Contrary to the practice in previous years, long-term contract prices for Japanese sponge were not established in 1982, and U.S. spot prices for sponge from Japan in the range of $3.75 to $4.00 per pound were reported during the last quarter.

Pigment.—Because of slack demand and competition from imported material, published prices of TiO_2 pigment in 1982 were reportedly being discounted by about 10%.

Table 11.—Published prices of titanium concentrates and products

		1981[1]	1982[1]
Concentrates:			
Ilmenite, f.o.b. eastern U.S. ports	per long ton	$70.00-$75.00	$70.00-$75.00
Ilmenite, f.o.b. Australian ports	do	25.00- 27.00	28.00- 31.00
Ilmenite, large lots, bulk, f.o.b. Titen, Fla	do	39.00	44.00- 45.00
Rutile, f.o.b. eastern U.S. ports	per short ton	450.00-475.00	450.00-475.00
Rutile, bagged, f.o.b. Australian ports	do	307.00-327.00	240.00-250.00
Rutile, bulk, f.o.b. Australian ports	do	276.00-297.00	231.00-240.00
Rutile, large lots, bulk, f.o.b. Titen, Fla	do	350.00	310.00
Synthetic rutile, f.o.b. Mobile, Ala	do	340.00	350.00
Titanium slag, 70% to 72% TiO_2, f.o.b. Sorel, Quebec	per long ton	135.00	150.00
Titanium slag, 85% TiO_2, f.o.b. Richards Bay, Republic of South Africa[e]	do	170.00-180.00	170.00-180.00
Metal:			
Sponge, domestic, f.o.b. plant	per pound	7.65	5.55- 5.85
Sponge, Japanese, under contract, c.i.f. U.S. ports, including import duty	do	8.85- 10.03	No quotation.
Sponge, imported, spot price	do	6.50- 7.00	6.50- 7.00
Mill products:			
Bar	do	18.00	18.00
Billet	do	15.00	15.00
Plate	do	17.00	17.00
Sheet and strip	do	20.00	20.00
Pigment:			
Titanium dioxide pigment, f.o.b. U.S. plants, anatase	do	.69	.69
Titanium dioxide pigment, f.o.b. U.S. plants, rutile	do	.75	.75

[e]Estimated.
[1]End of period.

FOREIGN TRADE

Exports and imports of titanium materials are shown in tables 12 through 15. Observable trends since 1980 include rather consistent increases in exports and imports of TiO_2 pigments and decreases in imports of natural and synthetic rutile. The major change in 1982 was the 79% drop in sponge imports from the 6,490-ton level reached in 1981.

Table 12.—U.S. exports of titanium products, by class

Class	1980		1981		1982	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Concentrates:						
Ilmenite	NA	NA	NA	NA	19,230	$618
Rutile	17,830	$3,444	7,297	$2,099	2,452	661
Total	17,830	3,444	7,297	2,099	21,682	[1]1,280
Metal:						
Sponge	113	1,088	58	451	36	256
Other unwrought	344	2,891	257	2,244	173	1,218
Scrap	3,300	12,681	3,280	6,811	4,287	6,718
Ingots, billets, slabs, etc	3,278	61,962	4,203	105,647	2,196	60,240
Other wrought	1,845	51,589	1,846	53,807	1,404	40,368
Total	8,880	130,211	9,644	168,960	8,096	108,800
Pigment and oxides:						
Titanium dioxide pigments	42,126	43,352	61,104	63,398	72,823	77,657
Titanium compounds, except pigment-grade	3,669	6,005	1,328	3,004	1,299	4,411
Total	45,795	49,357	62,432	66,402	74,122	82,068

NA Not available.
[1]Data do not add to total shown because of independent rounding.

Table 13.—U.S. imports for consumption[1] of titanium concentrates, by country

Concentrate and country	1980 Quantity (short tons)	1980 Value (thousands)	1981 Quantity (short tons)	1981 Value (thousands)	1982 Quantity (short tons)	1982 Value (thousands)
Ilmenite:						
Australia	338,676	$5,843	r234,562	r$5,791	342,279	$8,671
Finland	27	1	--	--	--	--
Germany, Federal Republic of[2]	--	--	--	--	24	2
India	18,739	829	--	--	--	--
Netherlands[2]	46	2	--	--	--	--
Norway	--	--	1,656	96	--	--
Sri Lanka	--	--	--	--	6,063	92
Total[3]	357,488	6,674	r236,217	r5,887	348,366	8,765
Titanium slag:						
Canada	145,475	14,299	246,137	27,326	201,168	24,908
South Africa, Republic of	49,519	6,115	22,685	3,001	45,685	7,348
Other	--	--	3	2	992	609
Total[3]	194,994	20,414	268,825	30,328	247,845	32,865
Rutile, natural:						
Australia	143,038	30,379	88,345	28,887	74,501	20,498
Malaysia	267	2,451	11	187	--	--
Sierra Leone	40,900	9,515	25,236	6,983	53,308	13,200
South Africa, Republic of	18,907	4,806	47,406	11,723	11,320	2,431
Thailand	197	1,643	--	--	--	--
Other	33	951	25	9	2	2
Total[3]	203,342	49,745	161,022	47,790	139,131	36,131
Rutile, synthetic:						
Australia	60,962	9,050	39,708	8,854	22,744	2,876
Germany, Federal Republic of	2	4	--	--	--	--
India	10,471	1,675	440	1,886	--	--
Japan	6,590	2,077	1,200	492	1,450	603
Taiwan	238	69	--	--	--	--
Other	--	--	3	2	--	--
Total[3]	78,263	12,874	41,351	11,234	24,194	3,479
Titaniferous iron ore:[4]						
Canada	10,185	423	12,271	509	6,996	336

rRevised.
[1]Adjusted by the U.S. Bureau of Mines.
[2]Country of transshipment rather than country of production.
[3]Data may not add to totals shown because of independent rounding.
[4]Includes materials consumed for purposes other than production of titanium commodities, principally heavy aggregate and steel furnace flux.

Table 14.—U.S. imports for consumption of titanium dioxide pigments, by country

Country	1980 Quantity (short tons)	1980 Value (thousands)	1981 Quantity (short tons)	1981 Value (thousands)	1982 Quantity (short tons)	1982 Value (thousands)
Australia	6,678	$5,830	5,341	$5,129	4,712	$4,850
Belgium-Luxembourg	422	385	4,860	4,525	4,731	4,902
Canada	10,325	10,445	15,710	17,288	21,912	25,135
Finland	4,392	4,018	5,196	5,262	4,026	4,176
France	12,771	12,470	22,663	24,029	20,862	22,726
Germany, Federal Republic of	27,126	25,921	38,482	39,229	37,506	37,432
Japan	4,471	4,741	4,724	4,936	5,266	6,084
Netherlands	323	318	2,635	1,893	--	--
Norway	4,217	3,716	4,992	4,583	7,312	7,125
South Africa, Republic of	1,110	878	--	--	--	--
Spain	7,579	6,595	13,017	13,061	19,234	19,614
United Kingdom	17,608	16,220	7,011	7,200	12,014	13,266
Yugoslavia	--	--	112	106	506	494
Other[1]	r568	r446	r162	r153	841	764
Total[2]	97,590	91,986	124,906	127,396	138,922	146,569

rRevised.
[1]Includes China, Gibraltar, Hong Kong, India, Italy, Mexico, and Sweden.
[2]Data may not add to totals shown because of independent rounding.

Table 15.—U.S. imports for consumption of titanium metal, by class and country

Class and country	1980 Quantity (short tons)	1980 Value (thousands)	1981 Quantity (short tons)	1981 Value (thousands)	1982 Quantity (short tons)	1982 Value (thousands)
Unwrought: Sponge						
Canada[1]	--	--	--	--	3	$32
China	861	$17,474	633	$9,947	24	287
Japan	3,720	39,546	5,747	81,822	1,283	16,753
U.S.S.R	165	2,741	110	1,746	44	160
United Kingdom	(2)	1	--	--	--	--
Other	31	452	--	--	--	--
Total	4,777	60,214	6,490	93,515	1,354	17,232
Ingot and billet:						
Austria	--	--	58	792	20	194
Canada	(2)	2	(2)	3	35	634
China	45	1,625	80	2,150	(2)	1
Germany, Federal Republic of	24	812	48	988	6	134
Japan	61	1,459	38	678	66	1,154
U.S.S.R	48	613	--	--	13	182
United Kingdom	13	333	20	526	71	1,260
Other	1	10	--	--	(2)	2
Total[3]	191	4,854	244	5,139	212	3,560
Waste and scrap:						
Austria	57	702	30	83	--	--
Belgium	10	55	39	78	63	62
Canada	284	1,792	1,483	5,436	195	698
China	454	4,842	74	812	17	88
Finland	181	792	127	511	--	--
France	144	1,874	103	1,054	31	106
Germany, Federal Republic of	568	3,722	213	1,267	72	261
Japan	211	2,227	251	1,820	48	191
South Africa, Republic of	10	136	--	--	--	--
Sweden	42	328	98	599	69	197
Switzerland	36	170	--	--	--	--
U.S.S.R	1,411	4,619	406	1,053	280	516
United Kingdom	668	6,472	876	6,128	475	1,489
Other	r62	r709	r86	r733	26	41
Total[3]	4,138	28,440	3,787	19,574	1,277	3,648
Wrought titanium:						
Canada	486	4,203	610	4,617	469	7,549
China	66	2,308	--	--	5	279
Germany, Federal Republic of	28	486	55	1,863	(2)	24
Japan	344	7,576	377	11,810	367	7,495
United Kingdom	10	343	55	2,708	16	695
Other	12	352	19	575	12	199
Total[3]	946	15,269	1,116	21,573	870	16,240

r Revised.
[1] Country of transshipment rather than country of production.
[2] Less than 1/2 unit.
[3] Data may not add to totals shown because of independent rounding.

WORLD REVIEW

World production of titanium concentrates for 1978-82 is shown in table 16. A series of review articles was published in 1982 covering developments of the last several years in world titanium minerals production,[14] TiO_2 pigment markets,[15] and TiO_2 pigment production.[16]

Australia.—Australia continued to be the largest producer of titanium minerals. Australian exports of ilmenite in 1982 were mainly to the United States, the United Kingdom, Japan, the U.S.S.R, and Brazil; exports of rutile were mainly to the United States, the United Kingdom, and Japan.

In a paper on mineral sands, a senior Bureau of Mineral Resources officer stated that Australia's low mineral sands reserves were a cause for concern, and that 70% of demonstrated economic mineral-sands resources would be depleted by the turn of the century, based on projected output from known deposits. However, a substantial proportion of known reserves was "frozen" for environmental and other reasons, so that reserves, especially rutile, actually available for mining would be depleted much earlier. Latest estimates for demonstrated economic resources of mineral sands in Australia were rutile, 10.5 million tons; ilmenite, 48.1 million tons; zircon, 15.1 million tons; and monazite, 368,000 tons.[17]

Conzinc Riotinto of Australia Ltd., one of Australia's largest mining companies, and Westralian Sands Ltd. began an 18-month feasibility study of a proposed titanium sponge plant. The plant reportedly would have a capacity of at least 5,500 tons per year.[18]

Canada.—QIT-Fer et Titane Inc., owned by Standard Oil Co. (Ohio), produced commercial quantities of 78% TiO_2 slag in 1982 at its Sorel, Quebec, smelter on a test-run basis. The normal Sorelslag product contained 70% to 72% TiO_2. Pigment producers who have processed trial lots of the 78% TiO_2 slag have given favorable reports on its behavior in the sulfate process. QIT planned to build a beneficiation plant to remove more gangue from its ilmenite-hematite ore and to produce an 80% TiO_2 slag from the improved concentrate beginning in 1984.

Germany, Federal Republic of.—In March 1982, Bayer AG announced the end of its dumping of sulfate-process pigment plant wastes in the North Sea. The company said the decision to end the dumping was due to the development of new process technologies that allow the recycling of sulfuric acid from these wastes.[19] In September 1982, the Dutch Council of State at The Hague rejected pleas for the termination of the dumping permits granted to two West German firms, Kronos Titan AG and Pigment Chemie. Although the dumping was not in line with the aims of European Economic Community legislation, the two companies had their dumping permits extended on the grounds that production cutbacks, and therefore job losses, would result if they were prevented from disposing of their waste at sea. However, it was the Dutch Government's stated intention to end all sea dumping that falls within its jurisdiction by the end of 1985.[20]

India.—Mishra Dhatu Nigam Co. Ltd. reportedly began production of titanium ingot in late summer 1982. The plant had a capacity of 1,000 tons of ingot per year, melting sponge from China, Japan, and the U.S.S.R.

Japan.—The 30th Anniversary Symposium of the Japan Titanium Society was held in Kobe in November 1982. The program included technical sessions on industry developments in Japan, the United States, and Europe and on titanium use for general industrial applications, commercial aircraft, and titanium alloys for jet engines. It was generally agreed that the future of the world's titanium industry will depend to a large extent on developing new applications and making titanium cost competitive with other metals.[21]

Osaka Titanium Co. Ltd. started operation of its new 5,500-ton-per-year sponge plant adjacent to its headquarters plant in Amagasaki, Japan. The new plant featured computer control in all phases of production. It was reportedly completed in 10 months at a cost of $28.6 million, bringing Osaka's sponge capacity to 19,800 tons per year. In case of production cutbacks, facilities in the old plant would be shut down. Japan's total annual sponge capacity in 1982 was estimated at 35,400 tons, including Toho Titanium Co. Ltd., 13,200 tons, and Nippon Soda Co. Ltd., 2,400 tons.

Japanese sponge producers had cut their operating rate to below 50% of capacity by early November 1982. The slow demand for titanium led Toho to suspend production of its sponge plant at Chigasaki for 1 month, beginning in mid-December 1982. The shutdown was aimed at reducing excessive stocks. In late November 1982, buyers of titanium in Japan were reportedly demanding that sponge prices be cut from $3.19 to $2.51 per pound.

During production cutbacks and layoff periods, both Osaka and Toho used a Government "employment adjustment subsidy" which provided laid-off workers full wages, with the cost shared equally by the Government and the employer.

Showa Denko K.K. and Ishizuka Research Institute submitted a detailed pollution statement plan for their proposed 3,300-ton-per-year, $20 million sponge plant at Toyama. The projected plant was claimed to be based on a new process using much larger reduction and separation furnaces than those currently in use, with possible electric power consumption savings of more than 30%.[22] Initial production was planned for mid-1983.

Sponge production in Japan in 1982 fell 32% from that of 1981 to 18,575 tons. Production in the last quarter of 1982 was 3,497 tons, or about 40% of capacity.

Table 16.—Titanium: World production of concentrates (ilmenite, leucoxene, rutile, and titaniferous slag), by concentrate type and country[1]

(Short tons)

Concentrate type and country	1978	1979	1980	1981[p]	1982[e]
Ilmenite and leucoxene:[2]					
Australia:					
Ilmenite	1,383,400	[r]1,267,656	1,442,924	1,452,033	[3]1,276,463
Leucoxene	[r]17,752	[r]24,001	26,393	21,657	[3]22,198
Brazil	22,131	[r]14,541	18,562	16,631	17,000
China	NA	NA	NA	150,000	150,000
Finland	145,395	131,947	175,267	178,023	176,000
India[4]	178,063	161,867	185,078	208,147	209,000
Malaysia[5]	205,929	220,262	208,470	190,432	121,000
Norway	845,461	903,690	912,508	724,907	[3]608,215
Portugal	358	295	258	368	370
Sri Lanka	36,421	61,035	37,430	88,197	88,000
U.S.S.R.[e]	450,000	450,000	460,000	470,000	475,000
United States[6]	589,751	639,292	548,882	509,342	[3]227,844
Total	[r]3,874,661	[r]3,874,586	4,015,772	4,009,737	3,371,090
Rutile:					
Australia	283,376	[r]307,435	323,801	263,729	[3]243,343
Brazil	402	484	472	190	220
India[4]	6,239	5,445	5,908	9,647	8,800
Sierra Leone[7]	--	[r]8,267	52,356	55,992	[3]52,590
South Africa, Republic of[e]	20,000	46,000	53,000	55,000	52,000
Sri Lanka	12,673	16,176	14,097	14,662	14,300
U.S.S.R.[e]	10,000	10,000	10,000	10,000	10,000
United States	W	W	W	W	W
Total	332,690	[r]393,807	459,634	409,220	381,253
Titaniferous slag:					
Canada[8]	937,000	[r]525,840	964,200	837,000	750,000
Japan[8]	193	198	--	--	--
South Africa, Republic of[e 9]	100,000	316,000	379,000	408,000	420,000
Total	1,037,193	[r]842,038	1,343,200	1,245,000	1,170,000

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data.

[1]Table excludes production of anatase ore in Brazil (4,298,731 tons produced prior to 1979 and apparently largely mined in 1978; 7,373,074 tons mined during 1979; and unreported quantities mined in 1980 and 1981), all of which was stockpiled without beneficiation. This material reportedly contains 20% TiO_2. The table includes data available through June 15, 1983.

[2]Ilmenite is also produced in Canada and in the Republic of South Africa, but this output is not included here because an estimated 90% is duplicative of output reported under "Titaniferous slag," and the rest is used for purposes other than production of titanium commodities, principally as steel furnace flux and heavy aggregate.

[3]Reported figure.

[4]Data are for fiscal year beginning Apr. 1 of year stated.

[5]Exports.

[6]Includes a mixed product containing ilmenite, leucoxene, and rutile.

[7]Contains 96% TiO_2.

[8]Contains 70% to 72% TiO_2.

[9]Contains 85% TiO_2.

Norway.—Construction of a plant to produce 220,000 tons per year of a 75% TiO_2 slag and about 110,000 tons per year of coproduct pig iron was expected to start at Tyssedal in western Norway in January 1983, with completion scheduled for 1985. The plant will replace the aging Government-owned DNN Aluminium AS smelter at Tyssedal and will be a joint effort between DNN, Elkem AS, and Titania AS. Titania, an NL Industries subsidiary, will supply ilmenite feed material from its Tellnes Mine near Hauge i Dalane in southern Norway and will assist in marketing the slag to sulfate-process titanium dioxide pigment plants.[23]

Sierra Leone.—Mining of rutile by Sierra Rutile Ltd. (SRL) was suspended for the last 3 months of 1982, because of the depressed market for titanium concentrates. Shipments were made from stocks through yearend.

Nord Resources Corp. of Ohio, announced that, following purchase in November 1982 of Bethlehem Steel Corp.'s 85% interest in SRL, it purchased the interests of its partner, Glickenhaus & Co., in SRL. Nord also made an agreement with The Anaconda Minerals Company, a division of Atlantic Richfield Co., giving Anaconda the right to purchase a 50% interest in SRL. Anaconda declined to exercise this right in early 1983, leaving Nord as the sole owner of SRL. Nord reportedly intended to continue operation of the property.

South Africa, Republic of.—Richards Bay Minerals (RBM) completed a $17.4 million expansion project that involved construction of a second pond, dredge, and floating concentrator. The expansion allows the utilization of lower grade reserves than have been mined so far. RBM has reportedly had no difficulty selling all it can produce.[24]

Spain.—The Spanish Government approved the sale of a 55% share of Titanio S.A., owned by Unión Explosivos Rio Tinto S.A., to the Tioxide Group, Ltd., of the United Kingdom, making Tioxide the sole owner of Titanio. Titanio has a production capacity of about 50,000 tons per year of TiO_2 pigments at its sulfate process plant near Huelva, in southern Spain.

U.S.S.R.—Based on reported plans to increase titanium production at Ust'-Kamenogorsk by 27.1% between 1981 and 1985, it is estimated that Soviet sponge production in 1982 was about 44,000 tons, and that production capacity was about 50,000 tons. There were reports that the U.S.S.R. had built at least six titanium-hulled Alfa class nuclear-powered attack submarines. U.S. Navy spokesmen confirmed that although the Alfa is nondetectable by magnetic devices, it is noisy and can be detected acoustically.[25]

United Kingdom.—Deeside Titanium Ltd. in Deeside, Wales, began production of titanium granules in the last quarter of 1982. The 5,500-ton-per-year plant is owned jointly by Billiton (U.K.) Ltd. (62.5%), Rolls Royce Ltd. (20%), and IMI Titanium Ltd., (17.5%), and replaces the ICI Ltd. Wilton works at Teeside, which had a capacity of 4,000 tons per year. Like the Wilton plant, the Deeside operation will use a sodium-reduction process, producing granular sponge metal that is claimed to be the only material that will yield the high-quality alloys needed by Rolls Royce for aerospace applications.[26] Much of the Deeside granules will be used by the IMI Witton works in Birmingham, which has melting capacity of over 5,500 tons per year. Further expansion of melting capacity was begun in late 1982.[27]

TECHNOLOGY

The Bureau of Mines studied methods for recovering unreacted titanium minerals and petroleum coke from titanium chlorination plant wastes prior to neutralization with lime. Samples of solid chlorination wastes were separated by tabling to recover mineral concentrates containing 69.0% to 92.4% TiO_2, and by selective carbon flotation to recover coke containing 94.0% to 96.8% carbon. Recovery of these materials would decrease the amount of solid waste to be disposed of by 65% to 85%. Preliminary tests on liquors obtained by leaching chlorination residues showed that large percentages of the vanadium, chromium, and columbium could be recovered by solvent extraction or ion exchange techniques.[28]

A bulletin was published summarizing the Bureau's research on the development of the inductoslag melting process. Inductoslag melting is an induction-melting technique using a segmented, water-cooled copper crucible. The process was developed as part of the Bureau's work on effective utilization of reactive metal scrap, and the process has been applied to melting titanium, zirconium, chromium, cobalt, iron, nickel, and vanadium.[29]

A National Materials Advisory Board (NMAB) report[30] on availability of titanium was completed and provided a broad, integrated overview of the titanium field. The NMAB panel concluded that, because of recent plant expansions and new plant construction, an excess of U.S. sponge production capacity over anticipated needs seems assured through the mid-1980's. Other problems cited include the world competitiveness of U.S. sponge plants, the quantity and form of metal in the stockpile, and promising technological opportunities that have not yet been extensively utilized. The panel suggested that the Government encourage U.S. titanium producers to modernize their plants by providing tax credits for research and development and by buying metal to alleviate deficiencies in the National Defense Stockpile.

Progress in forming titanium alloys directly to almost the desired shape, near-net-shape (NNS), continued. NNS technologies are now applicable as major manufacturing methods of producing structural and engine components for aircraft and have major advantages over conventional methods, including reduced material needs and cost, reduced machining requirements and cost, improved shape-making capability, and precise control of processing variables and resultant microstructure. Available NNS processes include precision forging, hot die-isothermal forging, powder metallurgy processing, hot isostatic pressing, precision casting, superplastic forming (SPF), and SPF-diffusion bonding processing.[31]

The Air Force completed tests of a center wing box for an advanced tactical fighter, the largest aircraft part yet made from SPF, a titanium alloy (Ti-6-4, containing 10% aluminum and 4% vanadium). The 1,361-pound wing box, made by Rockwell International Corp., weighs about 29% less than a similar wing box made by conventional methods, with an estimated 40% to 45% potential cost savings.[32] Other aircraft manufacturers such as Northrop Corp.[33] and McDonnell Aircraft Co.[34] reportedly were also making progress in the development of SPF and diffusion bonding of titanium into parts for aircraft. SPF was said to represent a major change in the forming of titanium and to allow consideration of titanium parts that were rejected in the past because of high fabrication costs.

Wyman-Gordon continued to conduct research programs on isothermal and near-isothermal forging in conjunction with the Air Force manufacturing technology program. Turbine components up to 18 inches in diameter were being isothermally forged from titanium alloys, with material savings of up to 30% compared with conventional forging.[35]

Large titanium parts in waterjet engines for hydrofoil boats were reported to be more economical than stainless steel or aluminum parts because of their longer life. The life of a powerjet engine made from a commercially pure titanium casting was said to be, at least from a theoretical standpoint, unlimited.[36]

As part of a study by Charles River Associates on critical materials, an analysis of the competition between titanium and stainless steel was conducted to determine the market for these materials in industrial piping into the early 1990's. Of the three major contenders for use in heat exchanger tubing, stainless steel, copper-nickel alloys, and titanium, titanium was the most expensive at equal wall thickness. As the relative thickness of tubing is reduced, titanium becomes increasingly competitive with stainless steels. At the existing relative cost, titanium was expected to capture essentially all of the nuclear powerplant market because of the stress on total reliability, but stainless steels were expected to increase their overall market share with respect to titanium and other tubing materials through 1990.[37]

Competing inventors were building experimental engines based on the shape-memory properties of Nitinol, a nickel-titanium alloy (NiTi). After being forcibly deformed, Nitinol springs back to its original shape on heating over a narrow temperature range and returns to the deformed shape on cooling. Commercial applications have been limited to some orthodontic materials and tubing couplings, but investigators see no fundamental barrier to the development of a practical Nitinol engine.[38] A copper-aluminum-nickel alloy was developed that provides a fully reversible (two-way) shape-memory effect at significantly higher temperatures than those afforded by commercial memory alloys such as Nitinol and copper-zinc-aluminum.[39]

Suisman Titanium Corp., a subsidiary of Suisman & Blumenthal, Inc., was granted a U.S. patent on an invention involving a technique and apparatus for removing high-density inclusions from titanium scrap turnings. The invention reportedly allows, for the first time, open-market titanium turnings to be returned to rotor-grade-quality titanium ingots.[40]

The Colorado School of Mines sponsored a symposium on critical and strategic materials, including a session on titanium. Presentations were made on economic, social, raw material, technology, aerospace, and industrial aspects of the titanium metal industry.[41]

A new nonpigmentary hiding additive for paints was described. It is supplied as an aqueous emulsion of a polymer that on drying remains as discrete particles. When water-based paints containing this additive are applied and allowed to dry, water in the core of each polymer particle diffuses out, leaving a sealed air void that serves as a light-scattering site and contributes to hiding. The opaque polymer also improves the hiding efficiency of TiO_2 by spacing the pigment particles.[42]

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Tungsten

By Philip T. Stafford[1]

Consumption of tungsten fell to its lowest level since 1975, and imports were at their lowest level since 1978. Mine production decreased 58% from that of 1981, to the lowest level since 1950. Tungsten prices fell 35%, primarily during the second and fourth quarters, to the lowest prices since 1975.

During 1982, more than 95% of domestic production came from five mining operations: two in California, two in Nevada, and one in Colorado. Most mines, mills, and ammonium paratungstate (APT) plants were closed part of the year.

The 19-year deadlock between tungsten producing and consuming countries continued, as no agreement was reached during 1982 at the Geneva conference on stabilization of the world tungsten market.

Domestic Data Coverage.—Domestic production data for tungsten are developed by the Bureau of Mines by means of three separate, voluntary surveys. These surveys are the Tungsten Ore and Concentrate, Tungsten Concentrate and Tungsten Products, and Tungsten Concentrate. Of the 48 operations to which surveys were sent, 100% responded, and the data are reported in table 1.

Table 1.—Salient tungsten statistics

(Thousand pounds of contained tungsten and thousand dollars)

	1978	1979	1980	1981	1982
United States:					
Concentrate:					
Mine production	6,896	6,643	6,072	7,948	3,354
Mine shipments	6,901	6,646	6,036	7,815	3,473
Value	$56,691	$55,785	$50,575	$62,231	$22,062
Consumption	18,806	21,589	20,432	21,692	9,935
Shipments from Government stocks	5,399	5,183	3,755	2,111	759
Exports	1,853	1,929	2,029	175	672
Imports for consumption	9,138	11,352	11,372	11,752	7,778
Stocks, Dec. 31:					
Producer	87	84	106	239	120
Consumer	1,424	1,538	1,325	1,480	2,891
Ammonium paratungstate:					
Production	16,062	17,758	16,897	19,522	10,833
Consumption	17,572	18,720	18,585	20,206	12,947
Stocks, Dec. 31: Producer and consumer	1,037	879	966	1,541	1,649
Primary products:					
Production	19,028	21,178	20,138	21,959	14,199
Consumption	18,296	20,433	20,200	21,192	13,997
Stocks, Dec. 31:					
Producer	3,349	3,385	3,524	3,245	3,256
Consumer	2,376	2,543	2,370	2,063	2,057
World: Concentrate:					
Production	[r]101,537	[r]106,937	112,899	[p]108,481	[e]98,926
Consumption	100,442	[r]106,896	112,263	[p]106,702	[e]88,658

[e]Estimated. [p]Preliminary. [r]Revised.

Legislation and Government Programs.—The General Services Administration (GSA) Office of Stockpile Transactions continued to sell excess stockpiled tungsten concentrate on the basis of monthly sealed bids. From January through September, regular offerings of excess concentrate were made at the disposal rate of 600,000 pounds of contained tungsten per month, of which 450,000 pounds was for domestic use and 150,000 pounds was for export. Additionally, supplemental offerings were made at the rate of 400,000 pounds per month, of which 300,000 pounds was for domestic use and 100,000 pounds was for export. From October through yearend, the monthly quantities offered were halved for regular-grade concentrate to 300,000 pounds, of which 225,000 pounds was for domestic use and 75,000 pounds was for export. The supplemental offerings were reduced to 200,000 pounds, of which 150,000 pounds was for domestic use and 50,000 pounds was for export. As a result of the regular and supplemental offerings, concentrate sales totaled 762,003 pounds of tungsten, of which 218,458 pounds was for domestic use and 543,545 pounds was for export. Actual shipments of excess concentrate from the stockpile totaled 758,640 pounds of contained tungsten in concentrate.

Stockpile goals in effect during 1982 remained as established in May 1980 by the Federal Emergency Management Agency and are shown in table 2.

Table 2.—U.S. Government tungsten stockpile material inventories and goals

(Thousand pounds of contained tungsten)

Material	Goals	Inventory by program, Dec. 31, 1982		
		National stockpile	DPA[1] inventory	Total
Tungsten concentrate:				
Stockpile grade	55,450	56,398	158	56,556
Nonstockpile grade	--	29,589	195	29,784
Total	55,450	85,987	353	86,340
Ferrotungsten:				
Stockpile grade	--	841	--	841
Nonstockpile grade	--	1,185	--	1,185
Total[2]	--	2,025	--	2,025
Tungsten metal powder:				
Stockpile grade	1,600	1,567	--	1,567
Nonstockpile grade	--	332	--	332
Total	1,600	1,899	--	1,899
Tungsten carbide powder:				
Stockpile grade	2,000	1,921	--	1,921
Nonstockpile grade	--	112	--	112
Total	2,000	2,033	--	2,033

[1]Defense Production Act (DPA) of 1950.
[2]Data may not add to totals shown because of independent rounding.

DOMESTIC PRODUCTION

Mine production fell 58% compared with that of 1981 and totaled 3.4 million pounds of contained tungsten in 1982, the smallest amount since 1950. Mine shipments decreased 56% to 3.5 million pounds. Although 24 mines in 5 Western States reported production, 5 mines provided more than 95% of the domestic tungsten production. No mine operated continuously, although the Strawberry Mine and mill of Teledyne Tungsten, a subsidiary of Teledyne, Inc., near North Fork, Calif., in Madera County, produced tungsten concentrate except during the winter, when it was closed owing to weather conditions.

Normally the largest producer, the Pine Creek Mine of the Metals Div., Union Carbide Corp. (UCC), located near Bishop, Calif., in Inyo County, was closed from early August through yearend, operating at a reduced capacity from April until its closure. The mill closed from mid-April through late December. Of the other major mines, the Emerson Mine and mill of UCC, at Tempiute, Nev., in Lincoln County, was closed from early 1982 through yearend; the Climax Mine and mill of Climax Molybdenum Co., a division of AMAX Inc., at Climax, Colo., in Lake County, principally a molybdenum producer, did not produce tungsten concentrate after September; and the Springer Mine and mill of Utah International Inc., near Imlay, Nev., in Pershing County, produced at a reduced level from its initial opening in April until its closure in October.

Intermittent tungsten concentrate production and shipments were reported from Kern, Los Angeles, Mono, San Bernardino, and San Diego Counties, Calif.; Boulder and Fremont Counties, Colo.; Valley County, Mont.; and Churchill, Elko, Mineral, Nye, Storey, and White Pine Counties, Nev.

The major domestic companies engaged in tungsten operations during 1982 are listed in table 4.

Table 3.—Tungsten concentrate shipped from mines in the United States

Year	Quantity			Reported value, f.o.b. mine[3]		
	Short tons, 60% WO_3 basis[1]	Short ton units of WO_3[2]	Tungsten content (thousand pounds)	Total (thousands)	Average per unit of WO_3	Average per pound of tungsten
1978	7,252	435,117	6,901	$56,691	$130.29	$8.22
1979	6,984	419,040	6,646	55,785	133.13	8.40
1980	6,343	380,561	6,036	50,575	132.90	8.38
1981	8,213	492,764	7,815	62,231	126.29	7.96
1982	3,649	218,976	3,473	22,062	100.75	6.35

[1]A short ton of 60% tungsten trioxide (WO_3) contains 951.6 pounds of tungsten.
[2]A short ton unit equals 20 pounds of tungsten trioxide (WO_3) and contains 15.86 pounds of tungsten.
[3]Values apply to finished concentrate and are in some instances f.o.b. custom mill.

Table 4.—Major producers of tungsten concentrate and principal tungsten processors in the United States in 1982

Company	Location of mine, mill, or processing plant
Producers of tungsten concentrate:	
Climax Molybdenum Co., a division of AMAX Inc	Climax, Colo.
Teledyne Tungsten	North Fork, Calif.
Union Carbide Corp., Metals Div	Bishop, Calif., and Tempiute, Nev.
Utah International Inc	Imlay, Nev.
Processors of tungsten:	
AMAX Inc., AMAX Tungsten Div	Fort Madison, Iowa.
Adamas Carbide Corp	Kenilworth, N.J.
Fansteel Inc	North Chicago, Ill.
General Electric Co	Euclid, Ohio, and Detroit, Mich.
GTE Products Corp	Towanda, Pa.
Kennametal Inc	Latrobe, Pa., and Fallon, Nev.
Li Tungsten Corp	Glen Cove, N.Y.
North American Phillips Lighting Corp	Bloomfield, N.J.
Teledyne Firth Stirling	McKeesport, Pa.
Teledyne Wah Chang Huntsville	Huntsville, Ala.
Union Carbide Corp., Metals Div	Niagara Falls, N.Y.

CONSUMPTION

Domestic consumption of tungsten in primary products fell 34%, to its lowest level since 1975. The major end use, 57% of the total, continued to be in cutting and wear-resistant materials, primarily as tungsten carbide. Other end uses were mill products, 25%; specialty steels, 3%; chemicals, 5%; superalloys, 5%; hard-facing rods and materials, 2%; and miscellaneous, 3%.

Consumption of tungsten products used to make end-use items was distributed as follows: tungsten carbide, 59%; tungsten metal powder, 27%; tungsten scrap, 4%; scheelite, 3%; ferrotungsten, 1%; and other, 6%.

Table 5.—Production, disposition, and stocks of tungsten products in the United States

(Thousand pounds of contained tungsten)

	Hydrogen- and carbon-reduced metal powder	Tungsten carbide powder: Made from metal powder	Tungsten carbide powder: Crushed and crystalline	Chemicals	Other[1]	Total
1981						
Gross production during year	19,754	11,146	2,532	7,606	383	41,421
Used to make other products listed here	11,485	282	526	7,075	94	19,462
Net production	8,269	10,864	2,006	531	289	21,959
Disposition:						
To other processors	569	2,916	602	42	41	4,170
To end-use consumers	10,043	6,553	521	548	201	17,866
To make products not listed in this table	1,854	2,058	1,592	13	--	5,517
Producer stocks, Dec. 31	1,721	684	626	121	93	3,245
1982						
Gross production during year	13,425	7,487	1,661	5,813	183	28,569
Used to make other products listed here	8,775	44	416	5,081	54	14,370
Net production	4,650	7,443	1,245	732	129	14,199
Disposition:						
To other processors	390	1,637	234	163	3	2,427
To end-use consumers	5,091	4,730	285	403	113	10,622
To make products not listed in this table	1,961	1,423	945	13	9	4,351
Producer stocks, Dec. 31	1,678	570	657	265	86	3,256

[1]Includes ferrotungsten, scheelite (produced from scrap), nickel-tungsten, and self-reducing oxide pellets.

Table 6.—Consumption and stocks of tungsten products in the United States in 1982, by end use

(Thousand pounds of contained tungsten)

End use	Ferro-tungsten	Tungsten metal powder[1]	Tungsten carbide powder	Scheelite (natural, synthetic)	Tungsten scrap[2]	Other tungsten materials[3]	Total
Steel:							
Stainless and heat-resisting	29	--	--	26	W	--	55
Alloy	24	--	--	W	W	2	26
Tool	106	--	--	280	W	6	392
Superalloys	W	304	W	W	280	75	659
Alloys (excludes steels and superalloys):							
Cutting and wear-resistant materials	--	63	7,958	--	W	2	8,023
Other alloys[4]	5	115	215	--	11	1	347
Mill products made from metal powder	--	3,353	W	--	--	--	3,353
Chemical and ceramic uses	--	--	--	--	--	729	729
Miscellaneous and unspecified	24	1	86	38	264	--	413
Total	188	3,836	8,259	344	555	815	13,997
Consumer stocks, Dec. 31, 1982	91	112	1,376	149	172	157	2,057

W Withheld to avoid disclosing company proprietary data; included in "Miscellaneous and unspecified."
[1]Includes both carbon-reduced and hydrogen-reduced tungsten metal powder.
[2]Does not include that used in making primary tungsten products.
[3]Includes melting base, self-reducing tungsten, tungsten chemicals, and others.
[4]Includes welding and hard-facing rods and materials and nonferrous alloys.

PRICES

In 1982, the average value of tungsten concentrate shipped from domestic mines and mills, as reported to the Bureau of Mines, decreased 20% to $100.75 per short ton unit of WO_3, compared with the 1981 value. Excess tungsten concentrate was purchased from GSA during the year at prices ranging from $92.66 to $99.65 per short ton unit for domestic use and from $94.09 to $96.29 per short ton unit for export.

The European prices of tungsten concentrate as reported in Metal Bulletin of London, the U.S. spot quotations as reported in Metals Week, and the International Tungsten Indicator prices showed similar trends and similar monthly and annual averages for 1982. The price of concentrate was unusually stable from 1978 until October 1981, when it began a drop that extended through 1982. For the year, prices fell 35%.

The reported price of APT delivered to large-volume contract customers was $151.75 per short ton unit at the beginning of 1982. It fell to $142.03 on April 1, to $138.77 on July 1, and to $129.54 on October 1, remaining at that level for the remainder of 1982.

The price of hydrogen-reduced tungsten metal powder, 99% purity, f.o.b. shipping point, as quoted in Metals Week, fell from a range of $13.90 to $15.50 per pound at the beginning of the year to a range of $13.10 to $13.72 on April 1, remaining at that level for the remainder of 1982. Within these ranges, the price was primarily dependent upon the particle size of the tungsten powder.

Table 7.—Monthly price quotations of tungsten concentrate in 1982

Month	Metal Bulletin (London), wolframite, European market, 65% WO_3 basis[1]					Metals Week, U.S. spot quotations, dollars per short ton unit of WO_3 65% basis, c.i.f. U.S. ports[2]			International Tungsten Indicator, weighted average price,[3] 60% to 79% WO_3	
	Dollars per metric ton unit of WO_3		Equivalent prices, dollars per short ton unit of WO_3							
	Low	High	Low	High	Average	Low	High	Average	Dollars per metric ton unit	Dollars per short ton unit
January	124.50	128.75	112.94	116.80	114.87	110.80	116.40	113.60	125.58	113.92
February	124.88	128.13	113.28	116.23	114.76	112.00	116.50	114.25	129.05	117.07
March	113.45	118.33	102.92	107.35	105.13	101.25	108.50	104.88	122.63	111.25
April	101.75	106.50	92.31	96.62	94.46	89.80	96.00	92.90	109.61	99.44
May	105.88	109.50	98.05	99.34	98.69	93.00	96.25	94.63	109.91	99.71
June	110.38	113.38	100.13	102.85	101.49	94.50	98.50	96.50	110.22	99.99
July	108.56	112.67	98.48	102.21	100.34	95.00	100.00	97.50	112.56	102.11
August	102.38	106.00	92.87	96.16	94.52	95.00	100.00	97.50	110.35	100.11
September	100.00	104.00	90.72	94.35	92.53	95.00	100.00	97.50	107.27	97.31
October	94.33	98.33	85.58	89.21	87.39	91.00	94.40	92.70	102.46	92.95
November	85.67	90.67	77.72	82.25	79.98	83.25	87.00	85.13	102.73	93.20
December	78.00	84.25	70.76	76.43	73.60	81.00	85.00	83.00	94.50	85.73

[1]Low and high prices are reported semiweekly. Monthly equivalent averages are arithmetic averages of semiweekly equivalent low and high prices. The equivalent average price per short ton unit of WO_3, which is an average of all semiweekly low and high prices, excluding duty, was $96.27 for 1982.

[2]Low and high prices are reported weekly. Monthly averages are arithmetic averages of weekly low and high prices. The average price per short ton unit of WO_3, which is an average of all weekly low and high prices, excluding duty, was $97.36 for 1982.

[3]Weighted average price per short ton unit of WO_3, excluding duty, was $102.68 for 1982.

FOREIGN TRADE

Exports of tungsten in concentrate and primary products decreased 15% from 5.2 million pounds in 1981 to 4.4 million pounds in 1982. Imports decreased 19% from 14.6 million pounds in 1981 to 11.8 million pounds in 1982.

Import duties for tungsten materials in effect January 1, 1982, as published in the Tariff Schedules of the United States, Annotated (1982), are shown in table 17.

Table 8.—U.S. exports of tungsten ore and concentrate, by country

(Thousand pounds and thousand dollars)

Country	1981		1982	
	Tungsten content	Value	Tungsten content	Value
Belgium	--	--	87	325
Bolivia	--	--	2	9
Canada	10	60	10	72
Germany, Federal Republic of	93	482	495	2,672
Netherlands	--	--	77	300
Sweden	72	608	1	6
Venezuela	--	--	([1])	3
Total	175	1,150	672	3,387

[1]Less than 1/2 unit.

Table 9.—U.S. exports of ammonium paratungstate, by country

(Thousand pounds and thousand dollars)

	1981			1982		
	Gross weight	Tungsten content[1]	Value	Gross weight	Tungsten content[1]	Value
Australia	1	(2)	2	(2)	(2)	1
France	3	2	7	3	2	8
Germany, Federal Republic of	1	(2)	5	1	(2)	7
Israel	--	--	--	(2)	(2)	1
Total[3]	4	3	14	4	3	17

[1]Tungsten content estimated by multiplying gross weight by 0.7066.
[2]Less than 1/2 unit.
[3]Data may not add to totals shown because of independent rounding.

Table 10.—U.S. exports of tungsten carbide powder, by country

(Thousand pounds and thousand dollars)

Country	1981		1982	
	Tungsten content	Value	Tungsten content	Value
Argentina	11	182	33	477
Australia	8	132	2	26
Austria	39	255	50	513
Belgium-Luxembourg	12	349	3	60
Brazil	35	836	10	239
Canada	311	5,033	172	2,303
Colombia	--	--	1	9
France	11	78	(1)	20
Germany, Federal Republic of	216	3,056	434	3,336
India	3	74	2	92
Ireland	4	94	--	--
Israel	128	908	19	58
Italy	13	332	44	906
Japan	66	992	173	1,860
Korea, Republic of	1	39	--	--
Mexico	155	2,613	44	906
Netherlands	92	1,036	14	409
Peru	6	74	(1)	4
Romania	--	--	66	618
Singapore	(1)	10	15	203
South Africa, Republic of	3	45	4	91
Sweden	(1)	4	2	16
Switzerland	30	404	(1)	2
Taiwan	(1)	6	1	12
Thailand	1	24	(1)	21
United Kingdom	65	1,538	122	1,801
Venezuela	1	23	2	32
Other	1	r21	1	45
Total	[2]1,213	18,158	1,214	14,059

rRevised.
[1]Less than 1/2 unit.
[2]Data do not add to total shown because of independent rounding.

Table 11.—U.S. exports of tungsten and tungsten alloy powder, by country

(Thousand pounds and thousand dollars)

Country	1981			1982		
	Gross weight	Tungsten content[1]	Value	Gross weight	Tungsten content[1]	Value
Australia	68	54	815	1	1	12
Brazil	13	10	178	3	2	33
Canada	67	53	875	28	22	402
Finland	18	14	205	22	18	239
France	7	5	80	(2)	(2)	1
Germany, Federal Republic of	135	108	2,491	174	139	2,176
Israel	1,900	1,520	21,571	1,093	874	11,258
Italy	1	1	30	(2)	(2)	2
Japan	62	50	721	60	48	840
Korea, Republic of	--	--	--	9	7	137
Mexico	24	19	299	29	24	305
Netherlands	366	293	4,677	201	161	1,544
Singapore	(2)	(2)	3	1	1	10
Sweden	--	--	--	1	1	12
Switzerland	1	1	16	2	2	47
Turkey	6	4	119	--	--	--
United Kingdom	5	4	113	32	25	194
Other	1	1	r14	2	2	27
Total[3]	2,672	2,138	32,207	1,658	1,327	17,239

rRevised.
[1]Tungsten content estimated by multiplying gross weight by 0.80.
[2]Less than 1/2 unit.
[3]Data may not add to totals shown because of independent rounding.

Table 12.—U.S. exports of miscellaneous tungsten-bearing materials

(Thousand pounds and thousand dollars)

Product and country	1981		1982	
	Gross weight	Value	Gross weight	Value
Tungsten and tungsten alloy wire:				
Belgium-Luxembourg	5	490	1	88
Brazil	22	1,705	19	1,548
Canada	37	2,019	39	2,590
France	5	404	4	372
Germany, Federal Republic of	9	1,419	9	1,481
India	8	369	4	189
Italy	7	561	5	420
Japan	16	1,289	13	984
Korea, Republic of	4	224	1	82
Mexico	14	1,697	10	940
U.S.S.R.	21	807	9	375
United Kingdom	4	528	4	459
Other	r14	r1,776	6	1,173
Total	166	13,288	124	10,701
Unwrought tungsten and alloy in crude form, waste, and scrap:				
Austria	29	28	46	144
Belgium-Luxembourg	--	--	14	32
Canada	179	1,553	47	314
Germany, Federal Republic of	224	1,322	367	1,378
Italy	12	150	7	72
Mexico	25	182	3	21
Netherlands	12	90	--	--
South Africa, Republic of	7	95	8	88
Sweden	156	1,216	91	357
Switzerland	6	81	--	--
Thailand	58	151	--	--
United Kingdom	107	321	66	315
Other	r12	r109	31	158
Total	827	5,298	680	2,879
Other tungsten metal:				
Australia	4	211	4	240
Austria	29	88	11	65
Canada	42	1,634	45	1,571
France	7	366	12	537
Germany, Federal Republic of	255	5,342	95	1,549

See footnotes at end of table.

Table 12.—U.S. exports of miscellaneous tungsten-bearing materials —Continued

(Thousand pounds and thousand dollars)

Product and country	1981 Gross weight	1981 Value	1982 Gross weight	1982 Value
Other tungsten metal —Continued				
Italy	6	322	11	353
Japan	8	591	(1)	23
Mexico	10	572	27	614
Singapore	6	117	17	1,132
Sweden	(1)	5	5	49
United Kingdom	63	2,025	69	1,882
Other	r37	r1,130	54	1,342
Total	467	12,403	350	9,357

rRevised.
[1]Less than 1/2 unit.

Table 13.—U.S. imports for consumption of tungsten ore and concentrate, by country

(Thousand pounds and thousand dollars)

Country	1981 Tungsten content	1981 Value	1982 Tungsten content	1982 Value
Australia	304	2,364	34	235
Austria	--	--	16	113
Bolivia	2,511	19,724	1,418	8,511
Brazil	444	3,546	545	3,516
Burma	272	2,080	127	635
Canada	2,005	15,222	2,775	15,003
Chile	--	--	7	40
China	2,532	20,674	936	7,343
El Salvador	11	34	--	--
France	228	1,796	60	342
Germany, Federal Republic of	1	18	15	47
Guatemala	2	5	--	--
Italy	--	--	24	155
Korea, Republic of	156	1,257	20	167
Malaysia	62	483	72	386
Mexico	616	3,655	542	2,340
Peru	652	4,787	252	1,618
Portugal	1,028	8,159	528	3,534
Rwanda	19	154	--	--
Spain	49	396	--	--
Thailand	706	5,543	295	2,037
Turkey	52	393	7	47
United Kingdom	14	103	26	185
Zaire	89	802	77	495
Total[1]	11,752	91,195	7,778	46,748

[1]Data may not add to totals shown because of independent rounding.

Table 14.—U.S. imports for consumption of ammonium paratungstate, by country

(Thousand pounds and thousand dollars)

Country	1981 Tungsten content	1981 Value	1982 Tungsten content	1982 Value
Australia	16	141	57	422
China	743	6,585	941	7,109
Germany, Federal Republic of	49	444	192	1,873
Japan	23	228	--	--
Korea, Republic of	215	1,960	483	3,929
Total	1,046	9,358	1,673	13,333

Table 15.—U.S. imports for consumption of ferrotungsten, by country

(Thousand pounds and thousand dollars)

Country	1981 Tungsten content	1981 Value	1982 Tungsten content	1982 Value
Austria	92	814	24	193
Brazil	16	144	16	135
France	17	167	--	--
Germany, Federal Republic of	26	259	8	77
Portugal	155	1,462	94	747
Sweden	19	174	--	--
United Kingdom	--	--	11	70
Total	325	3,020	153	1,222

Table 16.—U.S. imports for consumption of miscellaneous tungsten-bearing materials

(Thousand pounds and thousand dollars)

Product and country	1981 Tungsten content	1981 Value	1982 Tungsten content	1982 Value
Other metal-bearing materials in chief value of tungsten:				
United Kingdom	19	129	--	--
Other	(1)	3	4	17
Total	19	132	4	17
Waste and scrap containing not over 50% tungsten:				
South Africa, Republic of	364	217	--	--
Other	r7	r64	2	15
Total	371	281	2	15
Waste and scrap containing over 50% tungsten:				
Australia	17	126	4	20
Belgium	36	320	9	62
Canada	83	691	63	314
China	1	12	17	174
France	72	569	16	119
Germany, Federal Republic of	251	2,049	104	772
Israel	445	3,220	658	3,831
Italy	3	23	24	178
Japan	109	1,002	297	2,254
Korea, Republic of	28	201	34	321
Netherlands	70	598	128	645
Poland	28	257	--	--
Singapore	78	1,078	79	789
Sweden	22	193	12	73
United Kingdom	241	1,812	239	1,566
Other	r3	r9	5	37
Total[2]	1,488	12,162	1,687	11,154
Unwrought tungsten, except alloys, in lumps, grains, and powders:				
Germany, Federal Republic of	91	1,153	132	1,341
Korea, Republic of	271	3,127	356	3,868
Other	9	111	12	135
Total	371	4,391	500	5,344
Unwrought tungsten, ingots, and shot	(1)	1	(1)	1
Unwrought tungsten, other:[3]				
China	--	--	21	331
Other	3	48	(1)	5
Total	3	48	21	336
Unwrought tungsten, alloys:				
China	--	--	70	810
Other	2	92	5	91
Total	2	92	75	901

See footnotes at end of table.

Table 16.—U.S. imports for consumption of miscellaneous tungsten-bearing materials —Continued

(Thousand pounds and thousand dollars)

Product and country	1981 Tungsten content	1981 Value	1982 Tungsten content	1982 Value
Wrought tungsten:[3]				
Austria	17	584	14	484
Canada	75	901	10	66
China	28	322	--	--
Japan	15	1,393	13	1,318
Netherlands	5	380	4	192
Singapore	8	97	([1])	([1])
United Kingdom	36	r315	3	72
Other	2	97	4	124
Total	186	4,089	48	[2]2,255
Tungstic acid	--	--	1	11
Calcium tungstate:				
Germany, Federal Republic of	27	610	26	622
United Kingdom	--	--	([1])	1
Total	27	610	26	623
Potassium tungstate	--	--	1	17
Sodium tungstate:				
China	([1])	1	15	109
Germany, Federal Republic of	([1])	2	--	--
Total	([1])	3	15	109
Tungsten carbide:				
Belgium	15	272	36	575
China	66	708	62	642
Germany, Federal Republic of	536	7,587	615	7,150
Korea, Republic of	110	1,302	66	768
Mexico	18	356	3	42
Taiwan	3	20	6	67
Other	r9	r129	10	146
Total	757	10,374	798	9,390
Other tungsten compounds:				
China	r79	r643	732	4,597
Other	1	r13	4	57
Total	r80	656	736	4,654
Mixtures, organic compounds, chief value in tungsten:				
France	--	--	12	137
Other	5	83	4	66
Total	5	83	16	203

rRevised.
[1]Less than 1/2 unit.
[2]Data may not add to totals shown because of independent rounding.
[3]Estimated from reported gross weight.

Table 17.—U.S. import duties on all forms of tungsten

TSUS No.	Item	Rate of duty effective Jan. 1, 1982	
		Most favored nation (MFN)	Non-MFN
601.54	Tungsten ore	17 cents per pound on tungsten content.	50 cents per pound on tungsten content.
603.45	Other metal-bearing materials in chief value of tungsten.	10 cents per pound on tungsten content and 4.8% ad valorem.	60 cents per pound on tungsten content and 40% ad valorem.
606.48	Ferrotungsten and ferrosilicon tungsten	8.8% ad valorem	35% ad valorem.
629.25	Waste and scrap containing by weight not over 50% tungsten.	6.6% ad valorem	50% ad valorem.
629.26	Waste and scrap containing by weight over 50% tungsten.	4.2% ad valorem	Do.
629.28	Unwrought tungsten, except alloys, in lumps, grains, and powders.	15 cents per pound on tungsten content and 12.5% ad valorem.	58% ad valorem.
629.29	Unwrought tungsten, ingots, and shot	9.8% ad valorem	50% ad valorem.
629.30	Unwrought tungsten, other	11.5% ad valorem	60% ad valorem.
629.32	Unwrought tungsten, alloys, containing by weight not over 50% tungsten.	6.1% ad valorem	35.5% ad valorem.
629.33	Unwrought tungsten, alloys, containing by weight over 50% tungsten.	11.5% ad valorem	60% ad valorem.
629.35	Wrought tungsten	10.3% ad valorem	Do.
416.40	Tungstic acid	13.3% ad valorem	55% ad valorem.
417.40	Ammonium tungstate	12.1% ad valorem	49.5% ad valorem.
418.30	Calcium tungstate	10.8% ad valorem	43.5% ad valorem.
420.32	Potassium tungstate	19.4% ad valorem	50.5% ad valorem.
421.56	Sodium tungstate	11.7% ad valorem	46.5% ad valorem.
422.40	Tungsten carbide	5 cents per pound on tungsten content and 12.5% ad valorem.	55.5% ad valorem.
422.42	Other tungsten compounds	11.2% ad valorem	45.5% ad valorem.
423.92	Mixtures of two or more inorganic compounds in chief value of tungsten.	do	Do.

WORLD REVIEW

A meeting was held in Geneva, Switzerland, during October by the Committee on Tungsten (COT) of the United Nations Conference on Trade and Development (UNCTAD) in an effort to resolve a 19-year deadlock between producing and consuming countries concerning the stabilization of the world tungsten market. No agreement was reached by COT, but it recommended that another meeting be convened in 1983 and requested the UNCTAD Secretariat to prepare recycling and substitution studies for the session.

Bolivia.—The Anschutz Corp. through its subsidiary, Churquini Enterprises Ltd., was developing a major mine in a large tungsten deposit, the El Chicote Grande, about 150 miles southeast of La Paz. Production in 1982 was from a small rehabilitated vintage mill with a capacity of about 20 metric tons of concentrate per month. Maximum production from 100,000 metric tons of ore per year was expected to be reached in late 1983 or 1984, after a new mill goes into operation at a capacity of 500 to 1,000 metric tons of ore per day.

Canada.—The mine and mill operated by Canada Tungsten Mining Corp. Ltd. at Tungsten, Northwest Territories, the largest tungsten mine in the market economy countries, produced 6.3 million pounds of tungsten, an increase of 43% from that of 1981. Production was cut in the latter part of the year owing to low prices and decreased demand. Recovery was 86.6% from 361,000 tons of ore at a grade of 1.28% WO_3. Ore reserves were reported by the company to contain 55 million pounds of tungsten at yearend.[2]

Development of the Mount Pleasant

Table 18.—Tungsten: World concentrate production, by country[1]

(Thousand pounds of contained tungsten)[2]

Country	1978	1979	1980	1981[p]	1982[e]
Argentina	214	130	77	132	90
Australia	5,968	7,039	7,928	7,754	[3]5,706
Austria	2,599	3,298	3,296	3,197	3,100
Bolivia	5,373	5,445	6,023	6,127	[3]5,587
Brazil	[r]1,376	[r]2,057	1,931	2,751	2,400
Burma	1,038	1,526	1,814	1,819	[3]1,861
Burundi	[e]4	--	--	--	--
Canada	5,046	5,726	7,010	4,393	[3]6,496
China[e]	25,400	28,900	33,100	29,800	27,600
Czechoslovakia[e]	175	175	175	175	175
France	1,340	[r]1,301	1,272	1,303	1,320
India	46	[r]40	49	40	[3]55
Japan	1,709	1,645	1,473	1,470	[3]1,400
Korea, North[e]	4,740	4,740	4,850	4,850	4,850
Korea, Republic of	5,910	5,981	6,034	5,825	[3]4,923
Malaysia	[r]82	[r]60	31	77	130
Mexico	516	556	586	580	[3]218
Namibia[e 4]	330	360	330	--	--
New Zealand	[r]2	[r]187	9	11	11
Peru	1,283	1,243	1,210	1,149	[3]1,396
Portugal	[r]2,416	[r]3,060	3,457	3,075	3,000
Rwanda	[r]849	1,113	950	1,149	1,100
Spain	789	[r]869	983	963	970
Sweden	699	[r]818	721	818	[3]606
Thailand	7,026	4,026	3,560	2,668	[3]1,888
Turkey	15	[r]123	211	337	330
Uganda[e]	240	[r]40	40	40	40
U.S.S.R.[e]	18,700	19,200	19,200	19,500	19,800
United Kingdom[e]	143	146	150	110	110
United States	6,896	6,643	6,072	7,948	[3]3,354
Zaire	326	247	159	300	300
Zimbabwe	287	243	198	120	110
Total	[r]101,537	[r]106,937	112,899	108,481	98,926

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through June 23, 1983.
[2]Conversion factors: WO_3 to W, multiply by 0.7931; 60% WO_3 to W, multiply by 0.4758.
[3]Reported figure.
[4]Production of Brandberg West Mine of South West Africa Co. Ltd. ceased in mid-1980.

tungsten-molybdenum mine, in Charlotte County, New Brunswick, was completed, but its opening was delayed until mid-1983 because of poor market conditions. The joint venture between Billiton Canada Ltd. and Brunswick Tin Mines Ltd. is expected to produce concentrate containing 3.2 million pounds of tungsten and 1.3 million pounds of molybdenite (MoS_2) from a 2,200-ton-per-day mill. Minable ore reserves were placed at 57 million pounds of tungsten in ore grading 0.39% WO_3 and 0.204% MoS_2.

A feasibility study was made of the MacTung tungsten deposit near MacMillian pass along the Yukon-Northwest Territories boundary by AMAX through its subsidiary, AMAX of Canada Ltd. The target date for production from a 1,000-ton-per-day mine-mill complex was late 1986 or later. Reserves were placed at 63 million tons of ore at the grade of 0.95% WO_3 or 950 million pounds of tungsten, the largest known deposit in the market economy countries.

United Kingdom.—AMAX Exploration of U.K. Inc. and Hemerdon Mining and Smelting (U.K.) Ltd. planned to construct a tungsten-tin mine and mill near Plymouth, Devon County. The expected annual capacity was 4.4 million pounds of tungsten in concentrate and 450 tons of tin. The goal for opening has been delayed beyond 1985 and is dependent on government approval and favorable economic conditions. Minable ore reserves were placed at 130 million pounds of tungsten.

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[1]Physical scientist, Division of Ferrous Metals.
[2]Canada Tungsten Mining Corp. Ltd. 1982 Annual Report. 12 pp.

Table 19.—Tungsten: World concentrate consumption, by country[1]

(Thousand pounds of contained tungsten)

Country[2]	1979	1980	1981[p]	1982[e] [3]
Reported consumption:				
Australia	93	168	220	320
Austria	[r]9,024	8,413	7,276	5,975
Canada	[e]660	[e]660	[e]660	500
France	2,112	1,854	1,508	1,500
Japan	5,712	6,462	4,934	4,600
Korea, Republic of	3,219	3,161	3,953	3,500
Mexico	[e]88	[e]88	[e]88	50
Portugal	[r]472	454	500	350
Sweden	4,049	4,751	3,157	1,543
United Kingdom	3,446	3,228	1,938	809
United States	21,589	20,432	21,692	9,935
Apparent consumption:[4]				
Argentina	192	42	44	126
Belgium-Luxembourg	[e]220	[e]220	20	20
Brazil	1,892	1,226	758	1,000
China[e] [3]	5,500	10,000	10,500	10,000
Czechoslovakia[e] [3]	2,900	2,900	2,900	2,900
German Democratic Republic[e]	600	600	600	600
Germany, Federal Republic of	4,354	3,305	2,972	1,900
Hungary[e]	1,320	1,320	1,320	1,320
India[e]	600	600	600	600
Italy[e]	155	200	90	100
Korea, North[e] [3]	3,500	3,500	3,500	3,500
Netherlands	437	[e]880	[e]880	660
Poland	3,395	1,947	944	1,200
South Africa, Republic of[e]	550	550	550	550
Spain	317	302	98	100
U.S.S.R.[e] [3]	30,500	35,000	35,000	35,000
Total	[r]106,896	112,263	106,702	88,658

[e]Estimated. [p]Preliminary. [r]Revised.

[1]Source, unless otherwise specified, is the Quarterly Bulletin of the UNCTAD Committee on Tungsten: Tungsten Statistics. V. 17, No. 1-2, January-April 1983, 54 pp.

[2]In addition to the countries listed, Bulgaria, Denmark, Finland, Israel, Norway, Romania, Switzerland, and Yugoslavia may consume tungsten concentrate, but consumption levels are not reported, and available general information is inadequate to permit formulation of reliable estimates of consumption levels.

[3]Estimated by U.S. Bureau of Mines.

[4]Production plus imports minus exports. For a few countries where data were available, variations in stocks were used in determining consumption.

Vanadium

By Peter H. Kuck[1]

The year 1982 was traumatic for the world vanadium industry. Consumption of vanadium plummeted during the second quarter as a result of the general world recession and remained depressed for the remainder of the year. Cutbacks in the production of virtually all types of steel caused stocks of ferrovanadium and related vanadium-carbon ferroalloys to rise at conversion plants in Western Europe and North America. At the same time, steel plants, foundries, and other consumers reduced their stocks of ferrovanadium to unprecedented levels as a cash conservation measure.

In the United States, ferrovanadium consumption was the lowest since 1963 because of cutbacks in the automotive, machinery, and construction industries. Domestic ferrovanadium producers were especially hurt by the postponement of oil exploration programs and the subsequent drop in sales of oil country tubular goods. Decreased orders for commercial aircraft and industrial equipment fabricated from titanium alloys led to a sharp drop in demand for vanadium-aluminum master alloys, further weakening the market for vanadium pentoxide. Vanadium oxide producers in the United States attempted to restore the balance between supply and demand by either closing mines and mills, or curtailing byproduct extraction operations. At yearend, four of the nine domestic facilities that had recovered vanadium oxide in 1981 were shut down. The remaining five operated far below capacity.

Table 1.—Salient vanadium statistics

(Short tons of contained vanadium unless otherwise specified)

	1978	1979	1980	1981	1982
United States:					
Production:					
Ore and concentrate:					
Recoverable vanadium[1]	4,272	5,520	4,806	5,126	4,098
Value thousands	$56,776	$73,892	$64,370	$71,496	$52,577
Vanadium oxides recovered from ore[2]	5,204	5,758	5,506	6,368	4,867
Vanadium oxides recovered from petroleum residue[3]	1,097	1,617	1,520	1,900	1,513
Consumption	6,630	6,719	6,139	6,863	3,496
Exports:					
Ferrovanadium (gross weight)	1,309	880	803	435	326
Ore and concentrate	191	101	46	56	57
Vanadium pentoxide, anhydride (gross weight)	1,239	630	724	346	1,582
Other compounds (gross weight)	291	316	190	61	361
Imports (general):					
Ferrovanadium (gross weight)	535	738	328	1,236	855
Ores, slags, residues	2,234	2,442	1,786	2,435	1,112
Vanadium pentoxide, anhydride	656	907	856	354	129
World: Production from ores, concentrates, slags	33,719	37,311	38,281	p38,683	e36,498

eEstimated. pPreliminary.

[1]Recoverable vanadium contained in uranium and vanadium ores and concentrates received at mills, plus vanadium recovered from ferrophosphorus derived from domestic phosphate rock.

[2]Produced directly from all domestic ores and ferrophosphorus; includes metavanadates.

[3]Includes vanadium recovered from ashes and spent catalysts.

Vanadium mining operations were halted in Australia and Norway because of the depressed price for pentoxide. Even discounted material from China was withheld from the European market when the spot price for metallurgical-grade pentoxide plunged during the fourth quarter from a general break-even point of about $2.10 per pound V_2O_5 to $1.20 per pound.

Domestic Data Coverage.—Domestic production data for vanadium are developed by the Bureau of Mines from four voluntary surveys of U.S. mills and processing facilities. All 21 of the plants or mills canvassed in 1982 responded. Supplemental information was provided by three power generating stations. Data on uranium-vanadium mining operations are obtained from an independent survey conducted by the Department of Energy. More than 70 mines in the United States reported production or shipments of vanadium-bearing ores in 1981.

Legislation and Government Programs.—The National Defense Stockpile goals of 1,000 short tons of vanadium contained in ferrovanadium and 7,700 tons of vanadium contained in vanadium pentoxide remained in effect throughout the year. These goals were established by the General Services Administration on May 1, 1980. As of December 31, 1982, U.S. Government inventory consisted of 541 tons of contained vanadium in the form of pentoxide and 2 tons of vanadium metal.

In December, the Environmental Protection Agency published final regulations under the Clean Water Act dealing with the discharge of wastewater from vanadium mining and milling operations.[2] A distinction was made between operations that process ore solely for vanadium, and those that recover vanadium as a byproduct of uranium mining or milling. Under these new rules, the concentration of uranium in mine drainage must be less than 4 milligrams per liter per day and average less than 2 milligrams per liter per day for 30 consecutive days. Upper limits were also specified for the concentration of zinc, arsenic, radium, and several other elements in the wastewater. Limitations on the concentration of vanadium were still under review. No discharge of process wastewater will be permitted from new uranium-vanadium mills or in situ leaching operations.

The Bureau of Mines has been investigating techniques for recovering vanadium and uranium from phosphate beneficiation tailings.[3] The results of bench-scale roasting and acid leaching studies on tailings from southeastern Idaho containing 0.20% to 0.25% vanadium suggest that this approach could lead to recovery of 80% of the vanadium. If an economic method were developed, phosphate tailings in Idaho, Montana, and Utah could yield as much as 5,500 tons of vanadium per year. The Bureau also continued research on the extraction of vanadium from low-grade uranium ores of the Colorado Plateau and Wyoming.[4] Work to date has focused on sulfuric acid leaching of sandstone containing authigenic carbonaceous material and carnotite. Several techniques were being evaluated, including agitation leaching, pugging, salt-roast leaching, and autoclave leaching.

DOMESTIC PRODUCTION

Mine production of vanadium declined sharply in 1982 because of plummeting demand for ferrovanadium by the hard-pressed United States and Canadian steel industries. Colorado was the leading producing State, followed by Utah and Idaho. In Colorado and Utah, the vanadium was obtained as a coproduct from the mining of uraniferous sandstones on the Colorado Plateau. In Idaho, pentoxide was produced from vanadium-bearing ferrophosphorus by Kerr-McGee Chemical Corp. at Soda Springs. The ferrophosphorus was a byproduct of nearby elemental phosphorus plants.

The depressed market for uranium added to the problems of the domestic vanadium industry by making most coproduct mining and milling operations on the Colorado Plateau unprofitable. In New Mexico, the number of uranium producers dropped from 15 in 1980 to 2. No byproduct vanadium production was reported for New Mexico for the first time in 27 years. More than 300 workers involved in the extraction of vanadium and uranium on the Colorado Plateau were laid off during the first quarter of 1982; another 250 were let go in November. By the end of 1982, almost 60% of the normal plateau work force of 1,500 were unemployed.

In April 1982, Union Carbide Corp. suspended production of vanadium liquor and yellowcake (U_3O_8) at its Uravan mill in

Montrose County, Colo., primarily because of reduced demand for uranium. Two months later, the company closed its vanadium mine and mill near Hot Springs in Garland County, Ark. Both facilities remained closed for the remainder of the year. The Arkansas facility was capable of recovering 5,000 to 7,500 tons of a modified vanadium oxide per year from vanadiferous clays. The Uravan mill had been processing various types of carnotite-tyuyamunite and montroseite-uraninite ores from the King Solomon, the Burro, and at least 30 other underground mines in the Uravan Mineral Belt. The mill, which has a daily feed capacity of 1,270 tons of ore, had been the major source of vanadium liquor for the company's finishing operations at Rifle in Garfield County, Colo. In December, production of vanadium pentoxide was halted at Rifle after feedstocks of vanadium liquor became exhausted. However, one-half of the 34 employees at Rifle were retained to ship stockpiled oxide and perform plant maintenance.

In January 1982, Atlas Corp. cut back operations at its uranium-vanadium mines and mill in southeastern Utah. The company shut down the uranium alkaline leach circuit at its Moab mill, but continued to process carnotite ore for vanadium and uranium through the more economical, strong acid leach circuit. The numbers of workers at the Moab mill, which is located in Grand County, dropped from 267 in 1981 to 167 in 1982. Atlas was able to keep its Velvet and Pandora Mines in San Juan County operating throughout the year because of the high ore grades, but was forced to keep its Snow and Probe Mines in Emery County on standby. In August, the company acquired the rights to the Bullfrog uranium properties in Garfield County from the Exxon Minerals Co. Atlas agreed to pay royalties to Exxon on future uranium production from the properties and planned to use the ore to feed the Moab mill. The Bullfrog properties are located on the southern flank of the Henry Mountains near the Tony M Mine operated by Plateau Resources Ltd. in Shootaring Canyon. A large part of the vanadium-uranium mineralization in the Henry Mountains Basin occurs as carnotite, tyuyamunite, and montroseite in Jurassic sandstones and mudstones.

Energy Fuels Nuclear Inc., continued to recover vanadium and uranium at its White Mesa mill 6 miles south of Blanding, Utah. The mill, which commenced operations in October 1980, was being operated at a greatly reduced rate because of weak market conditions. In the interim, high-grade uraninite ore for the White Mesa mill was being stockpiled at the Hack Canyon Mine in the Arizona Strip north of the Grand Canyon.

After 3 years of public hearings and environmental studies, the Colorado Department of Health issued a radioactive materials license to Pioneer Uravan Inc., for the construction of a uranium-vanadium processing mill in San Miguel County, Colo. Pioneer, however, was forced to postpone its mill construction plans indefinitely because of the recession. The 1,000-ton-per-day mill was to have been built northeast of Slick Rock in Disappointment Valley and would have produced about 500 tons of yellowcake and 2,000 tons of vanadium pentoxide annually from ores mined in the Uravan Mineral Belt. In Fremont County, Cotter Corp. kept the vanadium recovery circuit at its Canon City mill closed throughout 1982, but continued to ship pentoxide from stocks. Vanadium-poor uraninite ore from the company's Schwartzwalder Mine in Jefferson County was being used as feed for the uranium circuit.

The pentoxide recovered from imported vanadium-bearing materials and vanadium recovered directly as ferrovanadium from slags and residues, regardless of source, are not included in tables 2 or 3. In recent years, feed materials of foreign origin in these two categories have included iron slags from Chile, China, and the Republic of South Africa as well as utility ashes, spent catalysts from refineries, and a variety of petroleum residues. U.S. production from petroliferous materials in 1982 totaled 1,513 tons of contained vanadium, 20% less than the 1,900 tons for 1981.

Pentoxide concentrates were produced as a byproduct of the burning of Venezuelan and other Caribbean residual oils at a number of power-generating stations in the Eastern United States. Long Island Lighting Co. (LILCO) recovered high-grade ash containing 773 tons of pentoxide in 1982, compared with 681 tons in 1981. The New York utility operated two oil-fired power stations in Suffolk County, one at Northport and the other at Port Jefferson. LILCO, Florida Power Corp., and at least two other utilities on the Atlantic seaboard were investigating methods of solidifying and upgrading furnace washing sludges that contain 15% to 25% V_2O_5. The closure of the vanadium extraction plant at Bartlesville, Okla., in November 1982 has created a disposal problem for these low-grade sludges. The Bartlesville plant, owned by Somex Ltd. (a subsidiary of Phibro-Salomon Inc.), was hurt by declining vanadium prices and was not expected to reopen.

Hall Chemical Co. of Wickliffe, Ohio, announced plans to construct a catalyst reclamation facility near Mobile, Ala. The facility would recover vanadium, cobalt, and other transition metals from hydrotreating and hydroforming catalysts used in the refining of high-sulfur crude oil. The $40 million project was scheduled for completion in the spring of 1984. Gulf Chemical & Metallurgical Co., a division of Associated Metals & Minerals Corp., was also in the process of expanding the capacity of its catalyst reclamation facility near Freeport, Tex. Gulf Chemical extracts the vanadium "poison" from spent cobalt and molybdenum catalysts supplied by oil refineries and petrochemical plants and converts the metal into fused pentoxide.

Production of ferrovanadium and proprietary vanadium-iron-carbon additives declined dramatically during the second half of the year as a result of near-depression conditions in the U.S. steel industry. All six of the ferrovanadium producers listed in table 4 were affected by the massive cutbacks in crude steel production. In addition, the general world recession had an adverse effect on vanadium chemical production. Producers of primary vanadium chemicals included Foote Mineral Co., Cambridge, Ohio; Stauffer Chemical Co., Weston, Mich.; and Union Carbide, Niagara Falls, N.Y. Vanadium oxytrichloride and vanadium tetrachloride were the two ranking chemicals after pentoxide.

Table 2.—Mine production and recoverable vanadium of domestic origin produced in the United States

(Short tons of contained vanadium)

Year	Mine production[1]	Recoverable vanadium[2]
1978	4,446	4,272
1979	5,841	5,520
1980	5,832	4,806
1981	5,852	5,126
1982	4,093	4,098

[1]Measured by receipts of uranium and vanadium ores and concentrates at mills, vanadium content.
[2]Recoverable vanadium contained in uranium and vanadium ores and concentrates received at mills, plus vanadium recovered from ferrophosphorus derived from domestic phosphate rock.

Table 3.—Production of vanadium oxides in the United States[1]

(Short tons)

Year	Gross weight	Oxide content[2]
1978	9,785	9,290
1979	10,338	10,279
1980	10,048	9,829
1981	11,366	11,367
1982	8,850	8,689

[1]Produced directly from all domestic ores and ferrophosphorus; includes metavanadates.
[2]Expressed as equivalent V_2O_5.

CONSUMPTION, USES, STOCKS

Reported domestic consumption of vanadium declined 49% in 1982 and was lower than that of any year since 1963. The primary cause of the decline was a slump in U.S. steel production unequaled since the 1930-34 depression. Every vanadium end-use category exhibited a decrease in consumption.

As in 1981, approximately 86% of the vanadium was consumed by the iron and steel industry as ferrovanadium or related vanadium-carbon ferroalloys. This dependence on the iron and steel industry created a difficult marketing situation for the six domestic ferrovanadium producers. Several factors accentuated the slide in consumption of ferrovanadium. First, almost 53% of the Nation's steelmaking capacity was idled by mid-1982 because of cutbacks in the automotive, machinery, and construction industries. Second, a worldwide oil surplus forced the petroleum industry to sharply curtail its exploration and development programs at a time when steel mills and service centers were already carrying large inventories of microalloyed pipe and other oilfield supplies. Third, domestic steel mills and foundries restricted purchases of most ferroalloys and reduced their ferroalloy stocks to unprecedented levels to ease their cash flows. Fourth, steel cutbacks throughout the European Communities, low-priced imports of both ferrovanadium and vanadium-bearing specialty steels, and a strong dollar intensified competition in the already weakened U.S. ferrovanadium market.

Demand for vanadium in titanium alloys decreased significantly because of cutbacks in commercial aircraft production. Boeing Commercial Airplane Co., for example, received only 108 new orders for aircraft in 1982, compared with 224 in 1981. Ti-6Al-4V alloy, which has been used in jet engines and other aircraft parts for more than two decades, accounted for more than one-half of the titanium-based alloy market in 1982. Two newer alloys, Ti-10V-2Fe-3Al and Ti-15V-3Cr-3Al-3Sn, were being extensively evaluated for the next generation of commercial airliners. Forgings of Ti-10V-2Fe-3Al have already been used in some components of the new Boeing 757 and 737-300 jetliners.[5]

Consumption of ammonium metavanadate, granular pentoxide, and other vanadium chemicals for catalysts declined by almost one-half because of continuing cutbacks in the production of sulfuric acid, adipic acid, and maleic anhydride. The new maleic anhydride plant being completed for the Monsanto Co. at Pensacola, Fla., will utilize butane as feedstock instead of the traditional benzene. The butane process will reportedly employ a new proprietary vanadium catalyst that has a higher V_2O_5 content than the previous $2V_2O_5:MoO_3$ benzene catalyst.[6]

In addition to the consumers' stocks shown in table 5, producers' stocks of vanadium as fused oxide, precipitated oxide, metavanadates, metal, alloys, and chemicals totaled 5,222 tons of contained vanadium at yearend 1982, compared with 4,030 tons at yearend 1981.

Table 4.—Producers of vanadium alloys or metal in the United States in 1982

Producer	Plant location	Product[1]
Cabot Corp., Engineered Products Group	Boyertown, Pa	VAl and ZrVAl.
Do	Henderson, Ky	VAl and ZrVAl.
Do	Wenatchee, Wash	VAl and ZrVAl.
Engelhard Corp., Minerals & Chemicals Div	Strasburg, Va	FeV.
Foote Mineral Co., Ferroalloys Div	Cambridge, Ohio	FeV and Ferovan.[2]
Metallurg, Inc., Shieldalloy Corp	Newfield, N.J	FeV.
Pesses Co., The	Pulaski, Pa	FeV and VAl.
Reading Alloys, Inc	Robesonia, Pa	Do.
Teledyne, Inc., Teledyne Wah Chang, Albany Div	Albany, Oreg	V.
Union Carbide Corp., Metals Div	Marietta, Ohio[3]	Carvan[2] and Nitrovan.[2]
Do	Niagara Falls, N.Y	FeV and VAl.

[1]FeV, ferrovanadium; V, vanadium metal; VAl, vanadium aluminum; ZrVAl, zirconium vanadium aluminum.
[2]Registered trademarks for proprietary products.
[3]Union Carbide Corp. sold the plant to Elkem Metals Co. in 1981. However, Elkem has been converting vanadium oxide at Marietta for Union Carbide on a toll basis.

Table 5.—Consumption and consumer stocks of vanadium materials in the United States, by type

(Short tons of contained vanadium)

Type	1981 Consumption	1981 Ending stocks	1982 Consumption	1982 Ending stocks
Ferrovanadium[1]	5,941	548	2,995	280
Oxide	40	10	29	14
Ammonium metavanadate	21	7	6	1
Other[2]	861	118	466	31
Total	6,863	683	3,496	326

[1]Includes other vanadium-iron-carbon alloys.
[2]Consists principally of vanadium-aluminum alloy, plus relatively small quantities of other vanadium alloys and vanadium metal.

Table 6.—Consumption of vanadium in the United States, by end use

(Short tons of contained vanadium)

End use	1982
Steel:	
Carbon	698
Stainless and heat resisting	15
Full alloy	811
High-strength low-alloy	1,148
Tool	273
Unspecified	--
Total	2,945
Cast irons	20
Superalloys	12
Alloys (excluding steels and superalloys):	
Cutting and wear-resistant materials	W
Welding and alloy hard-facing rods and materials	W
Nonferrous alloys	461
Other alloys[1]	12
Chemical and ceramic uses:	
Catalysts	29
Other[2]	W
Miscellaneous and unspecified	17
Grand total	3,496

W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous and unspecified."
[1]Includes magnetic alloys.
[2]Includes pigments.

PRICES

The Metals Week price quotation for domestic 98% fused vanadium pentoxide (metallurgical-grade) at the beginning of 1982 was $3.35 to $3.65 per pound V_2O_5 f.o.b. mill. This price spread was established on May 15, 1981, and remained in effect throughout all of 1982. However, considerable discounting of metallurgical-grade material occurred during the fourth quarter of 1982 when domestic steel production plummeted.

In Western Europe, the spot price spread for metallurgical-grade pentoxide fell steadily from $2.65-$2.85 per pound to $1.20-$1.40 because of the worldwide steel recession, consumer inventory reductions, and the continuing availability of material of Chinese and South African origin. In early August, Highveld Steel and Vanadium Corp. Ltd. was forced to suspend its list price of $3.14 per pound V_2O_5 c.i.f. for 98% minimum fused pentoxide from the Republic of South Africa. Two months later, Highveld reinstated its pentoxide quotation at $2.40 per pound. At yearend, metallurgical-grade spot prices in Europe were well below the break-even cost for most producers.

In April, the Metals Week price spread for technical air-dried vanadium pentoxide (chemical grade) was expanded from $4.10-$4.57 per pound to $4.10-$4.94 when both Union Carbide and Foote announced price increases for various chemical grades of pentoxide. On April 1, Union Carbide increased its price for technical granular from $4.49 to $4.94 per pound V_2O_5. The new price for Union Carbide's high-purity granular was $7.15 per pound. Foote put the following price schedule into effect on April 15.

Grade	V (as V_2O_5) percent	New price per pound
Technical air dried	98.8%	$4.94
Purified	99.8	9.46
C.P. yellow air dried	99.9	14.65

On July 1, Foote and Shieldalloy Corp. reduced the prices of their ordinary grades of ferrovanadium to remain competitive with aggressively priced imports. Foote lowered the price of its 40% V minimum Ferovan from $7.75 to $7.50 per pound of contained vanadium. Shieldalloy, a division of Metallurg Inc. announced an identical price reduction for its "Standard" ferrovanadium. The Metals Week price quotation for the 70% to 80% V grade of ferrovanadium made by Engelhard Corp., Foote, Shieldalloy, and Union Carbide remained unchanged at $8.50 per pound of contained vanadium. On September 23, Union Carbide lowered its price for Carvan (82% to 86% V) from $7.75 to $7.36 per pound of contained vanadium. The company also reduced the price of Nitrovan from $7.90 per pound of contained vanadium to $5.88 per pound of alloy. Union Carbide made the price cuts in response to declining domestic steel production, increasing competition from imports of European ferrovanadium, and the earlier price reduction on July 1 by its two major competitors, Foote and Shieldalloy.

FOREIGN TRADE

A strong dollar combined with declining steel production in Canada and the European Communities caused U.S. exports of ferrovanadium to decline in 1982 for the fourth consecutive year. Exports of ferrovanadium totaled 326 tons (gross weight), 25% less than the 435 tons for 1981. The average declared value for the ferrovanadium was $5.27 per pound of alloy, compared with $5.06 for 1981. Cutbacks in U.S. ferrovanadium production forced domestic pentoxide producers to cultivate new customers in developing countries and to compete more aggressively in traditional overseas markets such as Japan. Exports of vanadium pentoxide (anhydride) totaled 1,582 tons (gross weight), a fourfold increase over the 346 tons of 1981.

The dramatic cutback in U.S. steel production and price reductions by domestic ferroalloy producers during the second half of 1982 weakened demand for imported ferrovanadium. The Belgium-Luxembourg Economic Union replaced Canada as the leading supplier and accounted for 41% of the imported alloy in terms of contained weight. Imports of vanadium pentoxide (anhydride) declined for the third consecutive year as a result of unprecedented cutbacks at domestic ferrovanadium conversion facilities and a depressed market for vanadium catalysts. The Republic of South Africa remained the principal source of imported pentoxide, with Finland a distant second. Imports of pentoxide from China were negligible in 1982.

Imports of vanadium contained in slags, residues, and ashes totaled 1,112 tons, a 54% decrease from 1981 imports. Almost one-half of this material was slag produced in the Republic of South Africa from Bushveld titaniferous magnetite ores. No slags were received from either China or the Huachipato steelworks in Chile. The closure of the Phibro vanadium extraction plant in Oklahoma and an oversupply of petroleum residues, utility ashes, and spent catalysts along the Atlantic seaboard limited the importation of similar vanadiferous material from Italy, Venezuela, and the West Indies.

Potassium vanadate imports amounted to 42 tons (gross weight), of which 23 tons came from the United Kingdom and 19 tons from the Federal Republic of Germany. In addition, 5 tons of ammonium vanadate were received from the United Kingdom. Imports classified as "Other vanadium compounds" totaled 128 tons (gross weight), of which 106 tons came from the United Kingdom. Imports of unwrought vanadium metal were relatively minor and totaled slightly more than 3 tons.

Table 7.—U.S. exports of vanadium in 1982, by country

(Thousand pounds and thousand dollars)

Country	Ferrovanadium (gross weight)		Vanadium ore and concentrate (vanadium content)		Vanadium compounds (gross weight)			
					Pentoxide (anhydride)		Other[1]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Argentina	--	--	--	--	8	14	--	--
Australia	--	--	--	--	100	181	(2)	1
Austria	--	--	--	--	44	99	--	--
Belgium-Luxembourg	88	390	--	--	1,079	1,505	--	--
Brazil	--	--	--	--	78	234	(2)	3
Canada	269	1,826	--	--	105	318	37	256
Chile	--	--	--	--	1	2	(2)	4
Colombia	2	15	--	--	3	6	--	
Czechoslovakia	--	--	--	--	33	49	--	
Ecuador	--	--	--	--	--	--	22	13
Egypt	19	81	--	--	--	--		
France	--	--	--	--			48	160

See footnotes at end of table.

Table 7.—U.S. exports of vanadium in 1982, by country —Continued

(Thousand pounds and thousand dollars)

Country	Ferrovanadium (gross weight)		Vanadium ore and concentrate (vanadium content)		Vanadium compounds (gross weight)			
					Pentoxide (anhydride)		Other[1]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Germany, Federal Republic of	--	--	91	506	1	6	19	18
Honduras	--	--	--	--	--	--	22	29
Iceland	(2)	2	--	--	--	--	--	--
Indonesia	26	100	--	--	26	80	--	--
Israel	8	35	--	--	--	--	--	--
Japan	97	459	--	--	746	1,954	529	720
Korea, Republic of	38	147	--	--	1	1	--	--
Malaysia	--	--	--	--	11	25	--	--
Mexico	--	--	23	120	73	226	--	--
Morocco	--	--	--	--	31	54	--	--
Netherlands	--	--	--	--	505	1,393	--	--
New Zealand	--	--	--	--	4	11	--	--
Pakistan	--	--	--	--	9	16	--	--
Philippines	--	--	--	--	9	30	--	--
South Africa, Republic of	--	--	--	--	189	350	--	--
Spain	--	--	--	--	--	--	(2)	2
Sweden	44	165	--	--	--	--	(2)	2
Taiwan	--	--	--	--	37	61	--	--
Trinidad and Tobago	13	62	--	--	--	--	--	--
Tunisia	--	--	--	--	20	60	--	--
United Arab Emirates	--	--	--	--	--	--	5	2
United Kingdom	(2)	1	--	--	40	75	40	92
Venezuela	47	155	--	--	4	17	--	--
Yugoslavia	--	--	--	--	6	40	--	--
Total[3]	653	3,436	114	626	3,163	6,808	723	1,303

[1]Excludes vanadates.
[2]Less than 1/2 unit.
[3]Data may not add to totals shown because of independent rounding.

Table 8.—U.S. imports of ferrovanadium, by country

(Thousand pounds and thousand dollars)

Country	1981			1982		
	Gross weight	Vanadium content	Value	Gross weight	Vanadium content	Value
General imports:						
Austria	169	137	913	112	87	512
Belgium-Luxembourg	441	356	2,299	712	547	3,185
Canada	1,114	873	6,072	499	400	2,531
China	11	9	55	--	--	--
France	--	--	--	26	21	126
Germany, Federal Republic of	664	534	3,555	214	170	1,032
Sweden	38	30	199	--	--	--
United Kingdom	35	28	194	146	120	708
Total[1]	2,472	1,968	13,288	1,710	1,344	8,094
Imports for consumption:						
Austria	169	137	913	112	87	512
Belgium-Luxembourg	441	356	2,299	712	547	3,185
Canada	1,114	873	6,072	499	400	2,531
China	11	9	55	--	--	--
France	--	--	--	26	21	126
Germany, Federal Republic of	664	534	3,555	214	170	1,032
Sweden	38	30	199	--	--	--
United Kingdom	35	28	194	140	115	679
Total[1]	2,472	1,968	13,288	1,704	1,339	8,065

[1]Data may not add to totals shown because of independent rounding.

Table 9.—U.S. imports of vanadium pentoxide (anhydride), by country

Country	1981 Gross weight (pounds)	1981 Vanadium content (pounds)	1981 Value	1982 Gross weight (pounds)	1982 Vanadium content (pounds)	1982 Value
General imports:						
China	298,173	167,026	$804,317	99	55	$267
Finland	119,049	66,687	352,183	79,366	44,458	211,896
Germany, Federal Republic of	3,594	2,013	16,707	6,614	3,705	22,895
Japan	551	309	2,744	--	--	--
South Africa, Republic of	842,658	472,028	2,345,447	338,141	189,415	827,582
United Kingdom	19	11	5,839	37,483	20,997	97,205
Total	1,264,044	708,074	3,527,237	461,703	258,630	1,159,845
Imports for consumption:						
China	227,625	127,508	621,020	99	55	267
Finland	119,049	66,687	352,183	79,366	44,458	211,896
Germany, Federal Republic of	3,594	2,013	16,707	6,614	3,705	22,895
Japan	551	309	2,744	--	--	--
South Africa, Republic of	842,658	472,028	2,345,447	300,662	168,421	730,682
United Kingdom	19	11	5,839	37,483	20,997	97,205
Total	1,193,496	668,556	3,343,940	424,224	237,636	1,062,945

WORLD REVIEW

Ferrovanadium consumption in Western Europe and Japan weakened during the second half of 1982 when the steel recession began to extend beyond North America. Vanadium producers in the market economy countries were particularly affected by the worldwide oil surplus, which led to a sharp drop in demand for high-strength seamless tubes and other oil country goods that contain vanadium to strengthen the steel. The existing imbalance between the supply of pentoxide and demand widened during the year, forcing higher cost mining operations in Australia, Norway, and the United States to close. Several low-cost producers also canceled mine expansion projects and cut back milling operations.

Australia.—In January, Agnew Clough Ltd. suspended production of vanadium pentoxide at its new mine and mill complex near Wundowie in Western Australia. The international steel recession, high interest rates, and burgeoning sales of Chinese pentoxide to Japan and Western Europe made financing of the Wundowie operation difficult. Approximately 120 employees were retained to conduct process improvement studies and to perform maintenance at the complex. Agnew Clough was planning to make several modifications to the mill before resuming production. The company has already added an undercover storage bin for calcined pebbles, tank storage for pregnant liquor, and a vanadium oxide fusion furnace to improve production. A wet scrubber system was also recently installed on the calciner exhaust stack.[7] The first shipment of Australian pentoxide to reach Europe was delivered to Klöckner and Co. in Hamburg. The Federal Republic of Germany received a total of 12 tons of pentoxide from Australia during calendar year 1982.[8] An additional 51 tons of Australian pentoxide went to Japan.[9]

In May, Esso Exploration and Production Australia Inc. withdrew from the Yeelirrie uranium-vanadium project in Western Australia after reevaluating future uranium demand.[10] Western Mining Corp. Ltd., which has a 75% interest in the $340 million venture, was searching for a partner to acquire the 15% relinquished by Esso. The third partner, Urangesellschaft Australia Pty. Ltd., was expected to retain its 10% interest in Yeelirrie. The deposit contains an estimated 37 million tons of carnotite ore, averaging 0.14% U_3O_8 and 0.07% V_2O_5. Pilot plant testing at the Kalgoorlie research plant was completed in late 1981 and involved the treatment of 6,700 dry tons of stockpiled ore. The final feasibility study of the Yeelirrie project was submitted to the partnership in September 1982.

Burundi.—The Finnish mining company Rautaruukki Oy and the United Nations Development Program have been evaluating a series of high-grade vanadium deposits recently discovered in Burundi. Preliminary drilling has delineated over 6 million tons of ore, containing up to 1.5% V_2O_5.[11] The vanadium mineralization occurs in a

60-mile-long belt of Proterozoic rock in the Buhoro region east of Lake Tanganyika.

China.—Preliminary data indicate that China exported almost 2,800 tons of vanadium to the Western World in 1982. Most of the vanadium was in the form of 98% minimum V_2O_5 flake or 17% to 20% V_2O_5 slag. A substantial part of the vanadium pentoxide was produced at the titanium sponge plant operated by China Titanium Corp. near Zunyi in Guizhou Province.[12] The vanadiferous slag used as feed material at the Zunyi plant comes from the Panzhihua Iron and Steel Works on the Jinsha River in southwestern Sichuan Province. Shanghai Metallurgical plant No. 2 was also a major producer of pentoxide.

In June, China's Ministry of Foreign Economic Relations and Trade instituted a system of export licensing for ferroalloys, selected chemicals, and a wide variety of other commodities. A tax of 10% is now applied to exports of ferrovanadium under the new regulations.[13] At least four plants are known to produce ferrovanadium in China. The Nanjing conversion plant in Jiangsu Province reportedly produces two types of 80% V ferrovanadium for export.

Colombia.—The Colombian Institute of Nuclear Affairs has been evaluating a deposit of uranium-vanadium-bearing phosphate rock near Berlin in the Department of Caldas, on the eastern slope of the Cordillera Central.[14] The vanadium occurs with molybdenum in a gently folded, 3- to 10-foot-thick black shale that assays 0.1% uranium and up to 10% P_2O_5. The strata-bound deposit has been drilled to a depth of 1,000 feet, and underground development work was in progress at yearend.

Finland.—Rautaruukki Oy kept its vanadium mines at Otanmäki and Mustavaara open throughout all of 1982 despite weakening market conditions and rising operational costs. The underground operation at Otanmäki produced 2,905 tons of vanadium pentoxide in 1982, a slight increase over the 2,866 tons in 1981.[15] Production at the Mustavaara open pit mine also rose slightly from 3,263 to 3,290 tons. Almost all of the pentoxide is normally exported, with the bulk in 1981 going to the Federal Republic of Germany, the United Kingdom, and the U.S.S.R. In November 1982, the supervisory body of Rautaruukki Oy announced that it had made plans to close the Mustavaara Mine in mid-1983 if the world market for vanadium deteriorated further.

Japan.—According to the Japan Ferroalloys Association, 5,150 tons of ferrovanadium was produced in 1982, a 12% increase over the 4,612 tons (revised) produced in 1981.[16] Imports of ferrovanadium decreased from 915 tons in 1981 to 769 tons in 1982.[17] Austria, Belgium-Luxembourg, and the Federal Republic of Germany were the principal suppliers of the alloy. Japan also imported 5,342 tons of vanadium pentoxide during the year. The Republic of South Africa was the principal pentoxide supplier and accounted for 74% of the total gross weight. China shipped 867 tons in 1982 and maintained its position as the second largest supplier of pentoxide to Japan.

The Japanese Government will begin stockpiling vanadium and six other strategic materials in July 1983, according to the Ministry of International Trade and Industry. Initial purchases for the stockpile will enable the Government to meet Japanese needs for 12 days in the event of a national emergency. However, over the next 5 years, the stockpile inventory would be raised gradually to a 2-month consumption level.

Norway.—Elkem AS halted production of Vantit pig iron at its Bremanger Smelting Works in June because the operation had been running a deficit for several years.[18] The pig iron furnace, one of five electric furnaces located at Svelgen, will eventually be rebuilt to produce ferrosilicon. However, no action will be taken until the difficult market situation for bulk ferroalloys eases. Elkem has not decided whether it will continue to produce ferrovanadium using imported pentoxide. In 1981, Norway exported a total of 463 tons of ferrovanadium to Sweden, the United Kingdom, and seven other European countries.

Underground mining of vanadiferous magnetite at Raudsand was halted at the beginning of 1982. The production equipment in the mine has been dismantled, and work was in progress to safeguard the underground workings.

Table 10.—Vanadium: World production from ores and concentrates, by country[1]

(Short tons of contained vanadium)

Country	1978	1979	1980	1981[p]	1982[e]
Production from ores, concentrates, slags:[2]					
Australia (in vanadium pentoxide product)[e]	--	--	--	95	110
Chile[e 3]	760	510	300	140	--
China (in vanadiferous slag product)[e]	2,200	4,000	5,000	5,000	5,000
Finland (in vanadium pentoxide product)	3,092	3,051	3,135	3,432	[4]3,470
Namibia (in lead vanadate concentrate)[5]	485	--	--	--	--
Norway[e]	510	630	540	290	120
South Africa, Republic of:[e 6]					
Content of pentoxide and vanadate product	4,023	4,300	4,500	4,200	3,800
Content of vanadiferous slag product	8,377	9,300	9,500	9,900	9,400
Subtotal	12,400	13,600	14,000	14,100	13,200
U.S.S.R.[e]	10,000	10,000	10,500	10,500	10,500
United States (recoverable vanadium)	4,272	5,520	4,806	5,126	[4]4,098
Total	33,719	37,311	38,281	38,683	36,498
Production from petroleum residues, ashes, and spent catalysts:[7]					
Japan (in vanadium pentoxide product)[e]	600	720	710	680	550
United States (in vanadium pentoxide and ferrovanadium product)	1,097	1,617	1,520	1,900	[4]1,513
Total	1,697	2,337	2,230	2,580	2,063
Grand total	35,416	39,648	40,511	41,263	38,561

[e]Estimated. [p]Preliminary.

[1]Table expanded to include output derived from petroleum residues, ashes, and spent catalysts for countries for which such data are available; in addition to countries listed, vanadium is also recovered from petroleum residues in the Federal Republic of Germany, the U.S.S.R., and several other European countries, but available information is insufficient to make reliable estimates. Table includes data available through June 15, 1983.

[2]Production in this section is credited to the country that was the origin of the vanadiferous raw material.

[3]Based on U.S. imports of vanadium-bearing slag.

[4]Reported figure.

[5]Data represent output of South West Africa Co. Ltd. for the years ending June 30 of that stated.

[6]Data on vanadium content of vanadium slag are estimated on the basis of a reported tonnage of vanadium-bearing slag (gross weight) multiplied by an assumed grade of 14% vanadium.

[7]Production in this section is credited to the country where the vanadiferous product is extracted; available information is inadequate to permit crediting this output back to the country of origin of the vanadiferous raw material.

South Africa, Republic of.—Highveld Steel and Vanadium Corp. Ltd. became a subsidiary of the Anglo American Industrial Corp. in January 1982 as a result of the merger between Anglo American Corp. of South Africa Ltd. and the DeBeers Industrial Corp. Highveld produced 94,901 tons (gross weight) of slag containing about 25% V_2O_5 in the 18 months prior to December 31, 1982.[19] On October 29, the company announced that it was reducing production of pig iron, steel, and vanadium slag at its Witbank metallurgical complex in the Transvaal because of the worldwide recession and a concurrent downturn in the South African economy. This was the first reduction in output since the Witbank steelworks was commissioned in 1968. Two of the six 45-megavolt-ampere submerged-arc furnaces that convert prereduced magnetite ore into vanadium-bearing pig iron were shut down in November. The Vantra Div., which produces pentoxide directly from Bushveld magnetite ore, had already been operating far below capacity and had been running only one roasting unit out of eight since October 1980. Construction of the three prereduction kilns and the first submerged-arc furnace for the second iron plant continued on schedule and was expected to be completed by April 1983.

[1]Physical scientist, Division of Ferrous Metals.

[2]U.S. Code of Federal Regulations. Title 40—Protection of Environment; Chapter I—Environmental Protection Agency; Part 440—Ore Mining and Dressing Point Source Category; July 1, 1983.

[3]Russell, J. H., D. G. Collins, and A. R. Rule. Vanadium Roast-Leach Dissolution From Western Phosphate Tailings. BuMines RI 8695, 1982, 19 pp.

[4]Nichols, I. L., G. R. Palmer, and J. L. Huiatt. Extracting Vanadium and Uranium From Low-Grade and Mill-Grade Ores From the Colorado Plateau. BuMines RI 8766, 1983, 16 pp.

[5]Jones, S. Metalworking News. Titanium Alloy is Challenging Stainless in Some Aero Parts. Am. Met. Mark., v. 91, No. 105, May 30, 1983, p. 21.

[6]Hennion, F. J., and J. Farkas. Assessment of Critical Metals in Waste Catalysts. BuMines OFR 197-82, September 1982, p. 67; NTIS PB 83-144832.

[7]Department of Mines (Western Australia). Annual Report 1981. P. 31.

[8]Statistiches Bundesamt, Wiesbaden. Auszenhandel nach Waren und Ländern (Foreign Trade by Commodity and Country). V. 12, 1982, pp. 143, 487.

[9]Japan Tariff Association. Japan Exports and Imports. V. 12, 1982, pp. 125, 314.

[10]Financial Times (London). No. 28773, May 14, 1982, p. 26.

Engineering and Mining Journal. V. 183, No. 6, June 1982, p. 61.

[11]Mining Magazine. V. 147, No. 6, December 1982, pp. 527-528.

[12]Metal Bulletin. No. 6741, Nov. 23, 1982, p. 18.

[13]———. No. 6693, June 4, 1982, p. 19.

[14]Mining Journal (London). V. 229, No. 7678, Oct. 15, 1982, p. 277.

[15]Rautaruukki Oy. Annual Report 1982. P. 35.

[16]Japan Metal Journal. V. 13, No. 13, May 23, 1983, p. 9.

[17]Work cited in footnote 9.

[18]Elkem AS. Annual Report 1982. Pp. 29-30.

[19]Highveld Steel and Vanadium Corp. Ltd. Annual Report 1982. Pp. 3-20.

Vermiculite

By A. C. Meisinger[1]

Vermiculite concentrate sold and used in 1982 declined slightly for the third consecutive year to 316,000 short tons valued at $28.5 million. Compared with that of 1981, exfoliated vermiculite output sold and used declined 14% to 235,000 tons valued at $55.5 million.

W. R. Grace & Co. continued to be the largest domestic producer of concentrate and exfoliated vermiculite with mines in Montana and South Carolina and 24 exfoliation plants in 20 States.

Sales for all principal end uses declined in 1982 with the exception of aggregates for premixes.

Domestic Data Coverage.—Domestic production data for vermiculite are developed by the Bureau of Mines from two separate voluntary surveys, one for domestic mine operations and the other for exfoliation plant operations. Of the four mining operations to which a request was sent, three responded. The one nonrespondent's data were estimated using prior year production levels adjusted by trends in employment and other guidelines. Of the 46 exfoliating plants to which a request was sent, 41 plants responded, representing 84% of the total exfoliated vermiculite sold and used shown in table 1. Plant data for the remaining five nonrespondents were estimated using reported prior year production levels adjusted by trends in employment and other guidelines.

Table 1.—Salient vermiculite statistics

(Thousand short tons and thousand dollars unless otherwise specified)

	1978	1979	1980	1981	1982
United States:					
Sold and used by producers:					
Concentrate	337	346	337	320	316
Value	$19,700	$22,000	$23,500	$26,200	$28,500
Average value[1] dollars per ton	$58.46	$63.58	$69.73	$81.88	$90.19
Exfoliated	270	278	281	274	235
Value	$49,000	$51,300	$54,500	$58,600	$55,500
Average value[1] dollars per ton	$181.48	$184.53	$193.95	$213.87	$236.17
Exports to Canada	35	33	[r]30	31	22
Imports for consumption[e]	28	27	[r]26	27	21
World: Production[2]	598	595	593	[p]576	[e]564

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Based on rounded data.
[2]Excludes production by centrally planned economy countries.

DOMESTIC PRODUCTION

U.S. production of vermiculite concentrate in 1982 was 316,000 tons valued at $28.5 million, a slight decrease in quantity sold and used but a 9% increase in value over that of 1981.

The principal vermiculite mining and beneficiating operations continued to be those of W. R. Grace at Libby, Mont., and Enoree, S.C. Vermiculite was also mined and processed during the year by Patterson Vermiculite Co. near Enoree, S.C., and by Virginia Vermiculite, Ltd., in Louisa County, Va.

Exploration and development of several vermiculite deposits in Montana continued during 1982 by Western Vermiculite Co. in Ravalli County and Mine-X, Inc., on two deposits in Madison County.

Production of exfoliated vermiculite sold and used decreased 14% in 1982 to 235,000 tons. Production came from 46 plants in 30 States compared with 48 plants in 31 States in 1981. Producers and plant locations are shown in table 3.

The principal producing States were, in order of decreasing exfoliated vermiculite output, Ohio, Texas, California, Florida, South Carolina, New Jersey, and Illinois.

Table 2.—Exfoliated vermiculite sold and used in the United States, by end use

(Short tons)

End use	1981	1982
Aggregates:		
Concrete	61,200	51,300
Plaster	4,000	3,800
Premixes[1]	55,700	56,500
Total	120,900	111,600
Insulation:		
Loose-fill	32,500	23,300
Block	36,600	30,600
Other[2]	3,800	3,300
Total	72,900	57,200
Agricultural:		
Horticultural	20,500	16,900
Soil conditioning	17,500	14,800
Fertilizer carrier	39,600	33,500
Total	77,600	65,200
Other[3]	2,400	800
Grand total[4]	274,000	235,000

[1]Includes acoustic, fireproofing, and texturizing uses.
[2]Includes high-temperature and packing insulation and sealants.
[3]Includes various industrial uses not specified.
[4]Data may not add to totals shown because of independent rounding.

Table 3.—Active vermiculite exfoliating plants in the United States in 1982

Company	County	State
A-Tops Corp	Beaver	Pennsylvania.
Brouk Co	St. Louis	Missouri.
Cleveland Gypsum Co., Div. of Cleveland Builders Supply Co	Cuyahoga	Ohio.
International Vermiculite Co	Macoupin	Illinois.
Koos, Inc	Kenosha	Wisconsin.
O. M. Scott & Sons	Union	Ohio.
Patterson Vermiculite Co	Laurens	South Carolina.
Robinson Insulation Co	Cascade	Montana.
Do	Ward	North Dakota.
The Schundler Co	Middlesex	New Jersey.
Strong-Lite Products Corp	Jefferson	Arkansas.
Strong-Lite Products Corp. of Illinois	De Kalb	Illinois.
Verlite Co	Hillsborough	Florida.
Vermiculite-Intermountain, Inc	Salt Lake	Utah.
Vermiculite of Hawaii, Inc	Honolulu	Hawaii.
Vermiculite Products, Inc	Harris	Texas.
W. R. Grace & Co., Construction Products Div	Irondale	Alabama.
	Maricopa	Arizona.
	Pulaski	Arkansas.
	Alameda	California.
	Orange	Do.
	Denver	Colorado.
	Broward	Florida.
	Duval	Do.

Table 3.—Active vermiculite exfoliating plants in the United States in 1982 —Continued

Company	County	State
W. R. Grace & Co., Construction Products Div	Hillsborough	Florida
	Du Page	Illinois.
	Campbell	Kentucky.
	Orleans	Louisiana.
	Prince Georges	Maryland.
	Hampshire	Massachusetts.
	Wayne	Michigan.
	Hennepin	Minnesota.
	St. Louis	Missouri.
	Douglas	Nebraska.
	Mercer	New Jersey.
	Cayuga	New York.
	Guilford	North Carolina.
	Oklahoma	Oklahoma.
	Multnomah	Oregon.
	Lawrence	Pennsylvania.
	Greenville[1]	South Carolina.
	Davidson	Tennessee.
	Bexar	Texas.
	Dallas	Do.
	Milwaukee	Wisconsin.

[1]Two plants in county.

CONSUMPTION AND USES

Sales in end uses, with the exception of premixes, declined primarily because of decreased activity in construction of nonresidential buildings. Little change in the pattern was evident.

PRICES

The average value of vermiculite concentrate sold and used by U.S. producers in 1982 increased 10% to $90 per ton, f.o.b. plant, compared with that of 1981, and the average value for exfoliated vermiculite sold and used, f.o.b. plant, also increased 10% to $236 per ton.

Engineering and Mining Journal quoted 1982 yearend prices for unexfoliated vermiculite as follows: per short ton, f.o.b. mine, Montana and South Carolina, domestic, $75 to $121.50; and the Republic of South Africa, c.i.f. Atlantic ports, $100 to $160. For comparison, 1981 yearend quoted prices per ton were $78 to $106 for domestic ore and $100 to $160 for South African ore.

FOREIGN TRADE

Although data are not available, the United States has imported significant quantities of vermiculite concentrate from the Republic of South Africa for many years. During the period 1980-82, approximately 4,500 tons of vermiculite concentrate was imported from Brazil.

The quantity of vermiculite concentrate exported to Canada in 1982 was 7% of total sales compared with 10% in 1981.

WORLD REVIEW

Estimated world production declined for the fourth consecutive year. The United States and the Republic of South Africa, together, accounted for 92% of the estimated world production.

Brazil's measured and indicated reserves of vermiculite were reported to be about 16 million tons, as of December 1981. During the year, Eucatex Mineração, Ltda., one of Brazil's two major vermiculite producers, acquired a mine operation in Paulistana, Piauí. Production capacity of this operation was estimated to be 13,000 tons per year.[2]

[1]Industry economist, Division of Industrial Minerals.

[2]U.S. Embassy, Rio de Janeiro, Brazil. State Department Airgram CERP 429, Mar. 1, 1983.

Table 4.—Vermiculite: World production, by country[1]

(Short tons)

Country	1978	1979	1980	1981[p]	1982[e]
Argentina	4,878	6,478	10,920	3,557	[2]6,010
Brazil	4,443	8,137	13,427	15,771	16,500
Egypt	654	770	800	800	[2]309
India	2,079	3,376	4,054	3,995	[2]2,280
Japan[e]	16,000	17,000	19,000	19,000	19,000
Kenya	2,054	2,491	2,819	[e]2,900	2,900
South Africa, Republic of	230,485	211,173	204,698	210,101	[2]201,327
Tanzania[e]	20	20	20	20	20
United States (sold and used by producers)	337,000	346,000	337,000	320,000	[2]316,000
Total	597,613	595,445	592,738	576,144	564,346

[e]Estimated. [p]Preliminary.
[1]Excludes production by centrally planned economy countries. Table includes data available through July 6, 1983.
[2]Reported figure.

Zinc

By James H. Jolly[1]

Owing to the economic recession, zinc consumption in the United States in 1982 was at its lowest level since 1949. Primary slab zinc smelter production also was down sharply, and slab zinc stock levels fell during the year. One primary zinc plant closed down for 6 weeks in the summer months because of the poor zinc market, and another primary plant closed indefinitely at the end of October. A number of mines closed indefinitely in 1982, and one large zinc mine in Idaho was closed permanently. Despite these mine closures, mine production was only marginally lower, owing mainly to the opening of two new zinc mines, one in Tennessee and the other in New York. Zinc prices fell sharply in the first 6 months but improved near yearend.

Slab zinc imports fell but continued to be the major source of domestic slab zinc supply. Imports of concentrate fell to their lowest level since 1939, reflecting, to some extent, the low demand requirements of primary zinc plants in 1982. Exports of concentrate rose substantially and exceeded imports of concentrate for the first time since 1936.

Table 1.—Salient zinc statistics

(Metric tons unless otherwise specified)

	1978	1979	1980	1981	1982
United States:					
Production:					
Domestic ores, recoverable content	302,669	267,341	317,103	312,418	300,274
Value thousands	$206,854	$219,841	$261,671	$306,879	$254,668
Slab zinc:					
From domestic ores	267,350	255,344	231,850	[r]259,835	193,284
From foreign ores	139,348	217,137	108,606	86,728	34,892
From scrap	34,774	53,212	29,396	[r]50,192	74,288
Total	441,472	525,693	369,852	[r]396,755	302,464
Secondary zinc[1]	304,047	316,818	274,967	[r]290,658	210,681
Exports of slab zinc	723	279	302	323	341
Imports (general):					
Ores and concentrates (zinc content)	188,003	224,952	129,923	117,736	49,344
Slab zinc	617,840	527,212	410,642	602,694	447,442
Stocks of slab zinc, Dec. 31:					
Producer and consumer	137,253	151,661	92,151	126,581	105,766
Merchant	NA	NA	33,650	68,773	47,397
Government stockpile	345,872	345,684	342,380	340,581	340,578
Consumption:					
Slab zinc	1,050,585	1,000,606	811,146	[r]840,875	709,491
All classes	1,441,810	1,394,314	1,142,409	[r]1,189,369	953,111
Price: Prime Western, cents per pound (delivered)	30.97	37.30	[2]37.43	[2]44.56	[2]38.47
World:					
Production:					
Mine thousand metric tons	[r]5,854	[r]5,873	5,757	[p]5,657	[e]6,047
Smelter do	[r]5,882	[r]6,270	6,057	[p]6,112	[e]5,881
Price: Prime Western, London, cents per pound	26.88	33.59	34.47	38.34	33.74

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.
[1]Excludes redistilled slab zinc.
[2]Based on U.S. High Grade, cents per pound.

Domestic Data Coverage.—Domestic data for zinc are developed by the Bureau of Mines from seven separate, voluntary surveys of U.S. zinc operations. Typical of these surveys is the annual Zinc survey, which covered the five operating primary zinc plants. Of the five primary operations to which a survey request was sent, all responded, representing 100% of the primary slab zinc production shown in tables 1 and 7.

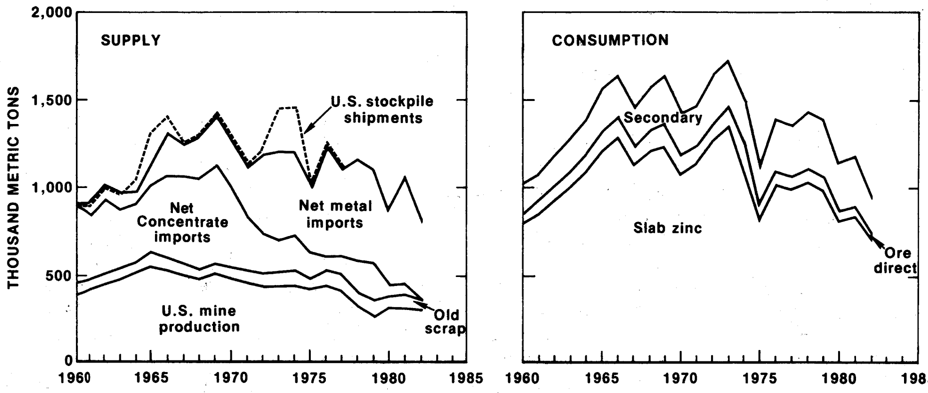

Figure 1.—Trends in supply and consumption in the United States.

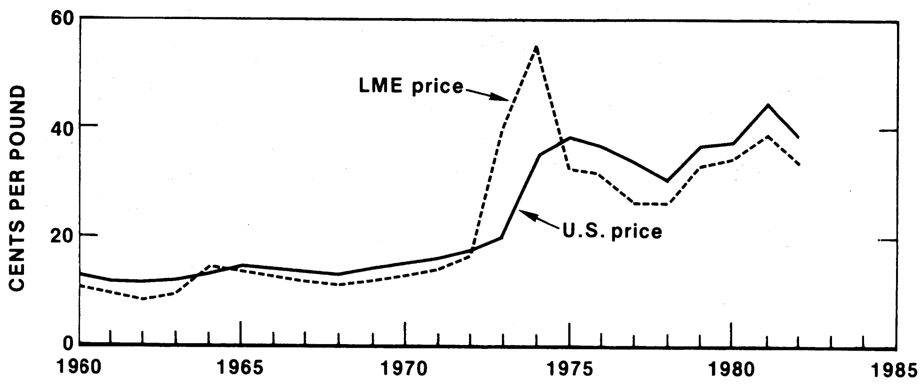

Figure 2.—Trends in average London Metal Exchange (LME) and domestic zinc prices.

Legislation and Government Programs.—The National Defense Stockpile goal for zinc was 1,292,739 tons, unchanged since May 1980. The total zinc inventory at yearend 1982 was 343,240 tons, including 2,625 tons of zinc in stockpiled brass.

The U.S. Bureau of the Mint produced and distributed about 4.5 billion copper-plated zinc pennies in 1982, the first year of distribution for the new zinc penny. The Denver Mint, the last of four stamping plants producing pennies, used up its backlog of copper penny blanks in October. In the last 2 months of 1982, all penny production was of the zinc type.

DOMESTIC PRODUCTION

MINE PRODUCTION

Although a number of zinc mines closed in 1982, U.S. production of recoverable zinc was only slightly less than that of 1981, owing to the opening of two new mines and increased output at several of the larger lead-zinc mines in Missouri. The largest decline in production occurred in Idaho. The 25 leading U.S. zinc-producing mines accounted for more than 99% of the recoverable zinc mined in 1982. The 10 leading mines accounted for 78% of the total mine production in 1982 compared with 65% in 1981.

Tennessee was the principal zinc-producing State, a position the State has held 23 times in the last 26 years. Zinc was produced in Tennessee from zinc ore mined from eight underground mines and from copper-zinc ores mined at the Copperhill deposit. Production in Tennessee was higher than in 1981 despite the closing of three major mines; one new mine opened.

ASARCO Incorporated operated four Tennessee mines—Young, New Market, Immel, and Coy—in 1982. According to Asarco's annual report, the company milled 2.5 million tons of ore, producing 60,700 tons of zinc in concentrate, slightly less than that produced in 1981. Ore reserves at the four mines were 6.8 million tons grading 3.35% zinc at yearend.

In April, Jersey Miniere Zinc Co. brought onstream its new mine and mill at Gordonsville, Tenn. The new 8,160-ton-per-day zinc concentrator replaced the company's 2,700-ton-per-day Elmwood mill, which first came into production in 1974. The new Gordonsville mill has the capacity to produce about 6,400 tons of concentrate per month from Elmwood-Gordonsville ore, with a yearly output of about 47,000 tons of zinc in concentrate. In 1982, the grade of zinc concentrate produced at the new mill exceeded 64.5% zinc, and zinc recovery was about 95%. In addition to zinc production, Jersey Miniere planned to produce annually about 2 million tons of limestone and dolomite, suitable for commercial agricultural lime and aggregate products, from mining and milling zinc ore at Gordonsville. Combined ore reserves at Jersey Miniere's Elmwood and Gordonsville Mines were about 27 million tons grading 3.7% zinc at yearend.

The New Jersey Zinc Co., owned by Gulf + Western Industries Inc., operated two mines in Tennessee in 1982. The company closed its Jefferson City Mine in May because of the poor zinc market. The Jefferson City mill and the company's nearby Beaver Creek Mine were also scheduled to close but remained open through 1982 following wage concessions by the local labor union. In December, the company announced it was closing down both facilities in early 1983. Production at the Beaver Creek Mine was increased in the latter half of the year to make up for the production loss caused by the closure of the Jefferson City Mine.

United States Steel Corp. closed down its Zinc Mine Works at Jefferson City, Tenn., in late October owing to depressed zinc demand and prices. The company indicated that the shutdown was temporary, but operations were not expected to resume until the zinc market improved.

Zinc production in Missouri was a coproduct from seven lead mines. Production in 1982 was up significantly over that of 1981 largely because 1981 production was reduced by labor strikes. Output of zinc at the Buick Mine, owned jointly by AMAX Inc. and Homestake Mining Co., increased 73%, owing mainly to a strike-free year and the mining of higher zinc ore grades. Yearend ore reserves at Buick were about 36 million tons grading 5.8% lead and 1.5% zinc. In December, Exxon Minerals Co. was negotiating to buy AMAX's 50% share of the Buick Mine. Zinc output at the Magmont Mine, jointly owned by Cominco American Inc. and Dresser Industries Inc., was down slightly mainly because of the mining of lower grade ore from the Magmont East extension. In 1982, 1.1 million tons of ore grading 1.0% zinc was milled, yielding about 12,800 tons of concentrate containing 60% zinc. At yearend, Magmont ore reserves were estimated at 4.7 million tons grading 9.4% lead, 1.2% zinc, and 0.3 ounce of silver per ton.

Ozark Lead Co., a unit of Kennecott Minerals Co., continued to reduce staff and zinc output in 1982 because of increasing lead inventories and declining lead and zinc prices. Asarco continued construction of its West Fork, Mo., mill and surface facilities with completion expected in mid-1983. The company, however, was delaying mine development until the lead market improved. The mill was designed for a throughput rate of 3,450 tons of ore per day with an expected annual yield of 46,000 tons of lead, 6,800 tons of zinc, and 125,000 ounces of silver in concentrates.

St. Joe Lead Co., a unit of Fluor Corp., increased zinc output at its four Missouri lead mines—Fletcher, Brushy Creek, Viburnum No. 28, and Viburnum No. 29—in 1982. Production in 1981 was reduced by a 3-month strike. St. Joe was expected to begin limited production at its new Bixby, Mo., lead-zinc-copper mine in August 1983. At full production, the new mine was expected to yield about 3,600 tons of lead-zinc ore per day. To handle the Bixby production, St. Joe's mill at Viburnum was being increased by 3,600 tons, raising the mill's capacity to 11,000 tons per day.

In New York, St. Joe Resources Co., a unit of Fluor Corp., brought its new zinc mine at Pierrepont, N.Y., onstream in April. The mine, developed at a cost of $4.5 million, produced about 450 tons of high-grade ore per day. The ore was milled at the company's Balmat mill, about 28 miles from the mine. Ore reserves at the Pierrepont Mine were estimated at 2.3 million tons grading 16% zinc. A mine life of 20 years was expected.

Zinc mine production in Idaho decreased sharply in 1982 owing to the closure of the Bunker Hill Mine in late 1981 and the permanent closure of the Star-Morning Unit of Hecla Mining Co. in June 1982. The Star-Morning Unit had operated continuously for 92 years. The mine was a major zinc, lead, and silver producer, and at 8,100 feet, the deepest mine in the United States. Hecla's Lucky Friday Mine was the principal zinc producer after the Star-Morning Unit was closed down. According to Hecla's annual report, the Star-Morning Unit and Lucky Friday Mine produced 6,209 tons and 1,877 tons of zinc, respectively, in concentrate in 1982. Minor zinc production came from five silver mines.

In November, Gulf Resources and Chemical Corp., owners of the Bunker Hill mine-smelter complex in Idaho, sold the closed complex to a group of local investors for $15 million. The new company, Bunker Ltd., was planning to reopen the complex in the latter half of 1983 if metal prices improved and feed sources for the smelting operations could be found.

In Colorado, zinc production came largely from the Leadville Mine, managed by Asarco but owned jointly with Resurrection Mining Co. Zinc output fell 5% to 11,340 tons in 1982, largely because of lower ore production. Ore reserves at yearend were 1.4 million tons grading 9.22% zinc, 4.23% lead, and 2.7 ounces of silver per ton.

Noranda Mines Ltd. suspended all work and terminated its lease with United Park City Mines Co. relative to the Ontario lead-zinc mine near Park City, Utah. Noranda had invested about $28 million on exploration and development at the site since it obtained the lease in 1979. Noranda terminated the lease because of prevailing low metal prices and a variety of operating problems including adverse rock conditions and excessive ground water.

In December, Exxon filed an Environmental Impact Report and several associated permit applications with the Wisconsin Department of Natural Resources for its proposed zinc-copper mine and mill south of Crandon, Wis. Development of the deposit, however, was not expected until the late 1980's. Ore reserves were estimated at 66 million tons grading 5.8% zinc, 1.4% copper, and 0.5% lead, with minor amounts of silver and gold.

In February, Cominco signed an agreement with the NANA Regional Corp. Inc., an Alaskan native-American organization, for the evaluation and potential development of the Red Dog zinc-lead-silver deposit northeast of Kotzebue, Alaska. A feasibility study was underway. The Red Dog ore reserves were estimated at 77 million tons grading 17.1% zinc, 5% lead, and 2.4 ounces of silver per ton.

Boliden Minerals Inc., a subsidiary of Boliden AB of Sweden, and Exxon reached an agreement that allows Boliden to explore and develop Exxon's Pinos Altos copper-zinc deposit near Silver City, N. Mex. If a mine is developed, Exxon would receive a revenue interest in the mine. Based on previous exploration by Exxon, estimated ore reserves were 6.4 million tons grading 2% copper and 3% zinc, plus minor quantities of silver and gold.

In August, all work, except that necessary for environmental permits, was deferred indefinitely by Superior Mining Co. at its Bald Mountain copper-zinc project in northern Maine, primarily because of depressed copper prices. The Bald Mountain deposit was estimated to contain about 33 million tons of ore grading 1.5% copper and 2% zinc. Exploration work on this deposit prompted the Maine Legislature to pass a new mining tax in May to help local communities bear extra costs if the deposit is developed.

SMELTER AND REFINERY PRODUCTION

Zinc production at Asarco's Corpus Christi, Tex., zinc refinery was about 37,400 tons in 1982, 18% less than in 1981, according to the company's annual report. The refinery operated at 50% of capacity since February and was indefinitely closed down at the end of October, owing mainly to a lack of feed materials. About one-half of the refinery's feed consisted of zinc fume from the company's lead smelters at El Paso, Tex., and East Helena, Mont., but for economic reasons, zinc fuming operations at these plants were suspended in May and early October, respectively. Concentrates from other sources were not adequate to sustain production at economic levels. After the refinery closure, Asarco contracted with National Zinc Co. to toll refine some of its concentrate. A $42 million modernization project at the Corpus Christi refinery was completed in June. Asarco operated the new facilities long enough to test thoroughly the new metallurgical systems.

Zinc production at the refinery owned by National Zinc in Bartlesville, Okla., also declined because of a temporary, 6-week summer shutdown because of poor markets and excessive stocks and a 5-week labor strike late in the year. During the strike, salaried employees maintained zinc production at about 50% of the smelter's 51,000-ton-per-year capacity. Production was not increased appreciably after the strike because of continuing poor market conditions.

St. Joe Resources Co. increased the annual capacity of its Monaca, Pa., zinc plant from 68,000 tons to 77,000 tons in 1982 by adding three new electric furnaces designed and licensed from Larvik Engineering Co. of Norway. The project cost $3 million. A fourth Larvik furnace was expected to come onstream in 1983, boosting capacity to about 81,000 tons per year. The new furnaces allowed St. Joe to process drosses, skimmings, ashes, and flue dusts that previously were uneconomic to process. These furnaces together with the company's rebuilt electrothermic equipment, which can process both concentrate and high-grade secondary material, provide wide flexibility in the utilization of feed material. At yearend, installed capacities at the Monaca smelter were 7,250 tons of dust, 45,000 tons of zinc oxide, and 77,000 tons of slab zinc.

Pacific Smelting Co. brought its new secondary zinc plant in Memphis, Tenn., onstream in March. The company produced French-process zinc oxide using mainly diecasting scrap from the automotive industry. The zinc oxide was sold mainly to the rubber industry. Pacific Smelting was also modernizing its zinc dust manufacturing plant in Torrance, Calif., by installing a new furnace and other equipment that will increase plant capacity by 5,500 tons per year. When completed in 1983, the company's zinc plants were expected to have a combined capacity of 45,000 tons for all zinc products, including dust, metal, and oxide.

Zinc Oxide.—The sources of domestic zinc oxide production were about 31% from ores and concentrates, about 33% from slab zinc, and about 36% from secondary material. French-process zinc oxide was about 62% of the total produced in 1982, compared with 56% in 1981. Lead-free zinc oxide was produced at 12 plants, and leaded zinc oxide was produced at 1 plant. Two companies produced oxide from ores and concentrates.

In 1982, Asarco's production of zinc oxide at its zinc oxide plants in Columbus, Ohio, and Hillsboro, Ill., was 18,960 tons, 28% less than in 1981. The two plants were operated at less than one-half of capacity owing to depressed demand by the rubber and paint industries. The New Jersey Zinc Co. Inc. (JZI) produced both American- and French-process zinc oxide and had the largest capacity. Zinc concentrates used in the production of American-process zinc oxide were from the company's Sterling Mine at Ogdensburg, N.J., and from foreign sources.

Zinc Salts.—Zinc sulfate was produced by about 14 companies from secondary material and concentrate. Zinc chloride production from five companies was derived entirely from secondary materials.

Slag-Fuming Plants.—In 1982, only two Asarco plants, one at El Paso, Tex., and the other at East Helena, Mont., produced zinc oxide fume from lead-blast-furnace slags and residues. For economic reasons, the company ceased fuming operations at both plants during the year. According to its annual report, Asarco recovered 12,300 tons of zinc in fume in 1982 compared with 27,400 tons in 1981. The fume was shipped to Asarco's Corpus Christi zinc refinery for processing.

Byproduct Sulfur.—Production of sulfur in byproduct sulfuric acid from five primary zinc plants was 112,000 tons in 1982, compared with 179,000 tons in 1981.

CONSUMPTION AND USES

In 1982, zinc consumption fell sharply in all basic uses except rolled zinc, which increased owing to production of the new zinc penny. Slab zinc consumption decreased 15% from that of 1981, as its use in brass, die-cast alloys, and galvanizing was down. Construction materials accounted for an estimated 40% of zinc consumption, followed by transportation equipment, 20%; machinery, 12%; electrical equipment, 8%; chemicals, 7%; and other uses, 13%.

Galvanizing continued to be the principal use of slab zinc, consuming 48%, followed by zinc-based alloys, 28%; brass and bronze, 11%; and other uses, 13%. Special High Grade constituted 46% of slab zinc consumption and was used mainly in diecasting alloys. Prime Western accounted for 29% of slab zinc consumption and was largely used in galvanizing.

The apparent consumption of zinc oxide was about 152,000 tons, down from about 177,000 tons in 1981. Reported shipments to user industries decreased 15% in 1982. All end-use categories declined, with the rubber, paint, and agricultural industries showing the largest decreases. Zinc sulfate shipments increased slightly although its principal use, in agriculture, declined marginally. Zinc chloride and other zinc chemical usage were also generally lower in 1982.

Zinc Institute Inc. studies reported that the weight of zinc diecastings, including optional equipment, used in the average U.S.-manufactured automobile for the 1982 model year was expected to be 22.69 pounds compared with 24.14 pounds in 1981 and 44.84 pounds in 1976. The declining use of zinc was attributed to substitution, elimination of parts, automobile downsizing, and increased use of thin-wall zinc diecastings. Trucks were estimated to use between 15 to 20 pounds of zinc diecastings per vehicle. In 1982, about 7.2 pounds of zinc was used per automobile to protect the steel underbody parts of automobiles. An additional 1.5 pounds of zinc dust was used in zinc-rich paints.

STOCKS

Annual data collected by the Bureau of Mines indicated that primary and secondary producer stocks of slab zinc declined 37% during the year. Monthly stock data as reported by the American Bureau of Metal Statistics Inc. showed that producer stocks at plants and elsewhere increased through March to 44,700 tons, declined to 17,200 tons by August, and rose through December, ending the year at 30,000 tons.

Inventories of slab at consumer plants generally trended downward in the first 9 months of 1982 but ended the year only marginally lower than at the start of the year. Merchant stocks declined sharply at midyear, mainly in response to depressed market conditions. In the latter half of 1982, stock levels began to rise, but at yearend, merchant stocks were 31% lower than at the beginning of the year.

PRICES

The High Grade slab zinc price ranged from 42 to 46.25 cents per pound at the beginning of the year. Poor demand related to the continuing economic recession resulted in a gradual reduction in High Grade prices to the 35-cent-per-pound level by mid-April. In mid-May, most North American producers raised their zinc prices 2 cents per pound, reportedly to maintain minimal levels of profitability rather than based on improved demand. Despite higher quoted prices, producer discounting resulted in average monthly prices for High Grade below 35 cents per pound in May and June. In early July, the High Grade price was raised across the board to 37 cents per pound, and by mid-July, most producers were quoting 40 cents per pound. Because of various contract provisions and forward buying by consumers, the new higher prices were not in effect until September. Several producers raised their High Grade price to 42 cents per pound in early September because of a shortage of metal caused by the temporary closure of four North American smelters during the summer and reduced production levels by other producers. In early November, Asarco lowered its High Grade price to 38 cents per pound. All producers, except Asarco, were 2 cents higher at 40 cents per pound by the end of November. Asarco further lowered its High Grade price to 36 cents per pound on December 9. At yearend, the High Grade price ranged from 36 to 40 cents per pound. Special High Grade and Prime Western list prices were generally quoted at 0.5 to 0.75 cent higher than High Grade in 1982.

The Commodities Exchange Inc. (Comex) declared its zinc futures contract dormant on October 27 and delisted it. The contract, which called for delivery of Special High Grade slab zinc, was first traded by Comex in February 1978. The contract was little used, and the last official trade was made in April 1981.

American- and French-process lead-free zinc oxide began the year at 50 to 52 cents and 51.5 to 53.5 cents per pound, respectively. Prices for both generally declined, paralleling the decrease in zinc metal prices. The low quotes of 44.5 cents per pound and 46.5 cents per pound for American- and French-process zinc oxide, respectively, were established in early April and prevailed to yearend. The high quotes for both oxides decreased to 46.5 and 48 cents per pound, respectively, by the end of June. Photoconductive-grade zinc oxide was listed at 2 to 3 cents per pound higher than French-process zinc oxide during the year.

The quoted prices of zinc sulfate, granular monohydrate industrial grade, 36% zinc in 100-pound bags in carload lots, ranged from $26.50 to $29 in 1982, the same as in 1981. Technical-grade zinc chloride, 50% solution, was quoted at $12 to $18 per 100 pounds in tanks, f.o.b., throughout the year. In 1982, standard pigment-grade zinc dust in drums was quoted at 48 cents per pound; pigment types 1 and 2 in drums were quoted at 59 to 69.5 cents per pound.

FOREIGN TRADE

Exports of concentrates increased 42% in 1982 and exceeded imports of concentrate for the first time since 1936. The increase was partially attributable to concentrates made available for export because of the closing down of the Bunker Hill zinc plant. Imports of concentrates were at their lowest level since 1939, owing mainly to reduced requirements caused by plant closings and lower production levels in 1982.

Slab zinc imports for consumption fell 25% compared with those in 1981. Canada was by far the principal exporter of slab zinc to the United States, supplying slightly more than one-half of U.S. imports. Peru, formerly a minor import source, increased shipments in 1982 and was the second largest supplier. Other major suppliers were Australia and Mexico.

Import duties on unwrought zinc and zinc alloys continued to be reduced in line with the Tokyo round of multilateral trade negotiations completed in 1979. Duties on zinc ores, concentrates, and certain other zinc-bearing materials continued to be suspended during 1982.

Table 2.—U.S. import duties for zinc materials, January 1, 1982

Item	TSUS No.	Most favored nation (MFN)	Non-MFN
Ores and concentrates[1]	602.20	0.53 cent per pound on zinc content.	1.67 cents per pound on zinc content.
Fume	603.50	do	Do.
Unwrought, other than alloys	626.02	1.8% ad valorem	1.75 cents per pound.
Alloys	626.04	19% ad valorem	45% ad valorem.
Waste and scrap[1]	626.10	4% ad valorem	11% ad valorem.

[1]Duty on zinc ores, concentrates, and zinc-bearing materials suspended until June 30, 1984, as provided by Public Law 96-467.

WORLD REVIEW

World consumption of zinc reflected the general weakness of the world economy in 1982. According to the International Lead and Zinc Study Group (ILZSG)[2] slab zinc consumption in the market economy countries was about 4.1 million tons in 1982 compared with 4.4 million tons in 1981 and 4.5 million tons in 1980. Consumption on a regional basis was about the same in most areas except in the Americas where consumption fell about 200,000 tons from that of 1981. The United States recorded the largest tonnage drop of all countries. Consumption also was off in Australia, Brazil, Canada, and most European countries. Consumption was up marginally in Japan, the Republic of South Africa, the Republic of Korea, the Netherlands, and Sweden. ILZSG reported that commercial slab zinc stocks fell during the first 10 months of 1982, but increased in the last 2 months, ending the year at about 796,000 tons or 9% less than at the beginning of the year. London Metal Exchange stocks increased about 18,000 tons in 1982, but slab zinc stocks in most market economy countries were lower at yearend.

World mine output, according to the Bureau of Mines, increased substantially in 1982 despite a number of mine closures, strikes, and production cutbacks. New mines and increased production at existing mines in Canada, Peru, Australia, Mexico, and Ireland accounted for most of the 390,000-ton gain in world mine output over that of 1981. Of the major producers, production fell, but not drastically, in the United States, Spain, and the Federal Republic of Germany.

Decreased smelter production in Canada, the United States, Australia, and several European countries accounted for most of the decline in output in 1982. These countries bore the brunt of cutbacks caused by weak demand. Peruvian production increased significantly because a new smelter became operational.

The European Commission granted preliminary approval in December for an industry plan to aid the ailing European zinc industry. Under the plan, producers could coordinate production cuts and be reimbursed $220 for each ton of capacity closed. Reimbursement funds were to be obtained from the producing companies.

At its annual October session in Geneva, Switzerland, the ILZSG projected that both world production and consumption of slab zinc would be higher in 1983 than in 1982 and that concentrate supply and demand would be in closer balance in 1983.

Australia.—Mine production increased substantially in 1982 owing to increased output at a number of mines including Mount Isa, Teutonic Bore, and Woodlawn, in conterminous Australia, and the Que River and Rosebery in Tasmania.

At Mount Isa in Queensland, MIM Holdings Ltd. completed in mid-1982 its $58 million project to expand mining and milling of silver-lead-zinc ore by 20%. The project included construction of a $25 million, 800-ton-per-hour, heavy-media separation plant designed to reject waste material from the downstream grinding and flotation circuits. The plant was expected to reject about 35% of the ore feed as waste.

In fiscal year 1982, MIM milled 3 million tons of silver-lead-zinc ore averaging 6.3% zinc, producing a record 258,165 tons of 55% zinc concentrate. Output was up 32% over that produced in fiscal year 1981. At the end of June, zinc ore reserves at Mount Isa totaled 46 million tons grading 6.6% zinc, 5.9% lead, and 4.6 ounces of silver per ton.

At MIM's Hilton deposit, about 12 miles north of the Mount Isa Mine, a 500-ton-per-day trial mining project was in progress. The Hilton deposit had 45 million tons of probable reserves grading 9.6% zinc, 6.6% lead, and 4.7 ounces of silver per ton.

EZ Industries Ltd. (EZI) completed construction of its $170 million Elura Mine and mill and planned to start production in January 1983 with full production by March 1983. Design capacity was 130,000 tons per year of zinc concentrate and 100,000 tons per year of silver-lead concentrate from milling 1.1 million tons of ore. Reserves were 27 million tons grading 8.3% zinc, 5.6% lead, and 4.5 ounces of silver per ton.

Woodlawn Mines Ltd., a joint venture of St. Joe, New Broken Hill Consolidated Ltd., and Conzinc Riotinto of Australia Ltd., produced about 70,000 tons of zinc in concentrate at its open pit mine in New South Wales in the fiscal year ending October 31. Woodlawn processed about 0.6 million tons of ore averaging 13% zinc in 1982. Metal recoveries improved owing to changes in ore blending and in the flotation circuit. In prior years, metal recoveries were adversely affected by extreme variability in ore grades and contamination by oxidized material from the surface gossan. Ore reserves, exclusive of simple copper ore reserves, totaled 6 million tons grading 9.5% zinc plus appreciable lead, copper, and silver.

Aberfoyle Ltd., 49% owned by Cominco, produced 228,000 tons of ore at its new Que River zinc-lead-silver mine in Tasmania in 1982. The ore was milled by EZI's West Coast Mines, which milled 760,000 tons of ore, including that from Que River. Zinc concentrate production was 146,900 tons containing 52.2% zinc. An additional 60,100 tons of lead and copper concentrates containing about 12.5% zinc was also produced. West Coast Mines produced 84,200 tons of zinc in concentrate compared with 54,400 tons in 1981.

MIM (40%) and Western Selcast Ltd. (60%) completed its first full year of production at their Teutonic Bore copper-zinc-silver open pit mine in Western Australia. For the fiscal year 1982 ending June 30, production at Teutonic Bore was about 31,500 tons of zinc contained in about 62,800 tons of concentrate. Ore treated was about 330,000 tons grading 13.1% zinc. Ore reserves available to open pit mining as of June 30 were 0.4 million tons grading 11.6% zinc, 4.0% copper, and 5 ounces of silver per ton. An additional 0.6 million tons of ore reserves grading 11.2% zinc, 3.5% copper, and 5 ounces of silver per ton was to be mined by underground methods.

EZI, AMAX Exploration (Australia) Inc., Aztec Exploration Ltd., and Esso Exploration and Production Australia Inc. revised upward the ore grades at their Scuddles copper and zinc deposit at Golden Grove in Western Australia. Resource data from the Zinc and Southern Merged zones indicate 16.2 million tons of ore grading about 10.7% zinc, 0.8% lead, 0.7% copper, and 2.7 ounces of silver per ton, plus some gold. Esso, as operator of the project, was conducting further engineering and metallurgical studies.

Australian slab zinc production fell slightly in 1982 despite higher production at the Risdon zinc plant of EZI's subsidiary, Electrolytic Zinc Co. of Australasia Ltd. Production at Risdon totaled 192,142 tons and accounted for two-thirds of Australian slab zinc output. Modifications to the Risdon plant were made in 1982 that allow for the treatment of concentrate from the new Elura Mine.

Canada.—Canada continued to lead the world in zinc mine production, accounting for about one-fifth of world production in 1982. Mine output was up over that of 1981, owing mainly to the first year's production from Cominco's Polaris Mine on Little Cornwallis Island near the magnetic North Pole. Increased production following expansions in 1981 was also recorded by Kidd Creek Mines Ltd. and Brunswick Mining and Smelting Corp. Ltd. (BMS). A number of mines closed indefinitely in 1982, and others closed temporarily in the summer months.

After 2 years of construction, the Polaris Mine began producing at commercial rates in February. Production in its first year was 129,200 tons of 57.3% zinc concentrate and 41,600 tons of 72.6% lead concentrate from milling 470,000 tons of ore that averaged 17.0% zinc and 7.0% lead. Zinc recovery from the ore was about 93%. Six shipments of concentrates were made during the limited shipping season in 1982. Most of the zinc concentrate was sold to European refineries although some was tolled and subsequently marketed by Cominco. The lead concentrate was sold to smelters in Europe. Ore reserves at yearend totaled 10 million tons averaging 15.2% zinc and 4.4% lead.

Cominco's principal sources of zinc and lead concentrate for its Trail, British Columbia, integrated smelter and refining complex continued to be the Sullivan Mine in British Columbia and Pine Point Mine in the Northwest Territories. Ore production at the Sullivan Mine was the highest since 1964, despite a 5-week shutdown. About 2.5 million tons of ore was milled in 1982, yielding 118,800 tons of zinc concentrate grading 49.4% zinc. Ore reserves at the Sullivan Mine at yearend were 44 million tons grading 6.1% zinc, 4.4% lead, and 1 ounce of silver per ton.

Pine Point Mines Ltd., 69% owned by Cominco, milled 2.4 million tons of ore in 1982, only two-thirds of that milled in 1981, but zinc concentrate output was up 4% owing to the processing of higher grade ores necessitated by the depressed state of the zinc and lead markets. Despite stringent measures to reduce costs, the company reported a $9 million operating loss in 1982. Late in the year, owing to continued low prices for lead and zinc, Pine Point announced plans to temporarily shut down mining and milling operations on January 2, 1983. In 1982, Pine Point produced 260,700 tons of zinc concentrate containing 57.3% zinc. Ore reserves at yearend were about 32 million tons grading 6.1% zinc and 2.4% lead.

Cominco continued modernization and expansion of its Trail zinc plant, which when completed in 1983 will have an annual production capacity of 272,000 tons of refined zinc. Construction was almost completed by yearend on the $172 million, highly automated zinc electrolytic and smelting plant. More than 60% of the cells in the electrolytic plant were installed by December. Refined zinc production at Trail was 204,800 tons in 1982 compared with 236,600 tons in 1981. Production was curtailed by a 5-week shutdown at midyear, and one of the old electrolytic zinc cell houses was closed permanently in the first quarter to control inventories.

In New Brunswick, BMS mined a record

3.5 million tons at its No. 12 Mine. Output at the No. 6 Mine was only 0.1 million tons in 1982. Exploration at the No. 6 Mine did not indicate any new reserves and mining was scheduled to terminate in 1983. In 1982, BMS produced 458,400 tons of zinc concentrate containing 51.6% zinc and 78,800 tons of bulk lead-zinc concentrate containing 30.5% zinc. Proven and probable ore reserves at the No. 12 Mine at yearend were 102,000 tons averaging 9.1% zinc, 3.7% lead, 0.3% copper, and 3 ounces of silver per ton.

Plans to build a 100,000-ton-per-year zinc reduction plant at Belledune, New Brunswick, in which BMS has a two-thirds interest, were deferred because of difficulties in arranging financing and the high market and operating risk.

Asarco was developing a new ore body at the bottom levels of the Buchans Mine in Newfoundland. Asarco had closed the mine in December 1981 because the ore was nearly exhausted, but since the additional ore was discovered, the company was planning to bring the mine back onstream in 1983 if lead-zinc markets improved. Ore reserves were estimated at 355,000 tons averaging 10.3% zinc, 5.9% lead, 1.4% copper, and 3 ounces of silver per ton.

Late in the year, the Matagami division of Noranda ceased operation at the Orchan Mine in Quebec because of ore exhaustion. Sherritt Gordon Mines Ltd.'s Fox and Ruttan Mines in Manitoba were closed down for 15 weeks in 1982 owing to poor base-metal markets. The Fox Mine produced only 5,200 tons of zinc in concentrate in 1982 compared with 8,750 tons in 1981. Ore reserves at the Fox Mine totaled 1.7 million tons averaging 2.3% zinc and 1.6% copper at yearend and were sufficient for only about 3 years of production at 1981 mining rates.

Hudson Bay Mining and Smelting Co. Ltd. also closed down its zinc and copper operations in the Flin Flon and Snow Lake areas in Manitoba for 8 weeks during the summer owing to poor base-metal markets. Hudson Bay closed permanently its White Lake Mine near Flin Flon owing to depletion of ore reserves.

Cyprus Anvil Mining Corp., a subsidiary of Hudson Bay Oil and Gas Ltd., a wholly owned subsidiary of Dome Petroleum Ltd., closed its Faro Mine in the Yukon in June, initially for 8 weeks; however, because of weak markets and high operating costs, the shutdown was extended through the end of 1982 and was expected to continue until the spring of 1983.

Germany, Federal Republic of.—Metallgesellschaft AG and MIM of Australia reached an agreement in which MIM purchased 50% interest in Ruhr-Zink GmbH and 30% in Rhein-Zinc GmbH, both Metallgesellschaft subsidiaries. At the same time, MIM arranged a 10-year contract to supply zinc concentrates to Metallgesellschaft. Beginning in 1983, MIM was to supply 60,000 tons of concentrate per year, and from 1985 through 1992, MIM would supply 100,000 tons per year.

Greece.—The Hellenic Industrial Development Bank (HIDB), a Government agency, authorized the construction of a 50,000-ton-per-year zinc refinery and a 40,000-ton-per-year lead smelter to be located at Amphipolis near Serrai. Construction of the $350 million smelting complex was to start in 1983. The new complex was to be owned and operated by Agean Metallurgical Industries S.A., 89% owned by HIDB. Domestic mines were expected to provide the necessary feed for the complex. Hellenic Products and Fertilizers Co., owners and operators of the Kassandra lead-zinc mines in northeastern Greece, was expected to provide most of the smelter feed. Hellenic Products was carrying out a $20 million expansion and modernization program at its Olympias Mine to increase ore production from 300,000 to 800,000 tons per year by 1984. Ore reserves at the three operating Kassandra Mines were estimated to total 20 million tons grading 4.5% zinc, 3.5% lead, 17% sulfur, 2.0% arsenic, 0.15% antimony, 0.2% copper, 3.8 ounces of silver per ton, and some gold.

Mexico.—Mine production was higher in 1982 owing mainly to production increases by mines owned by Industria Minera México S.A. (IMMSA), a subsidiary of Desarrollo Industrial Minera S.A. (MEDIMSA). The expanded facilities at IMMSA's Taxco and San Martin Mines, completed in 1981, operated at rated capacity throughout 1982. The improvements increased production of ore 2,300 tons per day. Construction of the second phase of the San Martin expansion, which will increase mine output by an additional 4,400 tons per day of ore, was scheduled for completion in early 1984. IMMSA's project to double the milling capacity of the Santa Barbara mill to 4,800 tons per day was completed in January 1982. A new production shaft at the Santa Barbara Mine was to be completed in early 1983 to raise production to the mill capacity level.

In October, IMMSA completed, at a cost of $175 million, the construction of its new 113,000-ton-per-year electrolytic zinc refinery at San Luis Potosí. All the required feed for the refinery was expected to come from mines wholly owned by subsidiaries of MEDIMSA.

TECHNOLOGY

The Bureau of Mines continued investigations to recover zinc and other metals from secondary and waste materials to lessen undesirable environmental conflicts and occupational hazards. A process was developed to separate and recover zinc, cadmium, and lead from hazardous lead smelter flue dust by hydrometallurgical and electrometallurgical methods.[3] Up to 95% of the zinc and cadmium was recovered as metal sponge or metal electrodeposits. Approximately 95% of the lead was converted into electrolyte suitable for recovery by electrowinning.

The recovery of zinc and sulfur from sphalerite concentrates by reaction with sulfuric acid was demonstrated in a three-stage process research unit.[4] Sulfur was recovered in elemental form, and zinc, as soluble zinc sulfate suitable as feed material in conventional zinc electrolysis. The Bureau also investigated the purification of zinc aqueous chlorine-oxygen leaching solutions by utilizing zinc cementation to remove cadmium, cobalt, copper, nickel, and lead.[5] The study was part of a project to investigate an aqueous chlorine-oxygen leaching process for treating complex sulfide concentrate.

Comprehensive coverage of zinc-related investigations and an extensive review of current world literature on the extraction and uses of zinc and its products are contained in quarterly issues of Zinc Abstracts published by the Zinc Development Association, London, England.[6]

Progress reports of the projects supported by the International Lead and Zinc Research Organization Inc. (ILZRO) are released annually in the ILZRO Research Digest.[7]

[1]Physical scientist, Division of Nonferrous Metals.
[2]International Lead and Zinc Study Group. Lead and Zinc Statistics. V. 23, No. 6, June 1983, 48 pp.
[3]Miller, V. R., T. L. Hebble, and D. L. Paulson. Recovery of Cadmium, Zinc, and Lead From Lead Smelter Flue Dusts. BuMines RI 8659, 1982, 12 pp.
[4]Dewing, H. H., S. E. Lay, and A. A. Cochran. Recovery of Zinc and Sulfur From Sphalerite Concentrates by Reaction With Sulfuric Acid. BuMines RI 8690, 1982, 16 pp.
[5]Atkinson, G. B., J. E. Murphy, and J. A. Eisele. Purification of Cl_2-O_2 Leach Liquors by Zinc Cementation. BuMines RI 8707, 1982, 8 pp.
[6]Zinc Development Association. Zinc Abstracts. V. 40, Nos. 1-4, 1982, 209 pp.
[7]International Lead and Zinc Research Organization Inc. Zinc Research Digest. No. 40, 1982, 62 pp.

Table 3.—Mine production of recoverable zinc in the United States, by month

(Metric tons)

Month	1981	1982
January	25,476	24,064
February	25,663	24,425
March	28,503	26,039
April	26,343	23,133
May	25,602	25,325
June	23,883	26,759
July	24,174	21,134
August	25,218	27,177
September	28,937	25,859
October	28,698	27,578
November	25,972	25,676
December	23,949	23,105
Total	312,418	300,274

Table 4.—Mine production of recoverable zinc in the United States, by State

(Metric tons)

State	1978	1979	1980	1981	1982
Arizona	W	W	W	138	--
California	W	W	--	W	--
Colorado	22,208	9,910	13,823	W	W
Idaho	32,353	29,660	27,722	W	W
Illinois	W	W	W	W	W
Kentucky	52	--	--	W	W
Missouri	59,038	61,682	62,886	52,904	63,680
Montana	79	104	71	25	W
Nevada	1,371	W	2	W	--
New Jersey	28,915	31,118	28,859	16,198	16,800
New Mexico	W	W	W	W	--
New York	26,463	12,133	33,629	36,889	49,351
Pennsylvania	19,099	21,447	22,556	24,732	24,762
Tennessee	87,906	85,119	111,754	117,684	121,306
Texas	W	--	--	--	--
Utah	3,509	W	W	1,576	--

See footnotes at end of table.

Table 4.—Mine production of recoverable zinc in the United States, by State —Continued

(Metric tons)

State	1978	1979	1980	1981	1982
Virginia	10,974	11,406	12,038	9,731	--
Washington	W	--	--	--	--
Wisconsin	W	W	W	--	--
Total	302,669	267,341	317,103	312,418	300,274

W Withheld to avoid disclosing company proprietary data; included in "Total."

Table 5.—Production of zinc and lead in the United States in 1982, by State and class of ore, from old tailings, etc., in terms of recoverable metals

(Metric tons unless otherwise specified)

State	Zinc ore			Lead ore			Zinc-lead ore		
	Gross weight (dry basis)	Zinc	Lead	Gross weight (dry basis)	Zinc	Lead	Gross weight (dry basis)	Zinc	Lead
Alaska	--	--	--	--	--	--	--	--	--
Arizona	--	--	--	W	--	W	--	--	--
California	--	--	--	--	--	--	--	--	--
Colorado	--	--	--	W	--	W	W	W	W
Idaho	--	--	--	W	--	W	W	W	W
Illinois	--	--	--	--	--	--	--	--	--
Kentucky	W	W	--	--	--	--	--	--	--
Missouri	--	--	--	8,530,735	63,680	474,460	--	--	--
Montana	--	--	--	--	--	--	--	--	--
Nevada	--	--	--	--	--	--	--	--	--
New Jersey	94,007	16,800	--	--	--	--	--	--	--
New Mexico	--	--	--	--	--	--	--	--	--
New York	609,152	49,351	974	--	--	--	--	--	--
Pennsylvania	461,156	24,762	--	--	--	--	--	--	--
Tennessee	4,445,879	119,022	--	--	--	--	--	--	--
Utah	--	--	--	--	--	--	--	--	--
Washington	--	--	--	--	--	--	--	--	--
Total	[1]5,610,194	[2]209,935	974	8,534,351	63,680	474,553	[1]308,726	[2]16,204	12,238
Percent of total zinc and lead	XX	70	([3])	XX	21	93	XX	[2]5	2

State	Copper-zinc, copper-lead, copper-zinc-lead ores			All other sources[4]			Total		
	Gross weight (dry basis)	Zinc	Lead	Gross weight (dry basis)	Zinc	Lead	Gross weight (dry basis)	Zinc	Lead
Alaska	--	--	--	W	--	W	W	--	W
Arizona	--	--	--	W	--	W	36,378,494	--	359
California	--	--	--	W	--	W	W	--	W
Colorado	--	--	--	W	W	W	W	W	W
Idaho	--	--	--	W	W	W	W	W	W
Illinois	--	--	--	([5])	W	W	([5])	W	W
Kentucky	--	--	--	--	--	--	W	W	--
Missouri	--	--	--	--	--	--	8,530,735	63,680	474,460
Montana	--	--	--	2,901,423	W	661	2,901,423	W	661
Nevada	--	--	--	W	--	W	W	--	W
New Jersey	--	--	--	--	--	--	94,007	16,800	--
New Mexico	--	--	--	W	--	W	W	--	W
New York	--	--	--	--	--	--	609,152	49,351	974
Pennsylvania	--	--	--	--	--	--	461,156	24,762	--
Tennessee	1,603,935	2,284	--	--	--	--	6,049,814	121,306	--
Utah	--	--	--	W	--	W	W	--	W
Washington	--	--	--	W	--	W	W	--	W
Total	1,603,935	2,284	--	41,475,733	8,171	24,660	57,532,939	300,274	512,425
Percent of total zinc and lead	XX	1	--	XX	3	5	XX	100	100

W Withheld to avoid disclosing company proprietary data; included in "Total." XX Not applicable.

[1]Zinc ore in Kentucky included with "Zinc-lead ore" to avoid disclosing company proprietary data.

[2]Zinc from "Zinc ore" in Kentucky included with "Zinc-lead ore" to avoid disclosing company proprietary data.

[3]Less than 1/2 unit.

[4]Lead and zinc recovered from copper, gold, silver, and fluorspar ores and from mill tailings and miscellaneous cleanups.

[5]Excludes tonnages of fluorspar from which lead and zinc were recovered as byproducts.

Table 6.—Twenty-five leading zinc-producing mines in the United States in 1982 in order of output

Rank	Mine	County and State	Operator	Source of zinc
1	Balmat	St. Lawrence, N.Y.	St. Joe Minerals Corp	Zinc ore.
2	Elmwood-Gordonsville	Smith, Tenn	Jersey Miniere Zinc Co	Do.
3	Buick	Iron, Mo	AMAX Lead Co. of Missouri	Lead ore.
4	Freidensville	Lehigh, Pa	The New Jersey Zinc Co	Zinc ore.
5	Young	Jefferson, Tenn	ASARCO Incorporated	Do.
6	Immel	Knox, Tenn	do	Do.
7	Sterling	Sussex, N.J	The New Jersey Zinc Co., Inc.	Do.
8	Zinc Mine Works	Jefferson, Tenn	United States Steel Corp	Do.
9	New Market	do	ASARCO Incorporated	Do.
10	Jefferson City and Beaver Creek.	do	The New Jersey Zinc Co	Do.
11	Leadville	Lake, Colo	ASARCO Incorporated	Lead-zinc ore.
12	Fletcher	Reynolds, Mo	St. Joe Minerals Corp	Lead ore.
13	Magmont	Iron, Mo	Cominco American Inc	Do.
14	Coy	Jefferson, Tenn	ASARCO Incorporated	Zinc ore.
15	Sunnyside	San Juan, Colo	Standard Metals Co	Gold ore.
16	Brushy Creek	Reynolds, Mo	St. Joe Minerals Corp	Lead ore.
17	Milliken	do	Ozark Lead Co	Do.
18	Star Unit area	Shoshone, Idaho	Hecla Mining Co	Lead-zinc ore.
19	Pierrepont	St. Lawrence, N.Y.	St. Joe Minerals Corp	Zinc ore.
20	Viburnum No. 29	Washington, Mo	do	Lead ore.
21	Viburnum No. 28	Iron, Mo	do	Do.
22	Copperhill plant	Polk, Tenn	Cities Service Co. and Tennessee Chemical Co.	Copper-zinc ore.
23	Lucky Friday	Shoshone, Idaho	Hecla Mining Co	Silver ore.
24	Hyatt	St. Lawrence, N.Y	St. Joe Minerals Corp	Zinc ore.
25	Rosiclare mill	Hardin & Pope, Ill	Ozark-Mahoning Co	Fluorspar.

Table 7.—Primary and redistilled secondary slab zinc produced in the United States

(Metric tons)

	1978	1979	1980	1981	1982
Primary:					
From domestic ores	267,350	255,344	231,850	r259,835	193,284
From foreign ores	139,348	217,137	108,606	86,728	34,892
Total	406,698	472,481	340,456	r346,563	228,176
Redistilled secondary:					
At primary smelters	24,085	40,343	13,113	r14,438	42,418
At secondary smelters	10,689	12,868	16,283	35,754	31,870
Total	34,774	[1]53,212	29,396	r50,192	74,288
Grand total (excludes zinc recovered by remelting)	441,472	525,693	369,852	r396,755	302,464

r Revised.
[1] Data do not add to total shown because of independent rounding.

Table 8.—Distilled and electrolytic zinc, primary and secondary, produced in the United States, by grade

(Metric tons)

Grade	1978	1979	1980	1981	1982
Special High	179,812	173,082	148,384	r137,210	112,648
High	32,830	39,247	24,552	51,990	31,076
Continuous Galvanizing	41,250	62,683	45,275	55,008	57,739
Controlled Lead	25,422	40,319	18,650	38,660	7,612
Prime Western	162,158	210,362	132,991	113,887	93,389
Total	441,472	525,693	369,852	r396,755	302,464

r Revised.

Table 9.—Annual slab zinc capacity of primary zinc plants in the United States, by type of plant

Type of plant	Plant location	Slab zinc capacity (metric tons)	
		1981	1982
Electrolytic:			
AMAX Zinc Co., Inc	Sauget, Ill	76,000	76,000
ASARCO Incorporated	Corpus Christi, Tex	104,000	104,000
The Bunker Hill Co	Kellogg, Idaho	[1]103,000	[1]103,000
Jersey Miniere Zinc Co	Clarksville, Tenn	82,000	82,000
National Zinc Co	Bartlesville, Okla	51,000	51,000
Electrothermic:			
St. Joe Resources Co	Monaca, Pa	68,000	77,000

[1]Zinc plant closed in December 1981.

Table 10.—Secondary slab zinc plant capacity in the United States

(Metric tons)

Company	Plant location	Capacity 1981	Capacity 1982
Arco Alloys Corp	Detroit, Mich	90,000	108,000
Belmont Smelting & Refining Works	Brooklyn, N.Y		
W. J. Bullock, Inc	Fairfield, Ala		
T. L. Diamond & Co., Inc	Spelter, W. Va		
Huron Valley Steel Corp	Belleville, Mich		
Illinois Smelting & Refining Co	Chicago, Ill		
Interamerican Zinc Co	Adrian, Mich		
New England Smelting Works, Inc	West Springfield, Mass		
The New Jersey Zinc Co	Depue, Ill		
Pacific Smelting Co	Torrance, Calif		
Do	Memphis, Tenn		
Prolerized Schiabo Neu Co	Jersey City, N.J		
Do	Los Angeles, Calif		
S-G Metals Industries Inc	Kansas City, Kans		

Table 11.—Stocks and consumption of new and old zinc scrap in the United States in 1982, by class of consumer and type of scrap

(Metric tons, zinc content)

Class of consumer and type of scrap	Stocks, Jan. 1	Receipts	Consumption			Stocks, Dec. 31
			New scrap	Old scrap	Total	
Smelters and distillers:						
New clippings	15	410	404	--	404	21
Old zinc	734	3,894	--	3,929	3,929	699
Remelt zinc	6	55	52	--	52	9
Engravers' plates	57	573	--	567	567	63
Rod and die scrap	1,050	817	--	893	893	974
Diecastings	1,405	11,502	--	11,372	11,372	1,535
Fragmentized diecastings	2,448	18,782	--	18,221	18,221	3,009
Remelt die-cast slab	711	7,541	--	7,610	7,610	642
Skimmings and ashes	14,963	87,817	54,758	--	54,758	48,022
Sal skimmings	28	142	156	--	156	14
Die-cast skimmings	2,179	3,928	3,827	--	3,827	2,280
Galvanizers' dross	6,268	40,239	34,700	--	34,700	11,807
Flue dust	3,154	3,059	3,059	--	3,059	3,154
Chemical residues	295	2,900	2,900	--	2,900	295
Other	64	2,564	2,552	--	2,552	76
Total	33,377	184,223	102,408	42,592	145,000	72,600
Chemical plant, foundries, other manufacturers:						
Old zinc	10	23	--	23	23	10
Rod and die scrap	10	131	--	131	131	10
Diecastings	18	222	--	222	222	18
Skimmings and ashes	1,811	3,671	3,903	--	3,903	1,579
Sal skimmings	1,978	6,321	4,921	--	4,921	3,378
Die-cast skimmings	161	--	161	--	161	--
Galvanizers' dross	2,114	783	2,895	--	2,895	2

Table 11.—Stocks and consumption of new and old zinc scrap in the United States in 1982, by class of consumer and type of scrap —Continued

(Metric tons, zinc content)

Class of consumer and type of scrap	Stocks, Jan. 1	Receipts	Consumption: New scrap	Consumption: Old scrap	Consumption: Total	Stocks, Dec. 31
Chemical plant, foundries, other manufacturers —Continued						
Flue dust	756	2,544	2,825	--	2,825	475
Chemical residues	3,766	8,614	8,631	--	8,631	3,749
Other	821	1,267	2,087	--	2,087	1
Total	11,445	23,576	25,423	376	25,799	9,222
All classes of consumers:						
New clippings	15	410	404	--	404	21
Old zinc	744	3,917	--	3,952	3,952	709
Remelt zinc	6	55	52	--	52	9
Engravers' plates	57	573	--	567	567	63
Rod and die scrap	1,060	948	--	1,024	1,024	984
Diecastings	1,423	11,724	--	11,594	11,594	1,553
Fragmentized diecastings	2,448	18,782	--	18,221	18,221	3,009
Remelt die-cast slab	711	7,541	--	7,610	7,610	642
Skimmings and ashes	16,774	91,488	58,661	--	58,661	49,601
Sal skimmings	2,006	6,463	5,077	--	5,077	3,392
Die-cast skimmings	2,340	3,928	3,988	--	3,988	2,280
Galvanizers' dross	8,382	41,022	37,595	--	37,595	11,809
Flue dust	3,910	5,603	5,884	--	5,884	3,629
Chemical residues	4,061	11,514	11,531	--	11,531	4,044
Other	885	3,831	4,639	--	4,639	77
Total	44,822	207,799	127,831	42,968	170,799	81,822

Table 12.—Production of zinc products from zinc-base scrap in the United States

(Metric tons)

Product	1978	1979	1980	1981	1982
Redistilled slab zinc	34,774	53,212	29,396	r50,192	74,288
Zinc dust	33,346	34,141	35,557	39,626	25,296
Remelt zinc	94	89	229	195	69
Remelt die-cast slab	3,775	3,911	3,568	6,722	3,905
Zinc-die and diecasting alloys	6,024	6,328	4,146	6,902	5,366
Galvanizing stocks	2,686	2,731	2,461	2,612	2,507
Secondary zinc in chemical products	58,650	59,148	55,890	62,557	61,827

rRevised.

Table 13.—Zinc recovered from scrap processed in the United States, by kind of scrap and form of recovery

(Metric tons)

	1981	1982
KIND OF SCRAP		
New scrap:		
Zinc-base	138,515	127,651
Copper-base	116,681	94,891
Magnesium-base	143	113
Total	255,339	222,655
Old scrap:		
Zinc-base	62,891	42,334
Copper-base	22,014	19,385
Aluminum-base	376	376
Magnesium-base	230	219
Total	85,511	62,314
Grand total	340,850	284,969

Table 13.—Zinc recovered from scrap processed in the United States, by kind of scrap and form of recovery —Continued

(Metric tons)

	1981	1982
FORM OF RECOVERY		
As metal:		
By distillation:		
Slab zinc[1]	r50,192	74,288
Zinc dust	39,626	25,296
By remelting	2,807	2,576
Total	r92,625	102,160
In zinc-base alloys	13,624	9,271
In brass and bronze	r171,295	111,003
In aluminum-base alloys	376	376
In magnesium-base alloys	373	332
In chemical products:		
Zinc oxide (lead free)	36,236	35,969
Zinc sulfate	14,313	16,079
Zinc chloride	11,572	9,490
Miscellaneous	436	289
Total	r248,225	182,809
Grand total	340,850	284,969

rRevised.
[1]Includes zinc content of redistilled slab made from remelt die-cast slab.

Table 14.—Zinc dust produced in the United States

Year	Quantity (metric tons)	Value	
		Total (thousands)	Average per pound
1978	38,487	$37,427	$0.441
1979	36,186	36,075	.452
1980	42,640	41,202	.438
1981	43,734	53,871	.554
1982	37,516	49,316	.607

Table 15.—Consumption of zinc in the United States

(Metric tons)

	1978	1979	1980	1981	1982
Slab zinc	1,050,585	1,000,606	811,146	r840,875	709,491
Ores and concentrates (zinc content)[1]	89,959	79,710	58,986	60,643	35,515
Secondary (zinc content)[2]	301,266	313,998	272,277	r287,851	208,105
Total	1,441,810	1,394,314	1,142,409	r1,189,369	953,111

rRevised.
[1]Includes ore used directly in galvanizing.
[2]Excludes redistilled slab and remelt zinc.

Table 16.—Slab zinc consumption in the United States, by industry and product

(Metric tons)

Industry and product	1978	1979	1980	1981	1982
Galvanizing:					
Sheet and strip	268,687	267,825	220,744	248,006	204,519
Wire and wire rope	22,801	23,557	22,748	22,119	17,180
Tubes and pipe	47,379	45,643	37,075	39,418	34,322
Fittings (for tubes and pipe)	6,926	8,231	7,394	6,369	5,707
Tanks and containers	2,896	4,081	3,297	5,781	6,507
Structural shapes	33,264	33,875	33,376	33,667	28,816
Fasteners	4,839	4,993	3,189	3,693	2,898
Pole-line hardware	4,869	4,839	4,078	3,788	2,955
Fencing, wire cloth, netting	24,997	21,920	16,022	17,722	17,330
Other and unspecified uses	37,356	37,839	31,304	30,484	21,810
Total	454,014	452,803	379,227	411,047	342,044
Brass products:					
Sheet, strip, plate	70,181	64,222	37,730	42,006	31,718
Rod and wire	46,284	51,130	32,554	36,639	26,551
Tubes	6,779	6,690	4,702	6,440	3,465
Castings and billets	4,427	3,634	2,808	2,880	2,211
Copper-base ingots	6,581	6,800	17,190	20,167	13,278
Other copper-base products	7,236	8,928	3,842	4,854	3,915
Total	141,488	141,404	98,826	112,986	81,138
Zinc-base alloys:					
Diecasting alloys	345,968	308,722	248,024	234,957	191,607
Dies and rod alloys	544	68	--	--	--
Slush and sand-casting alloys	7,622	5,266	6,203	8,408	6,147
Total	354,134	314,056	254,227	243,365	197,754
Rolled zinc	24,869	22,044	21,100	[1]23,156	[1]37,168
Zinc oxide	37,202	35,513	27,047	[r]25,657	32,374
Other uses:					
Light-metal alloys	11,030	12,850	11,137	8,183	8,326
Miscellaneous[2]	27,848	21,936	19,582	16,481	10,687
Total	38,878	34,786	30,719	24,664	19,013
Grand total	1,050,585	1,000,606	811,146	[r]840,875	709,491

[r]Revised.
[1]Includes zinc used in penny production.
[2]Includes zinc used in making zinc dust, wet batteries, desilverizing lead, powder, alloys, chemicals, castings, and miscellaneous uses not elsewhere mentioned.

Table 17.—Slab zinc consumption in the United States in 1982, by industry

(Metric tons)

Industry	Special High Grade	High Grade	Continuous Galvanizing Grade	Controlled Lead Grade	Prime Western	Remelt	Total
Galvanizing	30,354	39,638	5,176	68,367	197,711	798	342,044
Brass and bronze	31,445	42,835	53	361	5,234	1,210	81,138
Zinc-base alloys	196,692	1,039	--	--	18	5	197,754
Rolled zinc	17,937	--	19,231	--	--	--	37,168
Zinc oxide	32,374	--	--	--	--	--	32,374
Other	15,975	1,119	--	--	1,919	--	19,013
Total	324,777	84,631	24,460	68,728	204,882	2,013	709,491

Table 18.—Slab zinc consumption in the United States in 1982, by State

(Metric tons)

State	Galvanizers	Brass mills[1]	Die-casters[2]	Other[3]	Total
Alabama	13,734	W	--	W	15,302
Arizona	--	--	--	W	W
Arkansas	W	--	--	W	W
California	23,610	1,715	7,956	5,356	38,637
Colorado	W	--	W	W	W
Connecticut	W	12,271	W	W	20,120
Delaware	W	W	--	W	W
Florida	3,875	--	--	--	3,875
Georgia	W	--	W	--	W
Hawaii	W	--	--	--	W
Illinois	46,244	12,890	37,381	3,923	100,438
Indiana	52,697	W	W	W	70,835
Iowa	W	--	W	1,098	1,178
Kansas	--	--	W	--	W
Kentucky	W	--	--	--	W
Louisiana	2,143	--	W	W	2,950
Maine	W	--	--	--	W
Maryland	W	--	--	--	10,943
Massachusetts	W	W	--	W	4,355
Michigan	782	7,580	37,811	191	46,364
Minnesota	501	--	--	--	501
Mississippi	W	--	--	--	W
Missouri	4,662	W	W	W	5,859
Nebraska	5,581	W	W	W	6,200
New Jersey	1,906	4,222	W	W	11,382
New York	11,292	W	52,408	W	76,724
North Carolina	W	--	W	W	W
Ohio	55,568	W	27,496	W	89,182
Oklahoma	W	--	--	W	3,811
Oregon	1,065	W	--	--	1,066
Pennsylvania	41,443	5,059	W	W	89,490
Rhode Island	W	W	W	W	W
South Carolina	W	--	--	--	W
Tennessee	W	--	W	W	W
Texas	14,771	W	W	W	20,643
Utah	W	W	--	--	W
Virginia	W	W	W	W	592
Washington	W	--	--	W	1,335
West Virginia	W	--	--	W	15,987
Wisconsin	686	W	4,331	W	5,682
Undistributed	60,686	36,190	30,367	77,987	64,027
Total[4]	341,246	79,927	197,750	88,555	707,478

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Includes brass mills, brass ingot makers, and brass foundries.
[2]Includes producers of zinc-base alloy for diecastings, stamping dies, and rods.
[3]Includes slab zinc used in rolled zinc products and in zinc oxide.
[4]Excludes remelt zinc.

Table 19.—Rolled zinc produced and quantity available for consumption in the United States

	1981			1982		
	Metric tons	Value		Metric tons	Value	
		Total (thousands)	Average per pound		Total (thousands)	Average per pound
Production:[1]						
Photoengraving plate	W	W	W	W	W	W
Strip and foil	W	W	W	W	W	W
Total rolled zinc[2]	22,414	$32,738	$0.663	36,365	$37,688	$0.470
Exports	1,500	3,226	.976	995	2,351	1.072
Imports	332	472	.645	700	694	.450
Available for consumption	19,355	XX	XX	30,143	XX	XX

W Withheld to avoid disclosing company proprietary data; included in "Total rolled zinc." XX Not applicable.
[1]Figures represent net production. In addition, 19,892 tons in 1981 and 27,997 tons in 1982 were rerolled from scrap originating in fabricating plants operating in connection with zinc-rolling mills.
[2]Includes other plate over 0.375 inch thick, sheet zinc less than 0.375 inch thick, and rod and wire. The Bureau of Mines is not at liberty to publish separately.

Table 20.—Production and shipments of zinc pigments and compounds[1] in the United States

(Metric tons)

	1981		1982	
	Production	Shipments	Production	Shipments
Zinc oxide	145,304	148,951	123,461	127,434
Zinc sulfate	38,682	37,879	42,934	38,922
Zinc chloride, 50° Baumé[2]	26,678	19,597	23,776	24,585

[1]Excludes leaded zinc oxide and lithopone.
[2]Includes zinc content of zinc ammonium chloride and chromated zinc chloride.

Table 21.—Zinc content of zinc pigments[1] and compounds produced by domestic manufacturers

(Metric tons)

	1981				1982			
	Zinc in pigments and compounds produced from—			Total	Zinc in pigments and compounds produced from—			Total
	Ore	Slab zinc	Secondary material		Ore	Slab zinc	Secondary material	
Zinc oxide	54,569	25,657	36,236	116,462	30,506	32,374	35,969	98,849
Zinc sulfate	1,353	--	14,313	15,666	W	--	17,388	17,388
Zinc chloride[2]	--	--	6,043	6,043	--	--	5,675	5,675

W Withheld to avoid disclosing company proprietary data; included with "Secondary material."
[1]Excludes leaded zinc oxide, zinc sulfide, and lithopone.
[2]Includes zinc content of zinc ammonium chloride and chromated zinc chloride.

Table 22.—Distribution of zinc oxide shipments, by industry

(Metric tons)

Industry	1978	1979	1980	1981	1982
Agriculture	4,847	4,397	6,930	7,328	3,929
Ceramics	9,245	9,236	5,702	7,822	5,215
Chemicals	27,057	27,710	17,551	20,561	19,432
Paints	13,237	12,503	12,165	12,346	9,283
Photocopying	19,096	16,148	9,604	10,308	9,516
Rubber	97,989	93,075	61,796	69,364	62,923
Other	9,981	16,700	22,028	21,222	17,136
Total	181,452	179,769	135,776	148,951	127,434

Table 23.—Distribution of zinc sulfate shipments

(Metric tons)

Year	Agriculture	Other	Total
1979	18,512	7,363	25,875
1980	27,768	7,928	35,696
1981	30,928	6,951	37,879
1982	29,882	9,040	38,922

Table 24.—Stocks of slab zinc in the United States, December 31

(Metric tons)

	1978	1979	1980	1981	1982
Primary producers	34,570	56,971	18,190	41,124	24,370
Secondary producers	3,358	2,095	4,362	3,540	3,831
Consumers	99,325	92,595	69,599	81,917	77,565
Merchants	NA	[1]NA	33,650	68,773	47,397
Total	137,253	151,661	125,801	195,354	153,163

NA Not available.
[1]Stocks on Jan. 1, 1980, were 63,637 tons, which can be considered identical to stocks at yearend 1979.

Table 25.—Consumer stocks of slab zinc at plants in the United States, December 31, by grade

(Metric tons)

Year	Special High Grade	High Grade	Continuous Galvinizing Grade	Controlled Lead Grade	Prime Western	Remelt	Total
1981	32,467	9,423	2,153	3,805	33,957	112	81,917
1982	36,312	8,047	1,615	6,863	24,599	129	77,565

Table 26.—Average monthly U.S., LME,[1] and European producer prices for Prime Western zinc and equivalent

(Metallic zinc, cents per pound)

Month	1981			1982		
	United States[2]	LME cash	European producer	United States[2]	LME cash	European producer
January	41.19	35.22	37.42	42.17	37.10	41.39
February	41.25	33.11	37.42	42.72	37.30	39.69
March	41.30	34.33	37.42	39.23	35.78	40.19
April	42.56	37.31	38.19	35.51	33.65	39.01
May	45.20	38.56	40.14	34.67	34.01	39.01
June	46.12	38.06	41.96	34.60	31.33	36.79
July	46.25	39.21	41.96	35.66	32.80	36.29
August	47.47	43.28	41.96	37.79	32.43	36.29
September	48.72	42.57	45.36	39.64	33.97	36.29
October	45.87	40.41	45.36	40.83	34.06	36.29
November	46.15	39.74	45.36	40.39	32.18	36.29
December	42.59	38.31	43.09	38.46	30.30	36.29
Average	44.56	38.34	41.30	38.47	33.74	37.82

[1]London Metal Exchange.
[2]Based on High Grade zinc.

Source: Metals Week.

Table 27.—U.S. exports of zinc and zinc alloys, by country

Country	1980		1981		1982	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Unwrought zinc and zinc alloys:						
Argentina	1	$1	--	--	--	--
Australia	1	6	1	$1	2	$8
Bahrain	1	1	--	--	--	--
Belgium-Luxembourg	--	--	9	25	5	16
Canada	232	456	320	760	260	573
Chile	97	98	6	17	--	--
Colombia	--	--	4	7	--	--
Costa Rica	6	11	26	44	21	35
Dominican Republic	38	41	26	25	2	3
Ecuador	2	4	4	8	1	4
Egypt	20	61	14	26	2	6
Germany, Federal Republic of	1	4	1	1	--	--
Guatemala	63	112	1	6	3	6
Honduras	2	5	--	--	--	--
Israel	3	81	5	20	3	14
Italy	2	5	--	--	(1)	1
Japan	21	69	29	88	75	83
Korea, Republic of	--	--	16	50	1	28
Leeward and Windward Islands	13	33	15	100	--	--
Mexico	73	544	21	193	175	507
Netherlands	20	45	--	--	5	27
New Zealand	1	2	1	7	(1)	3
Nicaragua	1	2	1	2	--	--
Nigeria	4	11	10	13	--	--
Panama	4	9	25	64	5	16
Philippines	9	10	2	3	3	6
Saudi Arabia	4	14	28	120	50	171
Singapore	64	119	1	3	1	3
South Africa, Republic of	1	2	30	51	4	11

See footnotes at end of table.

Table 27.—U.S. exports of zinc and zinc alloys, by country —Continued

Country	1980 Quantity (metric tons)	1980 Value (thousands)	1981 Quantity (metric tons)	1981 Value (thousands)	1982 Quantity (metric tons)	1982 Value (thousands)
Unwrought zinc and zinc alloys —Continued						
Spain	9	$20	12	$22	([1])	$1
Switzerland	--	--	3	7	60	253
Taiwan	45	57	7	18	442	490
United Arab Emirates	--	--	5	9	--	--
United Kingdom	27	92	57	275	73	293
Venezuela	1	3	14	28	1	18
Yugoslavia	9	21	--	--	--	--
Other	12	37	7	77	10	72
Total	787	1,976	701	2,070	1,204	2,648
Wrought zinc and zinc alloys:						
Algeria	25	47	2	8	--	--
Argentina	67	125	74	145	22	56
Australia	15	37	32	69	6	15
Austria	--	--	9	26	4	14
Belgium-Luxembourg	11	20	1	6	([1])	1
Bermuda	([1])	1	1	1	([1])	1
Canada	631	994	909	1,503	893	1,512
Chile	15	27	13	24	1	2
Colombia	56	125	75	137	40	96
Denmark	6	14	4	12	--	--
Dominican Republic	704	585	10	11	([1])	1
Ecuador	21	52	14	35	15	63
Egypt	20	32	2	5	([1])	1
El Salvador	3	5	4	11	8	21
Finland	4	11	1	3	3	1
France	72	200	9	20	18	23
Germany, Federal Republic of	1	8	4	34	--	--
Guatemala	9	18	10	26	3	10
Guyana	5	12	4	14	2	8
Hong Kong	38	65	69	80	1	3
India	24	48	60	124	166	157
Israel	42	76	27	50	12	26
Italy	92	241	45	99	5	13
Japan	--	--	28	65	153	156
Korea, Republic of	31	55	8	34	([1])	3
Kuwait	1	2	5	26	([1])	21
Lebanon	26	51	3	8	--	--
Malaysia	26	78	6	10	--	--
Mexico	144	301	393	786	221	400
Netherlands	([1])	2	6	11	1	1
New Zealand	10	16	9	18	1	3
Pakistan	14	27	19	38	5	31
Panama	1	2	7	11	3	8
Peru	22	40	50	109	9	28
Philippines	101	161	37	93	15	45
Portugal	35	67	3	7	([1])	2
Saudi Arabia	11	51	172	378	56	153
Singapore	51	59	24	48	76	188
South Africa, Republic of	77	137	116	197	49	133
Spain	71	126	23	46	30	74
Sri Lanka	22	42	22	44	5	18
Sweden	1	6	--	--	--	--
Switzerland	2	6	3	5	([1])	3
Syria	27	59	--	--	--	--
Taiwan	127	195	33	85	17	51
Thailand	13	25	--	--	--	--
Turkey	14	26	12	26	--	--
United Arab Emirates	4	8	2	7	1	4
United Kingdom	125	596	128	314	113	268
Uruguay	6	10	8	13	8	16
Venezuela	21	49	21	61	10	54
Other	63	138	143	315	51	115
Total	2,907	5,078	2,660	5,198	2,023	3,799

[1]Less than 1/2 unit.

Table 28.—U.S. exports of zinc

Year	Ores and concentrates		Blocks, pigs, anodes, etc.: Unwrought		Blocks, pigs, anodes, etc.: Unwrought alloys		Wrought zinc and zinc alloys: Sheets, plates, strip		Wrought zinc and zinc alloys: Angles, bars, pipes, rods, etc.		Waste and scrap (zinc content)		Dust (blue powder)	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
1980	54,457	$29,473	302	$664	485	$1,312	2,103	$3,810	804	$1,268	29,542	$14,121	4,512	$7,491
1981	54,232	29,280	323	812	378	1,258	1,500	3,226	1,160	1,972	30,046	17,611	5,003	7,841
1982	77,289	32,534	341	547	863	2,101	995	2,351	1,028	1,448	16,993	10,611	2,066	3,207

Table 29.—U.S. exports of zinc ores and concentrates, by country

(Zinc content)

Country	1981 Quantity (metric tons)	1981 Value (thousands)	1982 Quantity (metric tons)	1982 Value (thousands)
Algeria	5,173	$4,156	10,894	$6,344
Belgium-Luxembourg	10,868	4,079	3,377	2,189
Bulgaria	6,565	4,992	7,067	3,210
Canada	21,748	9,587	27,397	12,071
Dominican Republic	1	1	--	--
Ecuador	5	2	1	1
Finland	57	13	--	--
France	--	--	710	362
German Democratic Republic	--	--	5,162	2,478
Germany, Federal Republic of	6,240	3,493	2,256	746
Guatemala	--	--	99	117
India	--	--	159	70
Italy	1,860	1,457	--	--
Japan	--	--	1	6
Korea, Republic of	1	1	--	--
Leeward and Windward Islands	82	36	--	--
Mexico	2	2	560	321
Netherlands	165	271	--	--
Philippines	10	6	60	39
Romania	--	--	4,567	2,026
Saudi Arabia	48	56	--	--
Spain	--	--	(1)	2
Sweden	--	--	10,039	554
Taiwan	6	5	3	3
United Kingdom	1,401	1,123	--	--
Yugoslavia	--	--	4,937	1,995
Total	54,232	29,280	77,289	32,534

[1]Less than 1/2 unit.

Table 30.—U.S. general imports of zinc, by country

Country	1980 Quantity (metric tons)	1980 Value (thousands)	1981 Quantity (metric tons)	1981 Value (thousands)	1982 Quantity (metric tons)	1982 Value (thousands)
ORES AND CONCENTRATES (zinc content)						
Australia	1,473	$195	903	$201	2,848	$872
Belgium	--	--	497	242	--	--
Canada	63,017	25,631	53,673	22,607	10,574	4,570
Chile	14	2	432	295	21	10
Colombia	--	--	6	1	20	3
Germany, Federal Republic of	2,422	1,271	8,687	5,301	7,925	4,431
Honduras	7,031	2,558	4,167	2,623	6,303	2,117
Mexico	15,790	4,053	20,045	10,969	15,381	6,376
Peru	40,176	19,879	29,326	20,348	6,272	2,498
Total	129,923	53,589	117,736	62,587	49,344	20,877
BLOCKS, PIGS, OR SLABS[1]						
Algeria	6,005	4,497	721	579	6,499	5,578
Argentina	--	--	--	--	2,002	1,547
Australia	24,798	18,046	25,830	22,043	26,336	20,272
Austria	629	556	--	--	--	--
Belgium-Luxembourg	2,310	2,336	14,018	12,151	1,555	1,461
Brazil	--	--	1,493	1,159	10,500	9,680
Canada	280,075	222,411	308,647	285,642	239,839	200,731
Chile	--	--	1,450	1,212	--	--
China	1,220	886	1,492	1,140	258	210
Finland	18,128	12,998	29,156	25,231	20,774	16,514
France	6,835	5,619	17,882	16,491	5,377	4,682
Germany, Federal Republic of	12,056	8,939	22,817	24,228	4,702	3,621
Ghana	--	--	65	20	--	--
Italy	1,999	1,514	7,625	7,298	6,500	6,853
Japan	--	--	7,090	6,204	741	643
Korea, Republic of	1,400	1,047	1,500	1,240	--	--
Mexico	23,859	17,881	15,091	13,458	21,819	16,521
Namibia	--	--	994	836	--	--
Netherlands	6,508	5,183	20,216	17,579	7,121	5,688
Norway	--	--	10,801	9,200	9,723	8,063
Peru	3,951	2,798	43,339	37,836	48,565	35,639
Poland	--	--	600	573	476	450
Spain	10,727	7,592	28,671	23,545	6,573	5,599

See footnotes at end of table.

Table 30.—U.S. general imports of zinc, by country —Continued

Country	1980 Quantity (metric tons)	1980 Value (thousands)	1981 Quantity (metric tons)	1981 Value (thousands)	1982 Quantity (metric tons)	1982 Value (thousands)
BLOCKS, PIGS, OR SLABS[1] —Continued						
Tanzania	1,028	$731	--	--	--	--
United Kingdom	4,112	3,142	13,280	$11,012	4,770	$3,750
Yugoslavia	--	--	999	867	503	442
Zaire	--	--	28,540	22,778	22,408	15,943
Zambia	5,002	3,443	377	296	401	329
Total	410,642	319,619	602,694	542,618	447,442	364,216

[1]In addition, in 1982, 199 tons of zinc anodes was imported from Belgium, Canada, China, the Federal Republic of Germany, Hong Kong, Israel, Italy, Japan, the Netherlands, Norway, Sweden, Taiwan, and the United Kingdom.

Table 31.—U.S. imports for consumption of zinc, by country

Country	1980 Quantity (metric tons)	1980 Value (thousands)	1981 Quantity (metric tons)	1981 Value (thousands)	1982 Quantity (metric tons)	1982 Value (thousands)
ORES AND CONCENTRATES (zinc content)						
Australia	8,782	$4,590	1,964	$305	2,971	$988
Belgium	--	--	497	242	--	--
Canada	110,285	42,093	179,566	70,037	22,827	9,234
Chile	--	--	432	295	21	10
Colombia	14	2	6	1	20	3
Germany, Federal Republic of	2,422	1,271	8,687	5,301	7,925	4,431
Honduras	7,031	2,558	4,363	2,677	6,303	2,116
Mexico	13,660	3,640	21,120	11,165	20,534	7,853
Peru	40,176	19,879	29,075	20,230	6,208	2,497
Total	182,370	74,033	245,710	110,253	66,809	27,132
BLOCKS, PIGS, OR SLABS[1]						
Algeria	6,005	4,497	721	579	6,499	5,578
Argentina	--	--	--	--	2,002	1,547
Australia	24,798	18,046	25,830	22,043	26,334	20,272
Austria	629	556	--	--	--	--
Belgium-Luxembourg	2,310	2,336	14,018	12,151	1,555	1,461
Brazil	--	--	1,493	1,159	8,500	7,761
Canada	280,075	222,411	308,647	285,642	239,839	200,731
Chile	--	--	1,450	1,212	--	--
China	1,327	934	1,492	1,140	258	210
Finland	18,128	12,998	29,156	25,231	20,774	16,514
France	7,799	6,486	18,135	16,385	5,376	4,682
Germany, Federal Republic of	12,056	8,939	22,727	24,159	4,702	3,621
Ghana	--	--	65	20	--	--
Hong Kong	105	62	--	--	--	--
Italy	1,999	1,514	6,626	6,518	6,500	6,853
Japan	--	--	15,003	12,456	6,852	5,106
Korea, Republic of	1,400	1,047	1,500	1,240	--	--
Mexico	23,652	17,728	15,146	13,491	23,161	17,480
Namibia	--	--	994	836	--	--
Netherlands	6,508	5,183	20,915	18,010	7,497	5,933
Norway	--	--	9,934	8,389	10,104	8,445
Peru	3,951	2,798	43,339	37,836	48,569	35,638
Poland	--	--	600	573	476	450
Spain	10,727	7,592	28,671	23,545	9,149	8,027
Tanzania	1,028	731	--	--	--	--
United Kingdom	2,064	1,607	15,630	12,770	4,769	3,750
Yugoslavia	--	--	999	867	503	442
Zaire	--	--	28,540	22,778	22,413	15,943
Zambia	5,602	3,823	376	296	401	329
Total	410,163	319,288	612,007	549,326	456,233	370,773

[1]In addition, in 1982, 199 tons of zinc anodes was imported from Belgium, Canada, China, the Federal Republic of Germany, Hong Kong, Israel, Italy, Japan, the Netherlands, Norway, Sweden, Taiwan, and the United Kingdom.

Table 32.—U.S. imports for consumption of zinc

	Ores and concentrates (zinc content)		Blocks, pigs, slabs[1]		Sheets, plates, strips, other forms		Waste and scrap	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
1980	182,370	$74,033	410,163	$319,288	1,342	$1,041	3,470	$1,361
1981	245,710	110,253	612,007	549,326	332	472	5,782	2,578
1982	66,809	27,132	456,233	370,773	700	694	2,653	1,232

	Dross and skimmings (zinc content)		Zinc fume (zinc content)		Dust, powder, flakes		Total value[2] (thousands)
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	
1980	4,062	$1,732	25	$7	3,928	$3,672	$401,134
1981	7,629	4,090	184	61	7,993	9,519	676,299
1982	7,104	3,134	11	6	5,864	6,925	409,896

[1]Unwrought alloys of zinc were imported as follows, in metric tons: 1980—41 ($37,846); 1981—102 ($40,713); and 1982—136 ($75,269).
[2]In addition, manufactures of zinc were imported as follows: 1980—$254,317; 1981—$437,930; and 1982—$539,674.

Table 33.—U.S. imports for consumption of zinc pigments and compounds

	1981		1982	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Zinc oxide	29,109	$25,333	28,347	$23,640
Zinc sulfide	661	689	502	607
Lithopone	1,594	692	1,098	586
Zinc chloride	1,434	880	921	737
Zinc sulfate	2,857	1,186	2,305	982
Zinc cyanide	41	86	40	73
Zinc hydrosulfite	221	340	222	392
Zinc compounds, n.s.p.f.	2,698	4,295	2,286	3,915

Table 34.—Zinc: World mine production (content of ore), by country[1]

(Thousand metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Algeria	4.8	4.9	8.2	10.8	10.8
Argentina	36.6	37.5	33.4	35.4	[2]36.7
Australia	473.3	[r]529.2	495.3	518.3	[3]665.0
Austria	22.5	20.5	19.1	18.2	18.0
Bolivia	53.9	51.6	50.3	47.0	[2]45.7
Brazil	58.7	[r]97.9	105.0	96.6	101.0
Bulgaria[e]	88.0	85.0	87.0	87.0	87.0
Burma	2.6	3.0	4.1	3.6	[2]5.4
Canada[3]	1,066.9	1,099.9	894.6	911.2	1,033.0
Chile[3]	1.8	1.8	1.1	1.5	1.5
China[e 3]	160.0	160.0	160.0	160.0	160.0
Colombia	--	--	--	.1	.1
Congo (Brazzaville)[e]	4.8	4.0	3.5	3.0	3.0
Czechoslovakia	8.8	8.8	7.2	6.8	7.0
Ecuador	1.3	[e]1.0	.6	.7	.1
Finland	52.9	51.6	58.4	53.5	[2]54.6
France	39.9	[r]37.0	35.8	37.4	[2]37.0
Germany, Federal Republic of[3]	97.4	96.9	99.7	91.8	[2]86.9
Greece	25.6	23.2	27.1	27.0	22.0
Greenland	82.4	87.3	52.1	78.5	77.0
Guatemala	[r].3	.3	([4])	3.0	3.0
Honduras	24.3	[r]19.8	16.0	16.2	[2]24.6
Hungary[e]	2.8	2.6	2.8	2.0	2.0
India	36.3	39.5	26.5	29.1	29.1
Iran[e]	45.0	25.0	30.0	35.0	34.8
Ireland	176.0	212.3	228.7	117.0	167.2
Italy	[r]73.3	66.3	58.4	43.9	40.0
Japan[3]	274.6	243.4	238.1	242.0	[2]250.1
Korea, North[e 3]	145.0	145.0	140.0	140.0	140.0
Korea, Republic of	66.4	62.5	56.8	56.5	[2]59.1

See footnotes at end of table.

Table 34.—Zinc: World mine production (content of ore), by country[1] —Continued

(Thousand metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Mexico[3]	244.9	245.5	238.2	211.6	[2]231.9
Morocco	4.3	4.5	6.1	7.9	[2]11.2
Namibia	36.6	[r]23.3	31.9	29.6	[2]32.2
New Zealand	(4)	(4)	(4)	(4)	--
Nicaragua	3.6	--	--	--	--
Nigeria[e]	--	--	--	.1	.1
Norway	[r]29.6	[r]29.6	28.7	29.8	[2]31.4
Peru[3]	402.6	432.0	487.6	498.9	541.0
Philippines	9.5	9.7	6.8	5.3	3.0
Poland[3]	194.0	182.7	187.8	146.5	145.0
Romania[e]	60.0	60.0	60.0	55.0	55.0
South Africa, Republic of	65.2	53.8	79.1	87.2	[2]91.5
Spain	146.8	142.7	183.1	182.0	167.0
Sweden	162.8	169.9	167.4	180.9	[2]185.0
Tunisia	7.4	8.7	7.6	6.6	7.1
Turkey	[e]40.7	[e]27.1	[e]20.4	30.7	30.0
U.S.S.R.[e 3]	770.0	770.0	785.0	790.0	795.0
United Kingdom	2.7	.6	4.4	10.9	10.2
United States[3]	302.7	267.3	317.1	312.4	[2]300.3
Vietnam[e]	8.0	6.0	6.5	6.0	6.0
Yugoslavia	103.8	101.7	95.3	88.6	87.0
Zaire[3]	[r]82.8	[r]73.0	67.0	63.3	63.0
Zambia[3]	50.0	46.6	37.0	40.6	[2]52.0
Total	[r]5,854.2	[r]5,872.5	5,756.8	5,657.0	6,046.6

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through June 29, 1983.
[2]Reported figure.
[3]Recoverable content of concentrates.
[4]Revised to zero.

Table 35.—Zinc: World smelter production, by country[1]

(Thousand metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Algeria, primary	25.7	27.3	30.0	31.0	31.0
Argentina, primary	23.9	[r]38.7	25.4	25.9	30.0
Australia:					
Primary[2]	290.1	[r]305.2	301.0	295.9	[3]290.6
Secondary[e]	4.7	5.0	5.0	[r]4.5	4.5
Total[e]	294.8	[r]310.2	306.0	[r]300.4	295.1
Austria, primary and secondary	21.7	23.2	22.1	22.7	22.6
Belgium:					
Primary	233.9	256.7	239.0	247.2	250.0
Secondary[e]	7.6	9.1	10.2	10.2	10.0
Total[e]	241.5	265.8	249.2	257.4	260.0
Brazil:					
Primary	56.1	63.5	78.3	91.9	[3]95.5
Secondary	12.2	[r]15.3	17.7	19.0	[3]14.4
Total	68.3	[r]78.8	96.0	110.9	[3]109.9
Bulgaria, primary and secondary[e]	91.0	89.0	90.0	90.0	90.0
Canada, primary	495.4	580.4	591.6	619.0	505.0
China, primary and secondary[e]	160.0	160.0	160.0	160.0	160.0
Czechoslovakia, primary and secondary	[e]11.5	11.5	9.6	9.0	9.0
Finland, primary	132.9	147.1	146.7	139.8	[3]143.9
France:					
Primary[e]	216.2	[r]228.6	232.8	232.1	223.8
Secondary[e]	15.0	20.0	20.0	25.0	20.0
Total	231.2	[r]248.6	252.8	257.1	[3]243.8
German Democratic Republic, primary and secondary[e]	16.0	17.0	17.5	17.5	17.5

See footnotes at end of table.

Table 35.—Zinc: World smelter production, by country[1] —Continued

(Thousand metric tons)

Country	1978	1979	1980	1981[p]	1982[e]
Germany, Federal Republic of:					
Primary	288.7	333.7	342.8	331.2	300.0
Secondary	18.1	21.8	27.8	35.4	35.1
Total	306.8	355.5	370.6	366.6	[3]335.1
Greece, secondary	([4])	NA	.3	NA	NA
Hungary, secondary	.6	.6	.6	.6	.6
India:					
Primary	59.4	63.3	43.6	57.4	52.6
Secondary	NA	NA	.3	.2	.2
Total	59.4	63.3	43.9	57.6	52.8
Italy, primary and secondary	177.6	202.3	206.4	180.9	[3]158.7
Japan:					
Primary	767.9	789.4	735.2	670.2	[3]662.4
Secondary	24.8	27.0	49.9	50.3	[3]46.0
Total	792.7	816.4	785.1	720.5	[3]708.4
Korea, North, primary[e 5]	130.0	120.0	120.0	120.0	120.0
Korea, Republic of, primary	59.0	83.0	79.1	83.9	[3]99.2
Mexico, primary	173.1	161.7	143.9	126.5	[3]127.0
Netherlands, primary and secondary	135.4	154.0	169.5	177.4	180.0
Norway, primary	71.6	77.8	79.4	80.3	[3]78.7
Peru, primary	62.9	68.2	63.8	126.2	[3]160.7
Poland, primary and secondary	222.0	209.0	215.3	167.1	[3]165.0
Portugal, primary[e]	--	--	2.0	r4.6	3.6
Romania, primary and secondary	49.8	46.5	45.9	e40.0	40.0
South Africa, Republic of, primary[5]	79.1	75.4	81.4	80.0	[3]80.0
Spain, primary	177.0	182.7	151.8	179.5	[3]187.0
Thailand, primary	([4])	([4])	--	--	--
Turkey, primary	r17.3	r17.2	12.6	18.1	14.4
U.S.S.R.:[e]					
Primary	770.0	770.0	785.0	790.0	795.0
Secondary	80.0	80.0	80.0	80.0	80.0
Total	850.0	850.0	865.0	870.0	875.0
United Kingdom, primary and secondary	73.6	76.7	86.7	81.7	79.3
United States:					
Primary	406.7	472.5	340.5	r346.6	228.2
Secondary	34.8	53.2	29.4	50.2	74.3
Total	441.5	525.7	369.9	r396.8	302.5
Vietnam, primary[e]	7.2	5.4	5.5	5.5	5.0
Yugoslavia:					
Primary[e]	85.2	87.9	77.5	86.4	76.8
Secondary[e]	10.0	11.0	7.0	10.0	10.0
Total	95.2	98.9	84.5	96.4	[3]86.8
Zaire, primary	43.5	43.5	43.8	58.0	64.4
Zambia, primary	r42.5	38.2	32.7	33.3	[3]39.2
Grand total	r5,881.7	r6,269.6	6,056.6	6,112.2	5,881.2
Of which:					
Primary	r4,715.3	r5,037.4	4,785.4	4,880.5	4,664.0
Secondary	207.8	r243.0	248.2	285.4	295.1
Undifferentiated	958.6	r989.2	1,023.0	946.3	922.1

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.

[1]Whenever possible, detailed information on raw material source of output (primary—directly from ores, and secondary—from scrap) has been provided. In cases where raw material source is unreported and insufficient data are available to estimate the distribution of the total, that total has been left undistributed (primary and secondary). To the extent possible, this table reflects metal production at the first measurable stage of metal output. Table includes data available through July 6, 1983.

[2]Excludes zinc dust.

[3]Reported figure.

[4]Less than 50 metric tons.

[5]May include quantities of secondary.

Zirconium and Hafnium

By W. Timothy Adams[1]

Production of zircon, a zirconium silicate mineral, by domestic mining companies decreased by 26% in 1982. Zircon exports and imports decreased from those of 1981. Domestic consumption was 38% less than that of 1981. Production and shipments of zirconium mill products decreased slightly in 1982 because of the continued weak demand in nuclear powerplant construction. Demand for hafnium in superalloys dropped slightly because of the decrease in production of aircraft jet engines.

Zircon was used largely in foundry sands, refractories, abrasives, ceramics, and as a source of zirconium metal. Zirconium metal was used mostly in nuclear reactors, corrosion-resistant equipment for industrial plants, and refractory alloys. Hafnium was used in nuclear reactors, refractory alloys, and cutting-tool alloys.

Nuclear powerplant construction was at a virtual standstill in the United States. By contrast, France and Japan continued their stable national nuclear power generation programs based on the intention to reduce their imports of high-cost energy.

Domestic Data Coverage.—Domestic mine production data for zircon are developed by the Bureau of Mines from one separate voluntary survey of U.S. operations entitled, "Production of Zircon." Of the two operations to which a survey request was sent, both responded, representing 100% of production. Data are withheld to avoid disclosing company proprietary data.

Legislation and Government Programs.—There were no stockpile goals for zirconium or hafnium materials. As of December 31, 1982, the U.S. Department of Energy had an inventory of approximately 70 short tons of zirconium sponge, 1,022 tons of zirconium ingots and shapes, 2 tons of zirconium scrap, 32 tons of hafnium ingots and shapes, 4 tons of hafnium crystal bar, 5 tons of hafnium oxide, and 1 ton of hafnium scrap.

Table 1.—Salient zirconium statistics in the United States

(Short tons)

	1978	1979	1980	1981	1982
Zircon:					
Production	W	W	W	W	W
Exports	7,671	8,856	7,727	11,630	11,011
Imports	91,009	110,842	113,784	91,108	68,465
Consumption[e 1]	164,000	168,000	140,000	150,000	93,000
Stocks, yearend, dealers' and consumers'[2]	38,307	37,465	69,473	[r]33,385	[e]48,575
Zirconium oxide:					
Production[3]	8,605	11,130	10,218	8,251	5,059
Producers' stocks, yearend[3]	931	975	1,216	[r]1,483	1,349

[e]Estimated. [r]Revised. W Withheld to avoid disclosing company proprietary data.
[1]Includes insignificant amounts of baddeleyite.
[2]Excludes foundries.
[3]Excludes oxide produced by zirconium metal producers.

Table 2.—Producers of zirconium and hafnium materials in 1982

Company	Location	Materials
ZIRCONIUM MATERIALS		
Associated Minerals (USA) Ltd., Inc	Bow, N.H	Oxide.
Do	Green Cove Springs, Fla	Zircon.
The Carborundum Co	Falconer, N.Y	Refractories.
C-E Cast Industrial Products	Long Beach, Calif	Milled zircon.
C-E Refractories, a division of Combustion Engineering, Inc.	St. Louis, Mo	Refractories.
Do	Camden, N.J	Refractories and zircon.
Do	Vandalia, Mo	Do.
CIBA-GEIGY Corp., Drakenfeld Colors	Washington, Pa	Ceramic colors and milled zircon.
Continental Mineral Processing Corp	Sharonville, Ohio	Milled zircon.
Corhart Refractories Co	Buckhannon, W. Va	Refractories.
Do	Corning, N.Y	Do.
Do	Louisville, Ky	Do.
Didier-Taylor Refractories Corp	Cincinnati, Ohio	Do.
Do	South Shore, Ky	Do.
E. I. du Pont de Nemours & Co	Wilmington, Del	Zircon and foundry mixes.
Elkem Metals Co	Alloy, W. Va	Alloys.
Ferro Corp	Cleveland, Ohio	Ceramics and ceramic colors.
Foote Mineral Co	Cambridge, Ohio	Alloys.
A. P. Green Refractories Co., Remmey Div	Philadelphia, Pa	Refractories.
Harbison-Walker Refractories Co	Mount Union, Pa	Do.
Harshaw Chemical Co., Inc	Cleveland, Ohio	Oxide.
Leco Corp., Ceramics Div	St. Joseph, Mich	Refractories and milled zircon.
Lincoln Electric Co., Inc	Cleveland, Ohio	Welding rods.
M & T Chemicals, Inc	Andrews, S.C	Milled zircon.
Magnesium Elektron, Inc	Flemington, N.J	Alloys, chemicals, oxide.
Norton Co	Huntsville, Ala	Oxide.
Reading Alloys	Robesonia, Pa	Alloys.
Ronson Metals Corp	Newark, N.J	Baddeleyite (oxide).
Shieldalloy Corp	Newfield, N.J	Welding rods and alloys.
Sola Basic Industries, Engineered Ceramics Div	Gilberts, Ill	Ceramics.
TAM Ceramics	Niagara Falls, N.Y	Milled zircon, oxide, alloys, chloride.
Teledyne Wah Chang Albany	Albany, Oreg	Oxide, chloride, sponge, ingot, powder, crystal bar, mill products.
Thiokol Corp., Ventron Chemicals Div	Beverly, Mass	Alloys and powder.
Transelco, Inc	Dresden, N.Y	Chemicals, ceramics, oxide.
TRW, Inc	Cleveland, Ohio	Zircon ores.
Western Zirconium Co	Ogden, Utah	Oxide, sponge, ingot, mill products.
Zedmark, Inc	Butler, Pa	Refractories.
ZIRCOA Products	Cleveland, Ohio	Oxide and ceramics.
HAFNIUM MATERIALS		
Teledyne Wah Chang Albany	Albany, Oreg	Oxide, sponge, ingot, crystal bar.
Western Zirconium Co	Ogden, Utah	Oxide, sponge, crystal bar, ingot.

DOMESTIC PRODUCTION

Zircon was recovered as a coproduct with titanium mineral concentrates from mineral sands at the dredging and milling facilities of E. I. du Pont de Nemours & Co. at Starke and Highland, Fla., and of Associated Minerals (USA) Ltd., Inc., at Green Cove Springs, Fla. Production data were withheld from publication to avoid disclosing company proprietary data. The combined zircon capacity at these plants was estimated to be 100,000 tons per year.

Five firms produced 37,090 tons of milled (ground) zircon in 1982 from domestic and imported concentrates. Five companies, excluding those that produce the oxide as an intermediate product in making zirconium sponge metal, produced 5,059 tons of zirconium dioxide.

The production of alloys containing 3% to 70% zirconium was 60% less than in 1981. Hafnium crystal bar production was estimated at 55 tons in 1982.

Teledyne Wah Chang Albany (TWCA) utilized approximately 50% of its production capacity for zirconium metal in 1982 because of reduced demand for zirconium mill products resulting from the continued slowdown in commercial nuclear powerplant construction, the major market for zirconium shapes.

CONSUMPTION AND USES

Zircon, baddeleyite, and zirconium compounds were used in refractories, ceramics, polishes, glazes, enamels, welding rods, chemicals, and sandblasting. The use of zirconium chemicals increased in the paint, textile, and pharmaceutical industries.

Foundries used about 50% of the domestic zircon produced in 1982. The remainder was consumed by refractory, abrasive, ceramic, metal, and other industries. Domestic zircon was marketed in proprietary mixtures as foundry sand; in refractory sand blends with kyanite, sillimanite, and staurolite; in weighting agents; in zircon-titanium dioxide blends for welding-rod coatings; and for sandblasting applications. Zircon has largely replaced tin oxide as the major opacifying agent in ceramics because of its low price and its ability to combine well with the majority of colors used.

In 1982, baddeleyite from the Republic of South Africa was used mainly in the manufacture of alumina-zirconia abrasives, and also for ceramic colors, refractories, and other uses. The use of yttria-stabilized zirconia in ceramic coatings in jet engines and in other high temperature oxidation-resistant coatings continued to grow in 1982, but the quantity of zirconia consumed was small. The market for zirconia ceramics continued to develop in the automobile industry. The zirconia-oxygen cell functions as the working component in the oxygen sensor that is part of the microprocessor control of engines.

The nuclear power industry accounted for about 90% of the zirconium metal consumed, with the remainder being used primarily as corrosion-resistant metal in the chemical industry, for superalloys, and in electronics. Shipments of zirconium mill products declined for the fourth consecutive year in 1982.[2] The decline in demand was a result of the continued cancellations and delays in the construction of commercial nuclear powerplants. There were no new orders for commercial nuclear powerplants for the fourth consecutive year in 1982, and during the year, orders for 42 units were canceled.

Hafnium metal consumption for nuclear reactor control rods increased during the year.

Table 3.—Estimated[1] consumption of zircon in the United States, by end use

(Short tons)

End use	1981	1982
Zircon refractories[2]	25,000	15,000
AZS refractories[3]	5,000	4,400
Zirconia[4] and AZ abrasives[5]	13,000	8,000
Alloys[6]	5,000	3,100
Foundry applications	75,000	46,000
Other[7]	27,000	16,500
Total	150,000	93,000

[1]Based on incomplete reported data.
[2]Dense and pressed zircon brick and shapes.
[3]Fused cast and bonded alumina-zirconia-silica-based refractories.
[4]Excludes oxide produced by zirconium metal producers.
[5]Alumina-zirconia-based abrasives.
[6]Excludes alloys above 90% zirconium.
[7]Includes chemicals, metallurgical-grade zirconium tetrachloride, sandblasting, welding rods, and miscellaneous uses.

Table 4.—Estimated[1] consumption of zirconium oxide[2] in the United States, by end use

(Short tons)

End use	1981	1982
AZ abrasives	4,500	2,700
AZS refractories[3]	1,000	900
Other refractories	2,000	1,200
Chemicals	600	400
Glazes, opacifiers, colors	500	400
Total	8,600	5,600

[1]Based on incomplete reported data.
[2]Excludes oxide produced by zirconium metal producers. Includes baddeleyite.
[3]Fused cast and bonded.

Table 5.—Yearend stocks of zirconium and hafnium materials

(Short tons)

Item	1981	1982
Zircon concentrate held by dealers and consumers, excluding foundries	r27,596	e40,339
Milled zircon held by dealers and consumers, excluding foundries	r5,789	e8,236
Zirconium:[1]		
Oxide	r1,483	1,349
Sponge, ingot, scrap, alloys	594	e345
Refractories	r6,791	e5,591
Hafnium: Sponge and crystal bar[e]	35	35

eEstimated. rRevised.

[1]Excludes material held by zirconium sponge metal producers.

Table 6.—Published prices of Australian zircon

(U.S. dollars per ton)

	Standard grade	Intermediate grade	Premium grade
December 1981	102-107	107-113	113-123
March 1982	106-111	111-116	116-120
June 1982	108-113	113-117	117-122

Table 7.—Published prices of zirconium and hafnium materials

Specification of material	1981	1982
Zircon:		
Domestic, standard grade, f.o.b. Starke, Fla., bulk, per short ton[1]	$165.00	$165.00
Domestic, 75% minimum quantity zircon and aluminum silicates, Starke, Fla., bulk, per short ton[1]	99.00	99.00
Imported sand, containing 65% ZrO_2, f.o.b., bulk, per metric ton[2]	$113.00- 118.00	$111.00- 116.00
Domestic, granular, bags, bulk rail, from works, per short ton[3]	165.00- 177.00	165.00- 177.00
Domestic, milled, 200- and 325-mesh, rail, from works, bags, per short ton[3]	225.00	225.00
Baddeleyite, imported concentrate:[4]		
96% to 98% ZrO_2, minus 100-mesh, c.i.f. Atlantic ports, per pound	.33- .50	.40
99%+ ZrO_2, minus 325-mesh, c.i.f. Atlantic ports, per pound	.85- 1.00	.90
Zirconium oxide:[3]		
Chemically pure, white, ground, barrels or bags, works, per pound	4.75	NA
Powder, commercial grade, drums, 2,000-pound minimum, per pound	NA	4.25
Electronic, same basis, per pound	NA	7.25
Insulating, stabilized, 325° F, same basis, per pound	NA	3.31
Insulating, unstabilized, 325° F, same basis, per pound	NA	3.75
Dense, stabilized, 30° F, same basis, per pound	NA	2.82
Glass-polishing grade, ton lots, bags, 94% to 97% ZrO_2, from works, per pound	1.11	NA
Opacifier grade, 3,300-pound lots, 85% to 90% ZrO_2, bags, per pound	.81	NA
Stabilized oxide, 100-pound bags, 91% ZrO_2, milled, per pound	1.57	NA
Zirconium oxychloride: Crystal, cartons, 5-ton lots, from works, per pound[3]	.87	.87
Zirconium acetate solution:[3]		
25% ZrO_2, drums, carlots, 15-ton minimum, from works, per pound	.97	.97
22% ZrO_2, same basis, per pound	.78	.78
Zirconium hydride: Electronic grade, powder, drums, 100-pound lots, from works, per pound[3]	31.75	31.75
Zirconium:[5]		
Powder, per pound	50.00- 137.50	50.00- 137.50
Sponge, per pound	12.00- 17.00	12.00- 17.00
Sheets, strip, bars, per pound	18.00- 40.00	18.00- 40.00
Hafnium: Sponge, per pound[5]	70.00- 125.00	70.00- 125.00

NA Not available.

[1]E. I. du Pont de Nemours & Co. price list December 1981 (effective Jan. 1, 1982), and December 1982 (effective Jan. 1, 1983).

[2]Industrial Minerals (London). No. 171, December 1981, p. 93; and No. 183, December 1982, p. 91.

[3]Chemical Marketing Reporter. V. 221, No. 1, Jan. 4, 1982 (effective Dec. 31, 1981), p. 52; and v. 223, No. 1, Jan. 3, 1983 (effective Dec. 31, 1982), p. 51.

[4]Ronson Metals Corp. Baddeleyite price lists. Jan. 1, 1982, and Jan. 1, 1983.

[5]American Metal Market. V. 89, No. 250, Dec. 29, 1981, p. 16; and v. 91, No. 5, Jan. 7, 1983, p. 7.

Table 8.—U.S. exports of zirconium ore and concentrate, by country

Country	1981 Pounds	1981 Value	1982 Pounds	1982 Value
Algeria	--	--	112,435	$39,045
Argentina	462,601	$73,559	802,694	151,990
Brazil	2,897,162	541,605	2,190,235	237,077
Canada	2,445,021	504,117	1,760,169	305,783
Colombia	2,086,724	486,367	1,420,507	350,900
Dominican Republic	123,157	30,252	80,461	17,025
France	107,300	26,279	37,781	8,101
Germany, Federal Republic of	2,876,866	600,897	10,005,789	1,100,270
India	293,844	67,882	80,159	26,089
Leeward and Windward Islands	221,600	25,986	--	--
Mexico	10,370,083	1,068,233	3,270,140	380,643
Panama	12,416	1,625	95,874	18,216
Suriname	80,000	1,770	286,379	7,379
Taiwan	--	--	229,072	140,032
Venezuela	1,048,834	305,195	1,241,642	375,040
Other	r234,795	r104,543	409,479	110,455
Total	23,260,403	3,838,310	22,022,816	3,268,045

rRevised.

Table 9.—U.S. exports of zirconium, by class and country

Class and country	1981 Pounds	1981 Value	1982 Pounds	1982 Value
Zirconium and zirconium alloys, wrought:				
Belgium-Luxembourg	98,100	$4,798,002	39,284	$2,064,439
Canada	312,446	8,649,143	332,297	9,524,070
France	5,753	178,256	11,459	260,811
Germany, Federal Republic of	73,067	1,746,642	207,982	4,096,059
Japan	551,147	13,327,468	627,459	17,019,832
Sweden	4,303	147,096	66,299	892,922
Switzerland	17,701	650,713	12,828	719,075
Taiwan	331	21,518	13,951	351,453
United Kingdom	28,950	481,469	135,745	2,389,076
Other	r4,665	r157,646	4,805	166,888
Total	1,096,463	30,157,953	1,452,109	37,484,625
Zirconium and zirconium alloys, unwrought and waste and scrap:				
Canada	21,404	455,389	8,142	31,379
Germany, Federal Republic of	8,838	31,259	43,855	203,935
Japan	128,577	2,781,204	185,257	5,202,865
Netherlands	2,454	10,010	--	--
United Kingdom	100,996	1,539,640	65,805	1,003,785
Other	2,505	39,359	798	24,926
Total	264,774	4,856,861	303,857	6,466,890

rRevised.

Table 10.—U.S. exports of zirconium oxide, by country

Country	1981 Pounds	1981 Value	1982 Pounds	1982 Value
Argentina	11,025	$21,995	60,373	$128,785
Brazil	51,992	136,354	77,458	229,615
Canada	222,284	158,318	82,959	186,141
France	84,405	272,827	899,198	3,447,163
Germany, Federal Republic of	43,476	90,603	36,304	105,065
Hong Kong	29,191	45,742	9,404	10,362
Hungary	72,600	90,750	--	--
India	59,021	36,893	4,775	12,069
Italy	83,108	99,257	47,590	63,064
Japan	171,140	290,753	171,798	316,748
Mexico	133,730	38,279	108,948	54,658
Netherlands	36,998	47,184	62,940	79,285
Sweden	69,177	103,816	22,907	42,077
Taiwan	17,082	45,232	41,325	52,384
Thailand	40,000	4,000	--	--
United Kingdom	405,741	710,107	369,033	598,424
Other	33,908	61,551	38,256	94,642
Total	1,564,878	2,253,661	2,033,268	5,420,482

Table 11.—U.S. imports for consumption of zirconium ores, by country

Country	1980 Quantity (short tons)	1980 Value (thousands)	1981 Quantity (short tons)	1981 Value (thousands)	1982 Quantity (short tons)	1982 Value (thousands)
Australia	97,968	$8,888	71,852	$6,930	56,092	$5,142
Austria[1]	20	3	--	--	59	7
Canada[1]	1,082	165	2,444	305	705	70
Malaysia	--	--	72	5	--	--
South Africa, Republic of[2]	14,714	1,539	16,740	1,138	11,603	919
Other	--	--	--	--	6	6
Total	113,784	10,595	91,108	8,378	68,465	6,144

[1]Believed to be country of shipment rather than country of origin.
[2]In addition, very small quantities of baddeleyite were imported.

Table 12.—U.S. imports for consumption of zirconium and hafnium in 1982, by class and country

Class and country	Pounds	Value
Zirconium, wrought:		
Belgium-Luxembourg	70	$6,440
Canada	3,290	35,864
France	546,088	11,096,980
Germany, Federal Republic of	1,140	12,694
Japan	820	12,664
United Kingdom	792	30,786
Total	552,200	11,195,428
Zirconium, unwrought and waste and scrap:		
Canada	44,604	42,686
France	297	5,449
Germany, Federal Republic of	55,887	208,074
Japan	92,489	302,627
Netherlands	80,273	167,240
Sweden	20,860	26,106
United Kingdom	518	683
Total	294,928	752,865
Zirconium alloys, unwrought:		
Canada	5,369	1,900
Japan	7,590	12,883
United Kingdom	5,004	19,528
Total	17,963	34,311
Zirconium oxide:		
Belgium-Luxembourg	880	6,188
France	63,874	68,844
Germany, Federal Republic of	994	38,192
Japan	3,705	21,339
Switzerland	6	1,073
U.S.S.R.	85,623	225,431
United Kingdom	508,146	1,756,457
Total	663,228	2,117,524
Zirconium compounds:		
Denmark	4	630
France	80,737	111,017
Germany, Federal Republic of	39,077	680,520
Italy	22	1,687
Japan	2,251	24,235
Switzerland	143	3,462
South Africa, Republic of	508,657	256,860
United Kingdom	326,279	252,070
Total	957,170	1,330,481

WORLD REVIEW

Australia continued to lead the world in the production of zircon, a zirconium silicate mineral. With the mineral sands operation at Richards Bay in the Republic of South Africa reportedly producing at capacity, Australia no longer dominated the world market. Zircon was also produced in Brazil, China, India, Malaysia, the Republic of South Africa, Sri Lanka, Thailand, the U.S.S.R., and the United States. Baddeleyite, a zirconium oxide mineral, was produced in the Republic of South Africa and Brazil.

It was estimated that approximately 90% of worldwide zircon consumption was accounted for by refractory, ceramic, and foundry uses. Market economy countries used approximately 8 million pounds of zirconium ingot for commercial nuclear power generating stations and an additional 2 million pounds for other purposes.

Table 13.—Zirconium concentrate: World production, by country[1]

(Short tons)

Country	1978	1979	1980	1981[p]	1982[e]
Australia	431,671	490,500	541,837	468,138	350,000
Brazil	4,741	[r]2,891	3,759	[e]4,400	3,850
China[e]	10,000	12,000	14,000	15,000	15,000
India[2]	12,309	13,426	16,336	13,669	13,000
Malaysia[3]	1,022	1,401	388	1,441	1,650
South Africa, Republic of[e]	40,000	90,000	88,000	110,000	138,000
Sri Lanka	3,634	1,664	3,341	3,600	3,640
Thailand	28	128	67	115	110
U.S.S.R.[e]	75,000	80,000	80,000	80,000	86,000
United States	W	W	W	W	W
Total	578,405	[r]692,010	747,728	696,363	611,250

[e]Estimated. [p]Preliminary. [r]Revised. W Withheld to avoid disclosing company proprietary data; excluded from "Total."
[1]Includes data available through Apr. 15, 1983.
[2]Data are for fiscal year beginning Apr. 1 of that stated.
[3]Exports (production not officially reported; exports believed to closely approximate total output).

Australia.—Australia was a major producer of heavy minerals and concentrates and was the world's largest exporter of zircon.[3] The principal mineral sand deposits are found on the east coast between Newcastle, New South Wales, and Gladstone, in Queensland, and along the southwest coast of Western Australia. Producers assert that an unfavorable exchange rate has adversely affected the industry's profitability and that environmental laws deny access to about 45% of the known high-grade reserves of the Australian east coast.

For the second year in succession, Allied Eneabba Pty. Ltd., an Australian mineral sand producer, achieved a respectable profit in 1982, with a strong zircon market offsetting lower rutile sales.[4] The company expected prices to remain firm and reported that it had identified a long-term shortage of zircon on a world scale.

Production of mineral sands at North Stradbroke Island in Queensland could double if Consolidated Rutile Ltd. installs a planned additional dredge and wet plant.[5] Production at the new plant would be 50% greater than at the present Bayside plant. Consolidated had reserves estimated at 615,000 metric tons of zircon in the area to be served by the plants. A decision was expected by the end of March 1983.

Associated Minerals Consolidated Ltd. concluded a reorganization of its mining and processing operations.[6] The company's east coast operations were effectively centered on the North Stradbroke heavy mineral deposits. All its other east coast mining and separation operations, apart from the Brisbane grinding plant, were to be shut down. On the west coast, only 9,000 to 10,000 tons per year of zircon reportedly were to be produced in the future at Capel.

Brazil.—Rutilo a Ilmenita do Brasil S.A., a subsidiary of Titanio do Brasil was developing reserves at Matargca in Pernambuco for the production of 15,000 tons per year of zircon in 1983.[7]

Japan.—By the end of 1985, six pressurized water reactors (PWR) and six boiling water reactors (BWR) of the 1-million-kilowatt class were scheduled to come into operation.[8] The zircaloy tubes used in both the PWR and BWR reactors were being manufactured in Japan. Estimates were that demand for zircaloy tubing in 1982 was 1.3 million meters. All three of the Japanese manufacturers of zircaloy tubes were using the basic TWCA tubes of 50 to 60 millimeter diameter as their starting materials. However, the contracts for eight new reactors specified 100% Japanese materials.

TECHNOLOGY

The Bureau of Mines conducted research using zirconia as an alternate mold material for molybdenum investment castings.[9] The research demonstrated that molds prepared from calcia-stabilized zirconia with zirconia-forming binders could be used to prepare investment castings of molybdenum to near-net shape. Molds comprised of dip-coat slurries were sufficiently strong and erosion resistant to permit castings weighing at least 16 pounds to be centrifugally cast at 14 gravity centrifugal force. Superficial fusion of the mold innerface during contact with the molten metal gave a slight degree of surface roughness. Casting dimensions and details were predictable and reproducible.

A method of producing zirconium metal fins on zirconium heat exchange tubes was reported.[10] The product reportedly was resistant to solutions that tend to corrode tubes fabricated from titanium, Hastelloy, and other corrosion-resistant materials.

A new ceramic developed in Australia emerged as a candidate in the effort to develop an all-ceramic diesel engine such as the "adiabatic" diesel engine that Cummins Diesel Corp. hoped to build by 1984.[11] The ceramic, known as partially stabilized zirconia (PSZ) is composed of a matrix of zirconium dioxide containing small crystals of zircon. It is reported that the zircon crystals effectively impede the propagation of cracks in the material. PSZ was also used for the dies for the extrusion of metal pipe and tube. The ceramic dies showed less wear than metal dies and produced a smoother finish.

Du Pont developed an olefin polymerization catalyst that it claimed has many advantages over traditional Ziegler-Nata catalysts.[12] The new catalyst was formed by reacting tetraneopentyl zirconium with alumina particles. It reportedly was active at temperature as high as 300° C, and became inactive after polymerization.

The addition of approximately 20% of zirconium dioxide reportedly stabilized europium oxide in the cubic phase.[13] Europium materials are attractive as control and shutoff rod materials in fast neutron reactors because of their high capture cross-section in fast neutron fluxes. Results were compared for coprecipitated powders and pellets prepared from mechanically mixed powders fired at 1,300° C and 1,500° C. The thermal stability of the cubic structure at 600° C and 800° C was demonstrated.

An explosion-bonding method of producing zirconium-clad steel reportedly promised to allow the use of corrosion-resistant zirconium in many applications where it has been excluded because of the high cost.[14] The technique eliminated the metallic interlayers previously needed to overcome problems of incompatibility between zirconium and steel. It was reported that large clads could be produced, reducing the number of welds, and hence the cost required to fabricate items such as pressure vessels. Explosion-bonded slabs can be rolled into very large plates measuring up to 96 by 360 inches with zirconium layers as thin as 0.025 inch.

Milled zircon flour was a key element in a refinement of the centrifugal casting process.[15] The zircon flour was distributed and shaped by a special lining lance over the interior of a simple cylindrical tube. The zircon-lined mold reportedly enabled the more convenient production of items to exact or near-net shape. As a refractory molding material, zircon flour eliminated the chilling effect of a metal mold and promoted optimum cooling and metal structure.

The historical development of zirconium and its alloys as structural materials for nuclear reactors was described.[16] The various problems encountered in the early stages of the development of zircaloys, and their performance in nuclear reactors now operating were described in detail. The development of Zr-2.5% Nb alloys for pressure tube applications was discussed. The development potential of zirconium alloys for high temperature applications was discussed in detail.

[1]Physical scientist, Division of Nonferrous Metals.
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[4]Mining Journal. Allied Eneabba. V. 298, No. 7651, Apr. 9, 1982, p. 280.
[5]Industrial Minerals. World of Minerals. Mineral Sands Production to Double? No. 183, December 1982, p. 9.
[6]———. Titanium Minerals Producers Review, Australia. Associated Minerals Consolidated. No. 178, July 1982, p. 29.
[7]Mining Annual Review-1982. Countries, Brazil. P. 351.
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Other Metals

By Staff, Division of Nonferrous Metals

CONTENTS

ARSENIC[1]

The supply of arsenic trioxide in 1982 was adequate to meet domestic demand. Allocation of supply by major domestic and foreign producers that began in 1977 ended during the first quarter of 1982. Major demand was about evenly divided between industrial chemicals and agricultural chemicals.

Domestic Data Coverage.—Commercial-grade arsenic trioxide and arsenic metal were produced by only one U.S. company. In order to prevent disclosure of proprietary data, arsenic production data have been withheld.

Legislation and Government Programs.—In 1978, the Occupational Safety and Health Administration (OSHA) issued a standard reducing the permissible exposure level for inorganic arsenic from 500 to 10 micrograms per cubic meter ($\mu g/m^3$). OSHA concluded that inorganic arsenic was a carcinogen and that 10 $\mu g/m^3$ was the lowest feasible level to which exposure could be controlled. However, although there was quantitative evidence of risk at levels below the old 500 $\mu g/m^3$ level, OSHA had not quantitatively estimated risk at the lower levels nor made a formal significant risk determination. In response to challenges in court by U.S. nonferrous metals producers, the Ninth Circuit Court of Appeals ordered additional investigation of the issues. On April 9, 1982, OSHA published a notice presenting three risk assessments and OSHA's preliminary analysis, requesting comments and scheduling a hearing. OSHA's preferred assessment indicated that the 10 $\mu g/m^3$ standard would reduce by 98% the incidence of lung cancer from occupational exposure to arsenic in employees exposed to arsenic at the previous 500 $\mu g/m^3$ standard. On January 14, 1983, OSHA published its final assessment in which it reaffirmed that the 10 $\mu g/m^3$ permissible level of occupational exposure to inorganic arsenic, which had remained in effect during the reopening of the record, was needed to substantially reduce a significant risk of lung cancer.[2]

Agreements were reached between OSHA, the United Steelworkers of America, and ASARCO Incorporated, concerning limiting worker exposure to inorganic arsenic. These agreements covered at least four lead and copper smelters owned by Asarco and were designed to bring these facilities into compliance with the new arsenic standard. Under these agreements, Asarco was to install recommended engineering controls and adopt worker protection programs for positions identified by the company as exceeding the permissible 10 $\mu g/m^3$ exposure standard.

DOMESTIC PRODUCTION

Arsenic trioxide and commercial-grade arsenic metal were produced at the Tacoma, Wash., copper smelter of Asarco. Asarco processed arsenic-bearing residues and high-arsenic copper concentrates from both imported and domestic sources. Production of arsenic was primarily from imported material, principally from the Philippines.

Koppers Co. Inc., a major producer of arsenical wood preservatives, produced high-purity arsenic trioxide at its plant near Atlanta, Ga., from low-grade material imported from Canada. High-purity arsenic trioxide was used in the production of arsenic acid, an intermediate chemical in the production of arsenical wood preservatives for pressure-treating lumber. Production of high-purity arsenic trioxide was for internal consumption, the company being a net purchaser and major consumer of arsenic trioxide.

High-purity arsenic metal for use in electronic devices was refined from commercial-grade metal by at least two companies: Asarco at its Globe, Colo., plant and Canyonlands 21st Century Corp. at its Blanding, Utah, facility. Canyonlands also reprocessed new gallium-arsenide scrap from the electronics industry for gallium recovery. At the present time, arsenic is not recovered from the scrap material.

CONSUMPTION AND USES

Arsenic compounds, principally arsenic trioxide, accounted for 97% of arsenic consumption in 1982. The estimated end use distribution of arsenic in 1982 was 55% in industrial chemicals (wood preservations and flotation reagents), 35% in agricultural chemicals (herbicides and plant desiccants), 5% in glass and ceramics (fining agent and decolorant), 3% in metallic form in nonferrous alloys, and 2% in other uses (animal feed additives, pharmaceuticals, etc.).

The bulk of metallic arsenic is used in copper- and lead-based alloys as a minor additive (about 0.5%) to increase strength in the posts and grids of lead-acid storage batteries and to improve corrosion resistance and tensile strength in copper alloys. A small amount, approximately 2 tons in 1982, of high-purity arsenic metal was used in the electronics industry. Gallium arsenide and its alloys were among the most important compound semiconductors, and were used in such products as light-emitting diodes and displays, room-temperature lasers, discrete microwave devices, solar cells, and photoemissive surfaces. Gallium arsenide devices, as compared with silicon devices, can have higher operating frequencies, lower power consumption, lower noise, and superior resistance to nuclear radiation.[3]

Consumption of arsenical wood preservatives in 1981, the last year for which data were available, increased by 28% from the level of 1980. Annual consumption of arsenical wood preservatives in short tons was as follows:

	1979	1980	1981
Chromated copper arsenate (CCA)	16,882	18,082	23,193
Ammoniacal copper arsenate (ACA)	532	537	579
Fluor chrome arsenate phenol (FCAP)	[r]56	W	W

[r]Revised. W Withheld to avoid disclosing company proprietary data.

Source: American Wood-Preservers' Association.

In the above table, chromated copper arsenate refers to a group of compounds containing varying amounts of arsenic in the less toxic, or pentavalent form. Fluor chrome arsenic phenol (FCAP) was among the earliest arsenical wood preservatives. However, in recent years its use in the pressure treatment of wood has nearly been phased out and replaced with arsenical wood preservatives that are more resistant to leaching by water.[4]

PRICES AND GRADES

The price of domestically produced arsenic trioxide, guaranteed minimum 95% purity, remained at $0.40 per pound throughout 1982, unchanged since September 1981. The price of domestically produced arsenic metal, marketed in 250-pound drums or 2,000-pound pallets, was $2.75 per pound at the beginning of the year, decreased to $2.50 per pound in January, increased to $2.75 per pound by July, and decreased in stages to the year's low of $2.45 per pound at yearend.

High-purity arsenic metal for electronics usage was sold in evacuated or argon-filled ampules to inhibit oxidation. Domestic material guaranteed to be 99.999% pure, or better, sold for $100 per kilogram. Substantial premiums were paid for some imported material of higher guaranteed purity.

Table 1.—Arsenic price quotations

(Cents per pound, yearend)

	1980	1981	1982
Trioxide, domestic, 95% As_2O_3, f.o.b. Tacoma, Wash	32	40	40
Trioxide, Mexican, 99.13% As_2O_3, f.o.b. Laredo, Tex	46	78	59
Trioxide, imports	35	45	45
Metal, domestic, 99% As	300	275	245

FOREIGN TRADE

Imports of arsenic trioxide decreased yet remained above the import level of 1980. Sweden, Canada, Mexico and France were the major sources of imported trioxide. In 1981, the United States began importing low-grade arsenic trioxide from Canada and commercial-grade arsenic trioxide from China. These two new sources of supply helped end the U.S. supply shortage that began in 1978.

Imports of arsenic acid in 1982 declined from the previous year's historically high level, but were still more than twice the 1980 level.

Table 2.—U.S. imports for consumption of arsenic trioxide content, by country

Country	1980		1981		1982	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Australia	--	--	--	--	78	$121
Belgium-Luxembourg	388	$142	1,379	$708	1,136	1,205
Bolivia	--	--	41	77	25	43
Canada	486	110	6,152	965	3,695	786
China	--	--	475	585	1,411	1,998
France	2,780	1,597	826	1,093	2,196	2,479
Germany, Federal Republic of	116	92	146	226	18	19
Hong Kong	--	--	--	--	1	1
Japan	58	79	--	--	--	--
Korea, Republic of	18	26	218	389	205	289
Mexico	3,720	2,681	3,931	5,261	2,509	3,341
Netherlands	57	26	--	--	40	42
Peru	--	--	55	57	--	--
Portugal	--	--	73	142	--	--
South Africa, Republic of	--	--	19	17	--	--
Spain	135	170	159	198	--	--
Sweden	4,770	2,429	5,403	3,259	4,620	4,717
Taiwan	--	--	--	--	55	75
U.S.S.R	--	--	44	91	33	68
United Kingdom	(1)	(1)	37	59	32	24
Zimbabwe	--	--	--	--	37	33
Total[2]	12,528	7,352	18,958	13,126	16,092	15,241

[1]Less than 1/2 unit.
[2]Data may not add to totals shown because of independent rounding.

Table 3.—U.S. imports for consumption of arsenicals, by class

Class	1980		1981		1982	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Arsenic trioxide (As_2O_3)	12,528	$7,352	18,958	$13,126	16,092	$15,241
Metallic arsenic	266	1,524	323	2,079	150	1,044
Sulfide	11	2	--	--	20	9
Sodium arsenate	(1)	2	(1)	3	525	109
Arsenic acid	271	197	1,666	2,400	771	865
Arsenic compounds, n.e.c	1	113	5	133	400	616

[1]Less than 1/2 unit.

Table 4.—U.S. imports for consumption of arsenicals, by country[1]

(Short tons)

Country	Metal (TSUS 632.04)		Acid (TSUS 416.05)		Lead arsenate (TSUS 419.00)	
	1981	1982	1981	1982	1981	1982
Canada	12	5	--	--	--	--
China	33	34	--	--	--	--
Germany, Federal Republic of	--	1	--	--	--	--
Mexico	--	--	605	--	--	--
Peru	5	--	--	--	99	187
Sweden	273	110	20	--	--	--
United Kingdom	--	--	1,041	771	--	--
Total	323	150	1,666	771	99	187

[1]Figures of less than 1/2 unit are not indicated in this table.

Table 5.—U.S. import duties for arsenicals

Item	TSUS No.	Most favored nation (MFN)			Non-MFN
		Jan. 1, 1982	Jan. 1, 1983	Jan. 1, 1987	Jan. 1, 1983
Arsenic metal	632.04	1.3 cents per pound.	1.0 cent per pound.	Free	6.0 cents per pound.
Trioxide and sulfide	417.62, 417.60	Free	Free	do	Free.
Other compounds	417.64	4.5% ad valorem.	4.4% ad valorem.	3.7% ad valorem.	25% ad valorem.

WORLD REVIEW

Canada.—A new arsenic production plant was commissioned by Cominco Ltd. in Yellowknife, Northwest Territories. The plant was scheduled to process arseniferous sludge accumulated over 25 years from a stack scrubber, operated in conjunction with a roaster unit, in the recovery of gold and silver. The project was undertaken in response to a directive from the Northwest Territories Water Board, which was concerned with the potential environmental hazards from surface storage of the wastes.

The plant was designed to process 32 metric tons per day of sludge to produce 15 metric tons per day of high-purity arsenic trioxide and a residue that was to be processed to recover gold and silver.[5] The plant was expected to be in operation for 5 to 7 years.

Japan.—With at least three companies refining arsenic, Japan was a leading world producer of high-purity arsenic for electronic applications. It also was a leading producer of single-crystal gallium arsenide for semiconductor devices.

Table 6.—Arsenic trioxide:[1] World production, by country[2]

(Short tons)

Country[3]	1978	1979	1980	1981[p]	1982[e]
France	[e]6,500	6,118	[e]5,800	[e]5,700	5,600
Germany, Federal Republic of[e]	400	--	400	400	400
Japan	100	201	313	[e]330	330
Korea, Republic of	604	650	NA	187	NA
Mexico	6,884	7,206	7,641	7,184	[5]5,326
Namibia[4]	2,647	2,448	1,420	1,510	[5]2,089
Peru[6]	[r]1,457	[r]1,560	2,728	2,385	2,400
Portugal	279	[e]380	[e]220	216	220
Sweden[e 7]	6,700	5,600	4,500	4,400	4,400

See footnotes at end of table.

Table 6.—Arsenic trioxide:[1] World production, by country[2] —Continued

(Short tons)

Country[3]	1978	1979	1980	1981[p]	1982[e]
U.S.S.R.[e]	8,400	8,500	8,500	8,600	8,700
United States	W	W	W	W	W
Total	[r]33,971	[r]32,663	31,522	30,912	29,465

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data.

[1]Includes calculated arsenic trioxide equivalent of output of elemental arsenic and arsenic compounds other than arsenic trioxide where inclusion of such materials would not duplicate reported arsenic trioxide production.

[2]Table includes data available through May 9, 1983.

[3]In addition to the countries listed, Austria, Belgium, China, Czechoslovakia, Finland, the German Democratic Republic, Hungary, Spain, the United Kingdom, Yugoslavia, and Zimbabwe have produced arsenic and/or arsenic compounds in previous years, but information is inadequate to make reliable estimates of output levels.

[4]Output of Tsumeb Corp. Ltd. only.

[5]Reported figure.

[6]Output of Empresa Minera del Centro del Perú S.A. (CENTROMÍN PERÚ).

[7]Output of arsenic trioxide for sale plus the arsenic trioxide equivalent of the output of metallic arsenic for sale.

TECHNOLOGY

Stockpiles of arseniferous dusts, accumulated from various stages of copper, lead, and zinc smelting, have generated interest as a possible source material for arsenic, and because they pose a potential environmental hazard. Williams Strategic Metals, Inc., developed a bench-scale process for recovery of sodium arsenate from copper smelter flue dust. The high iron content of the flue dust allowed arsenic to be fixed early in the process as ferric arsenate, which was insoluble during the leaching of other metal values. Arsenic recovery was accomplished by leaching the ferric arsenate in hot caustic solution. A second process, used to treat lead smelter flue dusts containing approximately the same concentration of arsenic (10%) as the copper dusts, was under commercial development. In this process, the arsenic was first dissolved in hot sulfuric acid at elevated pressure and then arsenic acid was recovered from the pregnant solution using solvent extraction techniques.[6]

The Bureau of Mines conducted research to develop hydrometallurgical processes for treating arsenical flue dusts. Two laboratory processes were developed using sulfur dioxide to reduce arsenic dissolved in hot leach solution to form arsenous acid (H_3AsO_3) which is less soluble than compounds of arsenic of higher valence. In both Bureau of Mines process schemes, arsenic was crystallized from the filtrates as pure arsenic trioxide by cooling the solution.[7]

Cominco used a two-stage countercurrent leach system to recover arsenic trioxide from arseniferous sludge at its new Yellowknife plant. Arsenic trioxide was recovered from hot saturated leach liquid using a three-stage vacuum-cooling crystallization system. Precious metals were recovered from the residue in an existing cyanidation circuit.[8]

CESIUM AND RUBIDIUM[9]

DOMESTIC PRODUCTION

Small quantities of cesium metal and cesium compounds were produced from ore (pollucite) that was imported from Canada and Zimbabwe. Rubidium compounds and metal were produced from imported lepidolite ores. Production of cesium and rubidium products in 1982 was lower than that of 1981 because of weak demand.

The Cabot Corp. (KBI Div.) plant at Revere, Pa., was the only producer of cesium and rubidium metal and compounds. Other potential suppliers included the Callery Chemical Co., Callery, Pa., and Kerr-McGee Chemical Corp., Trona, Calif.

Domestic Data Coverage.—Domestic data for cesium and rubidium are developed by the Bureau of Mines from a voluntary survey of U.S. operations. Of the four operations to which a survey request was sent, all responded. Only one company reported production of cesium and rubidium products.

CONSUMPTION AND USES

Data concerning specific end-use and consumption patterns for cesium and rubidium and their compounds were not available. Cesium and rubidium and their respective compounds were interchangeable in most applications, although cesium compounds were the most widely accepted because of their availability and price advantages. Commercial consumption included uses for high-voltage rectifying tubes, which change alternating current to direct current, and for infrared lighting where cesium vapor emits light with a wavelength that is invisible. In photoelectric cells, cesium chloride was used because its color sensitivity is higher than that of other alkali salts.

PRICES

Prices for cesium and rubidium compounds and cesium metal rose in 1982 reportedly because of higher costs of production. At yearend, cesium was $275 per pound for technical-grade metal and $325 per pound for high-purity material. Rubidium metal prices were unchanged at $300 per pound for technical-grade and $375 for high-purity metal.

Table 7.—Prices of selected cesium and rubidium compounds in 1982

Compound	Base price per pound[1]	
	Technical grade	High-purity grade
Cesium bromide	$32.00	$69.50
Cesium carbonate	32.00	69.50
Cesium chloride	34.00	72.50
Cesium fluoride	40.70	80.00
Cesium hydroxide	38.50	78.00
Rubidium carbonate	78.00	125.00
Rubidium chloride	79.00	126.00
Rubidium fluoride	85.00	132.00
Rubidium hydroxide	85.00	132.00

[1]Price is for quantities of less than 100 pounds, f.o.b. Revere, Pa., excluding packaging costs.

Source: Cabot Corp. (KBI Div.)

FOREIGN TRADE

The sharp decline in imports was attributed to a marked drop in demand in the United States. Trade data on raw materials and metal were not available. Tariff schedules established at the Tokyo Round of trade negotiations, with downward escalation, are shown in table 9.

WORLD REVIEW

The Tantalum Mining Corp. of Canada Ltd., owned jointly by Cabot, 37.5%; Hudson Bay Mining and Smelting Co. Ltd., 37.5%; and the Manitoba Provincial Government, 25%, closed its Bernic Lake Mine for 1 month during the summer of 1982. Bernic Lake has long been the major supplier of pollucite to the United States. On December 31, 1982, the mine was shut down completely for an anticipated period of 1 year. The reasons given for termination of operations were lack of demand and increased cost of production.

During 1982, Bikita Minerals (Pvt.) Ltd., which operated several mines that produced cesium and rubidium minerals in the Victoria district of Zimbabwe, severely curtailed production. The company ceased all production at the end of 1982 because of the lack of a market and high production costs. No plans for reactivation were announced.

Table 8.—U.S. imports for consumption of cesium compounds, by country

Country	1981				1982			
	Cesium chloride		Cesium compounds, n.s.p.f.		Cesium chloride		Cesium compounds, n.s.p.f.	
	Quantity (pounds)	Value	Quantity (pounds)	Value	Quantity (pounds)	Value	Quantity (pounds)	Value
Canada	22	$808	--	--	--	--	--	--
France	--	--	226	$12,117	--	--	--	--
Germany, Federal Republic of	8,570	363,375	15,333	658,567	9,645	$403,047	6,995	$395,379
United Kingdom	264	14,355	--	--	--	--	7	1,015
Total	8,856	378,538	15,559	670,684	9,645	403,047	7,002	396,394

Table 9.—U.S. import duties for cesium and rubidium

Item	TSUS No.	Most favored nation (MFN)		Non-MFN
		Jan. 1, 1983	Jan. 1, 1987	Jan. 1, 1983
Ore and concentrate	601.66	Free	Free	Free.
Cesium	415.10	6.9% ad valorem	5.3% ad valorem	25% ad valorem.
Cesium chloride	418.50	5.0% ad valorem	4.0% ad valorem	Do.
Other cesium compounds	418.52	4.5% ad valorem	do	Do.
Rubidium	415.40	4.4% ad valorem	3.7% ad valorem	Do.
Rubidium compounds	423.00	do	do	Do.

TECHNOLOGY

Research and development in the area of magnetohydrodynamic (MHD) technology to generate electricity directly from heat continued through 1982. The Pacific Northwest Laboratories of Battelle Memorial Institute at Richland, Wash., announced plans to begin tests on a system that could be 8% more efficient than current methods under development. The conventional approach is to burn coal at a very high temperature to obtain a gas flow that produces electricity when passed through a magnetic field. The new concept substitutes a gasifier for the combustion area and utilizes waste heat for additional electric generation. If the Battelle experiments prove successful, they could stimulate an increased demand for cesium that is used as a "seed" material for thermionic generation of electricity.

Work was continued in conventional MHD development. Under a program of the U.S. Department of Energy, the Component Development and Intergration Facility at Butte, Mont., was testing a 20-ton-megawatt, two-stage coal-fired combustor made by TRW Energy Development Group at Redondo Beach, Calif. The unit was coupled with an MHD generation channel made by Avco Everett Research Laboratories located in Everett, Mass. In the next phase, TRW was scheduled to deliver a 50-ton-megawatt combustor to the Butte, Mont., facility.

The Albuquerque, N. Mex., municipal commission approved an $18 million plan to install technology to apply cesium irradiation to sludge from its wastewater-treatment operations. The technology was developed over the past 8 years at Sandia National Laboratory to produce sterilized sludge that can be used as fertilizer and possibly a feed supplement for ruminant animals. Albuquerque's sludge was reportedly suitable for fertilizer applications because it contains low concentrations of heavy metals and toxic chemicals.

GERMANIUM[10]

The domestic producer price for germanium metal and germanium dioxide stabilized during 1982. Despite a slight decrease in domestic production, the increased imports of wrought germanium products were sufficient to meet demand.

Domestic Data Coverage.—Domestic refinery production data for germanium are developed by the Bureau of Mines based on discussions with domestic producers concerning total industry production.

DOMESTIC PRODUCTION

Eagle-Picher Industries, Inc., Quapaw, Okla., was the sole domestic producer of primary germanium. Kawecki Berylco Industries, Inc., a division of Cabot, Revere, Pa., and Atomergic Chemetals Co., Plainview, N.Y., produced germanium products using imported metal, oxide, and scrap, and domestic waste and scrap.

Jersey Minière Zinc Co., Clarksville, Tenn., produced germanium-rich residues from zinc ores mined at Gordonsville and Elmswood, Tenn. These residues were shipped to Métallurgie Hoboken-Overpelt S.A. in Belgium for germanium recovery and refining.

Domestic primary and secondary production was estimated to be approximately 26,000 kilograms, a slight decrease from that of 1981. Based on the U.S. producer price for refined germanium, the approximate value of the production was $28 million.

CONSUMPTION AND USES

The estimated consumption pattern for various end uses of germanium in 1982 was infrared systems, 45%; fiber optics, 18%; semiconductors, 15%; detectors, 10%; and other uses, 12%.

Recent growth in the infrared systems market could be attributed in part to increased spending by the military on infrared systems for use in guidance and weapon-sighting systems. Germanium-containing lenses and windows transmit thermal radiation in a manner similar to visible light transmission by optical glass. Other important uses for germanium glass included nonmilitary surveillance and monitoring systems in fields such as satellite mapping and fire alarms.

Another growing market for germanium was fiber optic telecommunication systems. Although not used in all fiber optic systems, germanium was an important constituent in many applications. Fiber optics can be used as replacements for conventional wire-telecommunication systems and are finding increased use, especially in the busy northeastern corridor of the United States, because they can be installed in existing underground conduits where space is often at a premium. Fiber optic systems provide a compact, short-circuit-free transmission medium that is not susceptible to distortion by an electromagnetic field and that cannot be tapped by currently available technology.

Germanium was used as a substrate upon which gallium arsenide phosphide was deposited to form an essential part of light-emitting diodes. Germanium was also used in the manufacture of other semiconductor electronic equipment; to improve the hardness of copper, aluminum, and magnesium alloys; and as a catalyst in the production of polyester fibers and plastic bottles in some foreign countries.

PRICES

Germanium metal was listed at $1,060 per kilogram and germanium dioxide held at $660 per kilogram throughout the year.

The New York dealer price for imported germanium metal was $950 per kilogram at the start of the year, and imported germanium dioxide was listed at $570 per kilogram. Publication of the New York dealer price for imported germanium material stopped during May 1982 owing to numerous fluctuations in the value of the U.S. dollar versus foreign currencies.

FOREIGN TRADE

Total imports of germanium metal decreased in 1982 compared with those of 1981. Belgium-Luxembourg, which provided over two-thirds of the total imports, remained the largest single source for imported germanium, followed by France and the United Kingdom.

Table 10.—U.S. imports for consumption of germanium, by country

Country	1981		1982	
	Gross weight (kilograms)	Value	Gross weight (kilograms)	Value
Unwrought and waste and scrap:				
Belgium-Luxembourg	9,560	$1,792,340	1,854	$4,018,956
Canada	--	--	143	5,590
China	3,380	2,588,859	--	--
France	40	39,999	--	--
Germany, Federal Republic of	899	316,768	179	219,004
Japan	60	42,187	53	38,792
Netherlands	--	--	100	50,063
Switzerland	1,093	71,689	--	--
U.S.S.R	163	159,544	--	--
United Kingdom	1,476	916,100	821	95,577
Total	16,671	5,927,486	3,150	4,427,982

Table 10.—U.S. imports for consumption of germanium, by country —Continued

Country	1981 Gross weight (kilograms)	1981 Value	1982 Gross weight (kilograms)	1982 Value
Wrought:				
Belgium-Luxembourg	3,025	$4,120,440	6,955	$3,648,870
Canada	--	--	3	850
China	405	103,842	--	--
France	--	--	1,934	974,825
Germany, Federal Republic of	1,957	1,922,906	118	129,494
Japan	101	88,583	--	--
Netherlands	191	164,513	155	52,238
United Kingdom	(1)	268	144	52,500
Total	5,679	6,400,552	9,309	4,858,777

1Less than 1/2 unit.

Table 11.—U.S. import duties for germanium metal and germanium dioxide

Item	TSUS No.	Most favored nation (MFN) Jan. 1, 1982	Most favored nation (MFN) Jan. 1, 1983	Non-MFN Jan. 1, 1982-Jan. 1, 1983
Germanium dioxide	423.00	4.5% ad valorem	4.4% ad valorem	25% ad valorem.
Metal, unwrought and waste and scrap	628.25	do	do	Do.
Metal, wrought	628.30	7.7% ad valorem	7.3% ad valorem	45% ad valorem.

WORLD REVIEW

During 1982, germanium was produced by Métallurgie Hoboken-Overpelt, Belgium; Société Minière et Métallurgique de Peñarroya, France; Societá Mineraria e Metallurgica di Pertusola S.A., Italy; Bleibergerbergwerksunion AG, Austria; and Preussag AG, Federal Republic of Germany. Germanium refineries were also located in Japan, the U.S.S.R., and China.

TECHNOLOGY

Musto Explorations Ltd., Vancouver, British Columbia, Canada, announced that it had arranged for Hazen Research, Inc., Golden, Colo., to develop a new process technology for the recovery of gallium and germanium from a depleted copper mine near St. George, Utah. The hydrometallurgical process was being run on a pilot scale of 50 pounds of feed per hour. If successful, this would be the only such operation in the world. The Utah site was estimated to have more than 200,000 tons of ore containing about 0.05% germanium and 0.025% gallium.[11]

INDIUM[12]

Indium was produced by four firms: Indium Corp. of America, Utica, N.Y.; NJZ Alloys, Inc., Palmerton, Pa., a joint venture of The New Jersey Zinc Co. and Indium Corp.; Williams Strategic Metals Inc., Wheat Ridge, Colo.; and The Arconium Corp., Providence, R.I., which started operations in 1982. Both NJZ and Williams sent their indium product to Indium Corp. for further refining and marketing. Asarco, a company with a long history of indium production, continued to keep its indium facility idle. Domestic production declined as imports gained market share. The Bureau of Mines does not publish domestic production data on indium. Small quantities of secondary indium were available from specialty metal recycling firms.

CONSUMPTION AND USES

Indium consumption remained about the same as that of 1981. Usage in the fusible alloys category increased as a lower indium price made it more cost-effective in that application versus competitive materials. Usage for nuclear control rods remained low. Research studies continued on several new uses, especially for solar cells. Estimated consumption patterns for indium metal were electrical and electronic components, 40%; solders, alloys, and coatings, 40%; and research and other uses, 20%.

PRICES

The price of indium declined steadily during 1982. The price was $5.90 per troy ounce at the start of the year and was lowered in four stages to $2.60 per troy ounce by yearend. The price decreases were attributable to the need to meet competitive European pricing and a worldwide oversupply situation.

FOREIGN TRADE

Imports of indium rose significantly. Italy was the leading supplier, followed by Belgium-Luxembourg, Japan, and the United Kingdom. The 1982 value of indium imports, at $2.1 million, was lower than that of recent years, reflecting declining indium prices.

The duty on unwrought and waste and scrap indium (TSUS 628.45) during 1982 was 1.4% ad valorem for the most favored nations (MFN) and 25% ad valorem for non-MFN. The duty on wrought indium (TSUS 628.50) was 7.0% ad valorem for MFN and 45% ad valorem for non-MFN. For indium compounds (TSUS 423.96), the duty was 3.1% ad valorem for MFN and 25% ad valorem for non-MFN.

Table 12.—U.S. imports for consumption of indium, by country

(Thousand troy ounces and thousand dollars)

Country	1980		1981		1982	
	Quantity	Value	Quantity	Value	Quantity	Value
Unwrought and waste and scrap:						
Belgium-Luxembourg	148	2,349	91	579	141	452
Canada	36	690	14	159	14	124
China	--	--	5	30	--	--
France	--	--	59	307	83	226
Germany, Federal Republic of	3	50	(1)	8	--	--
Ireland	--	--	--	--	24	59
Italy	--	--	4	17	165	292
Japan	10	167	105	601	114	323
Netherlands	(1)	8	13	85	23	69
Peru	84	1,318	85	619	26	96
Switzerland	(1)	(1)	(1)	2	--	--
United Kingdom	14	404	65	580	95	486
Zaire	--	--	5	42	--	--
Total	295	4,986	446	3,029	685	2,127
Wrought:						
Canada	(1)	1	--	--	--	--
Germany, Federal Republic of	--	--	(1)	3	--	--
Ireland	--	--	(1)	2	--	--
Japan	--	--	1	7	(1)	2
Netherlands	(1)	4	--	--	--	--
Peru	4	80	10	60	--	--
United Kingdom	(1)	32	4	51	1	57
Total	4	117	15	123	1	59

[1]Less than 1/2 unit.

WORLD REVIEW

In response to declining indium prices, world production decreased. For many years, Peru has been one of the world's leading mine-source producers of indium metal. In Peru, indium was obtained as a byproduct from zinc concentrates at the Paragsha concentrator, located at Cerro de Pasco, and owned by the Government-controlled Empresa Minera del Centro del Perú S.A. (CENTROMÍN PERÚ). In 1982, indium averaged about 0.03% of these concentrates and total indium output was about 120,000 troy ounces. Peru exported most of its indium to Europe.

SELENIUM[13]

Despite an improved supply-demand relationship due to an increase in apparent consumption and a decline in domestic production, there was an oversupply of selenium in 1982 and domestic prices continued to drop.

Domestic Data Coverage.—Domestic production data for selenium are developed by the Bureau of Mines from a voluntary survey of U.S. operations. The three domestic refiners of selenium responded to a survey of their stocks, primary production and shipments of selenium, representing 100% of the values shown in table 13.

Table 13.—Salient selenium statistics

(Pounds of contained selenium unless otherwise specified)

	1978	1979	1980	1981	1982
United States:					
Production, primary	508,636	587,118	310,588	555,454	535,714
Shipments to consumers	324,378	467,338	310,764	458,240	678,165
Imports for consumption	799,853	683,903	625,472	686,887	765,731
Exports, metal, waste and scrap	227,449	333,282	180,269	133,430	258,530
Apparent consumption	896,782	817,959	755,967	1,011,697	1,185,365
Stocks, yearend, producer	507,377	627,157	626,981	644,980	560,437
Producers' price, average per pound, commercial and high-purity grades	$15.00-$18.00	$13.65-$15.31	$10.95-$12.66	[1]$4.38	$3.53
World: Refinery production	[r]3,180,420	[r]3,571,783	2,800,893	[p]2,870,880	[e]2,684,422

[e]Estimated. [p]Preliminary. [r]Revised.

[1]Represents average dealer price of commercial grade; other prices are average producer prices. In 1981, all producers ceased listing published prices.

Legislation and Government Programs.—The National Cancer Institute in Bethesda, Md., launched a chemoprevention program that will focus on interfering with the development of the latter stages of cancer. This marks a departure from the practice of studying cancer-causing substances. Research will concentrate on preventing cancer through dietary means using natural cancer inhibitors. The program development is based on studies that indicate that such nutrients as beta-carotene; selenium; vitamins A, C, and E; and other chemicals appear to act as cancer preventative agents. More than $2 million was diverted from other programs to finance studies of these natural cancer inhibitors.

DOMESTIC PRODUCTION

The majority of primary selenium was recovered from anode slimes generated in the electrolytic refining of copper. Selenium also was believed to have been recovered from lead slimes and nonferrous flue dusts. During 1982, primary selenium was recovered from both domestic and imported materials at three U.S. copper refineries: AMAX Copper Inc., at Carteret, N.J.; Asarco at Amarillo, Tex.; and Kennecott Minerals Co., at Magna, Utah. The Anaconda Copper Co. shipped selenium-containing materials to these refineries. Phelps Dodge Refining Corp. discontinued shipping anode slimes to these refineries during 1982. High-purity selenium metal and various selenium compounds were produced from commercial-grade metal by the three copper refineries and other processors.

Production of secondary selenium from scrap xerographic materials and used selenium rectifiers by two U.S. companies was discontinued during 1982. Scrap xerographic materials containing selenium were shipped to Canada and the United Kingdom for processing to recover the selenium.

CONSUMPTION AND USES

For the second consecutive year, consumption of selenium exceeded 1 million pounds. Consumption in 1982 was at the highest level since 1974, a peak year. The increase in demand for selenium in xerography offset the reduced consumption by pigment and metallurgical industries. Apparent consumption of selenium was calculated by adding selenium shipments to imports and subtracting exports. Estimated selenium consumption by end-use categories in 1982 was electronic and photocopier components, 35%; glass manufacturing, 30%; chemical and pigments, 25%; and other, 10%.

Selenium and selenium alloys were the predominant photoreceptors used in the electrophotographic industry. Based on a survey taken over the past 3 years, the number of copiers using selenium has grown substantially, whereas use of other types of photoreceptors remained unchanged during that period. Of the 104 plain paper copiers surveyed in 1981, 70% used selenium-based photoreceptors, compared with only 55% in 1979.[14]

STOCKS

U.S. producer stocks of refined selenium decreased in 1982 to the lowest level since 1978. At the 1982 rate of apparent consumption, end of year stocks represented less than a 6-month supply of selenium. Stocks included granular selenium, a semirefined form of selenium.

PRICES AND GRADES

Selenium was sold as a standard commercial-grade powder containing 99.5% selenium or as a high-purity powder containing 99.99% selenium or better. Commercial-grade material (99.1% to 99.5%) also was sold in the form of sticks, pellets, or shot for metallurgical applications. Pigment specifications required a 99.9% minimum purity. Other forms of selenium available included selenium dioxide, ferroselenium, sodium selenite, and sodium selenate.

Producers stopped listing published prices of selenium in January 1981 and quoted prices on a daily basis during 1982. Dealer prices for commercial-grade material declined from $3.55 to $4.00 per pound at the beginning of January to $3.25 to $3.50 per pound in December. Prices have continued to decline since 1975-76 when the average producer price was $18.00 per pound for commercial-grade material.

FOREIGN TRADE

Exports of selenium almost doubled in 1982 to the highest level since 1979, when exports reached a peak of 333,000 pounds. Exports to the United Kingdom, the largest recipient of selenium materials, increased markedly accounting for most of the increased exports. Much of the selenium exported to the United Kingdom was scrap material.

Imports of selenium increased in 1982 for the second consecutive year. Although Canada continued to be the largest supplier of imported selenium metal, imports from that country dropped by over 30%. Both the United Kingdom and Japan greatly increased their share in the domestic market, imports of selenium from these countries having increased from 1981 levels by 160% and 150%, respectively. Approximately 170,000 pounds of imported material, primarily from the United Kingdom and Canada, were refined from scrap, at least some of which was exported to those countries from the United States.

Table 14.—U.S. exports of selenium metal, waste and scrap in 1982, by country

Country	Quantity (pounds of contained selenium)	Value
Australia	2,090	$9,447
Brazil	210	4,392
Canada	2,052	11,297
Colombia	13,341	32,568
Germany, Federal Republic of	127	920
Guatemala	175	1,432
India	765	1,050
Jamaica	167	864
Japan	7,141	14,460
Mexico	16,899	69,414
Netherlands	25,932	96,330
Philippines	2,400	11,240
Portugal	1,100	4,260
South Africa, Republic of	2,000	7,275
Spain	2,204	8,440
Sweden	21,257	28,964
Taiwan	1,850	6,400
United Kingdom	158,820	440,026
Total	258,530	748,779

Table 15.—U.S. imports for consumption of selenium in 1982, by country

Country	Quantity (pounds of contained selenium)	Value
Unwrought and waste and scrap:		
Belgium-Luxembourg	50,033	$734,421
Canada	257,148	3,249,826
Chile	46,296	174,076
France	62	2,178
Germany, Federal Republic of	35,241	332,135
Hong Kong	350	6,545
Japan	118,674	1,177,806
Peru	21,625	73,204
Sweden	13,608	296,600
United Kingdom	159,501	1,151,788
Yugoslavia	11,023	24,976
Total	713,561	7,223,555
Selenium dioxide:		
Germany, Federal Republic of	14,591	109,360
Sweden	547	17,515
Total	15,138	126,875
Selenium salts:		
Japan	629	44,295
Korea, Republic of	2,226	2,150
United Kingdom	882	22,393
Total	3,737	68,838
Sodium selenite:		
Canada	8,775	78,482
France	507	4,651
Germany, Federal Republic of	8,432	49,458
Italy	3,448	34,332
Switzerland	252	2,774
United Kingdom	9,026	89,000
Total	30,440	258,697
Other selenium compounds:		
Japan	1	349
Spain	2,094	15,197
United Kingdom	760	17,461
Total	2,855	33,007
Grand total	765,731	7,710,972

Table 16.—U.S. import duties for selenium

Item	TSUS No.	Most favored nation (MFN)			Non-MFN
		Jan. 1, 1982	Jan. 1, 1983	Jan. 1, 1987	Jan. 1, 1983
Selenium metal	632.40	Free	Free	Free	Free.
Selenium dioxide and salts	420.50, 420.52	do	do	do	Do.
Sodium selenite and other selenium compounds	421.625, 420.54	4.5% ad valorem.	4.4% ad valorem.	3.7% ad valorem.	25% ad valorem.

WORLD REVIEW

World production of selenium in 1982 declined, primarily because of lower refined copper production in Canada. Estimated world selenium consumption remained unchanged in 1982.

On May 2, workers at Noranda Mines Ltd.'s Canadian Copper Refiners Div. rejected company offers and began a strike that lasted for 17 weeks. Canadian Copper Refiners operated Canada's largest selenium recovery plant, at Montreal East, Quebec. The refinery had an estimated capacity of 480,000 tons per year of copper and 350 tons per year of selenium. As a result of the strike, Noranda suspended shipments from the refinery until October 16.

Table 17.—Selenium: World refinery production, by country[1]

(Pounds of contained selenium)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Belgium[e]	130,000	130,000	130,000	130,000	130,000
Canada[3]	865,924	[r]1,128,111	831,591	771,639	[4]602,578
Chile	[r]66,335	[r]85,870	37,699	74,219	77,000
Finland	37,104	38,671	38,030	42,818	42,000
Japan	[r]1,059,521	[r]1,124,588	1,039,062	943,756	[4]904,974
Mexico	176,369	165,346	101,413	26,455	[4]63,934
Peru	28,499	40,389	50,503	49,555	50,000
Sweden	123,459	[r]125,663	112,436	[e]150,000	150,000
United States	[r]508,636	[r]587,118	310,588	555,454	[4]535,714
Yugoslavia	116,492	101,979	99,517	78,484	77,000
Zambia	68,081	44,048	50,054	[e]48,500	[4]51,222
Total	[r]3,180,420	[r]3,571,783	2,800,893	2,870,880	2,684,422

[e]Estimated. [p]Preliminary. [r]Revised.

[1]Insofar as possible, data relate to refinery output only; thus, countries that produce selenium contained in copper ores, copper concentrates, blister copper, and/or refinery residues, but do not recover refined selenium from these materials indigenously, are excluded to avoid double counting. Table includes data available through June 1, 1983.

[2]In addition to the countries listed, Australia, the Federal Republic of Germany, and the U.S.S.R. produce refined selenium, but output is not reported, and available information is inadequate for formulation of reliable estimates of output levels. Australia is known to produce selenium in intermediate metallurgical products (Peko Wallsend Ltd. at Juno and Warrego Mines, Tennant Creek) and has facilities to produce elemental selenium (Port Kembla refinery of the Electrolytic Refining and Smelting Co. of Australia Pty. Ltd.); output by Peko Wallsend is not reported in order to avoid double counting and output, if any, by the Port Kembla refinery is unreported.

[3]Refinery output from all sources, including imported materials and secondary sources.

[4]Reported figure.

TECHNOLOGY

Boeing Engineering and Construction Co., with Reading and Bates Corp., jointly undertook a solar cell development project at Boeing's laboratories in Bellevue, Wash. The jointly formed company, Solar Voltaic Co., is looking into commerical development of 2- by 4-foot solar cells with an estimated 15 volts and 50 to 60 watts of power output.[15]

A new photographic film, XDM, developed at the Xerox Research Center of Canada, uses a monolayer of closely packed, submicrometer selenium spheres to produce a visible image. The new film reportedly was dry, produced the finished image almost instantaneously, had high resolution, was more sensitive than other dry films, and had a long shelf- and image-life. The film was reported to be potentially inexpensive because it does not contain silver. The new film was expected to have applications in graphic arts, microfilming, and digital information recording.[16]

To cope with the problem of selenium deficiency diseases in farm livestock, Canadian researchers were studying the application of selenium to soil and foliage as alternatives to either Se-vitamin E injections or the addition of selenium to grain rations. The new techniques would benefit cattle and sheep, which rely mainly on pasture or stored forage, and may be fed with little or no grain.[17]

TELLURIUM[18]

In 1982, production of tellurium declined following the downturn in domestic copper refinery production. Apparent consumption decreased to a record low value.

Domestic Data Coverage.—Domestic tellurium refinery production data was obtained from the two domestic producers on a voluntary survey form. The figures have been withheld to avoid disclosing company proprietary data.

Table 18.—Salient tellurium statistics[1] in the United States

(Pounds of contained tellurium unless otherwise specified)

	1978	1979	1980	1981	1982
Refinery production	W	W	W	W	W
Shipments to consumers	W	W	W	W	W
Imports for consumption	173,989	167,760	64,860	83,671	36,600
Apparent consumption	402,232	494,010	177,880	r187,837	101,353
Stocks, yearend, producer	W	W	W	W	W
Producers' price, average per pound, commercial grade	$20.00	$20.00	$19.77	[2]NA	[2]NA

rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]World refinery production for selected countries given in table 21.
[2]The published list price of tellurium was suspended Jan. 5, 1981.

DOMESTIC PRODUCTION

Commercial-grade tellurium metal, recovered from copper anode slimes as a byproduct of electrolytic copper refining, was produced by Asarco at Amarillo, Tex. A limited amount of tellurium dioxide was produced by AMAX Copper at its Carteret, N.J., copper refinery, but by yearend the company had discontinued production. In the past, Phelps Dodge Refining shipped tellurium-containing materials to AMAX Copper for processing. High-purity tellurium, tellurium master alloys, and tellurium compounds were produced by primary and intermediate processors from commercial-grade metal and tellurium dioxide.

CONSUMPTION AND USES

Apparent consumption of tellurium was at a record low level in 1982. Tellurium's primary use is as an alloying material in the production of free-machining steels. The addition of up to 0.1% tellurium, usually in the form of stick metal, improves the machinability of steels. Similarly, the addition of tellurium improves the machining characteristics and corrosion resistance of copper alloys. The decline in tellurium consumption for the third consecutive year was attributed to the depressed automobile and construction industries, together with an increase in the substitution of bismuth for tellurium in free-machining steels.

Owing to the selectivity of tellurium catalysts, the favorable yields of desired products, and resistance to poisoning, tellurium catalysts have found application in various oxidation, hydrogenation and halogenation reactions. However, the use of tellurium catalysts was greatly reduced with the closure of the Oxirane Corp.'s ethylene glycol plant in 1979.

Tellurium consumption by end use in 1982 was estimated, as follows: iron and steel products, 55%; nonferrous metals, 22%; chemicals, 15%; and other uses, including rubber manufacturing and xerography, 8%.

PRICES AND GRADES

Producers discontinued listing prices of tellurium on January 5, 1981, and began quoting prices to customers on a daily basis. In the beginning of 1982, prices for commercial-grade tellurium were quoted at $12 to $14 per pound. By yearend, prices had dropped to $10 to $12 per pound. Commercial grades of tellurium metal, containing a minimum of 99% or 99.5% tellurium, are marketed as minus 200-mesh powder, 1-pound ingots, or 5-pound slabs. Tellurium dioxide is sold in the form of minus 40-mesh to minus 200-mesh powder containing a minimum of 75% tellurium.

FOREIGN TRADE

Data on tellurium exports were not available. Imports of tellurium in 1982 declined by over 50% compared with those of 1981, to the lowest level since 1971. Canada and the United Kingdom were the leading suppliers of imports. Peru, which was the second largest source for imports in 1981, supplied no tellurium in 1982. U.S. import duties for tellurium in 1982 are shown, with scheduled changes, in table 20.

Table 19.—U.S. imports for consumption of tellurium in 1982, by country

Country	Quantity (pounds of contained tellurium)	Value
Unwrought and waste and scrap:		
Belgium	161	$6,331
Canada	20,587	662,381
Germany, Federal Republic of	79	6,154
Japan	1,543	41,300
U.S.S.R	100	1,074
United Kingdom	13,278	164,284
Total	35,748	881,524
Compounds:		
Canada	559	7,327
Germany, Federal Republic of	11	1,078
Japan	177	3,194
United Kingdom	105	12,807
Total	852	24,406
Grand total	36,600	905,930

Table 20.—U.S. import duties for tellurium

Item	TSUS No.	Most favored nation (MFN)			Non-MFN
		Jan. 1, 1982	Jan. 1, 1983	Jan. 1, 1987	Jan. 1, 1983
Tellurium metal	632.48	2.5% ad valorem.	2.0% ad valorem.	Free	25% ad valorem.
Compounds	421.90	4.5% ad valorem.	4.4% ad valorem.	3.7% ad valorem.	Do.

WORLD REVIEW

Owing to reduced copper refinery production, a strike at one of the major tellurium producers, and a decline in consumption, world refinery production of tellurium decreased markedly.

Belgium.—As part of a large capital investment in new plants and equipment, Métallurgie Hoboken-Overpelt invested in new facilities for treating lead refinery wastes to recover byproduct tellurium and indium. Processing of wastes was expected to begin in 1983.[19]

Canada.—A 17-week strike, beginning on May 2, 1982, curtailed production of tellurium at Noranda's Canadian Copper Refiners. Noranda was by far the larger of the two Canadian tellurium producers. Tellurium was recovered from copper anode slimes containing about 2% tellurium in the form of insoluble tellurides.

Table 21.—Tellurium: World refinery production, by country[1]

(Pounds of contained tellurium)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Canada[3]	99,867	104,067	19,784	46,952	[4]34,577
Fiji	[e]50,000	[e]50,000	25,022	--	--
India[5]	--	--	440	485	500
Japan	[r]151,237	[r]122,356	151,457	136,025	132,300
Peru	[r]33,989	[r]46,811	46,121	46,980	[4]45,693
United States	W	W	W	W	W

[e]Estimated. [p]Preliminary. [r]Revised. W Withheld to avoid disclosing company proprietary data.

[1]Insofar as possible, data relate to refinery output only; thus, countries that produce tellurium contained in copper ores, copper concentrates, blister copper, and/or refinery residues, but do not recover refined tellurium, are excluded to avoid double counting. Table is not totaled because of the exclusion of data from major world producers, notably the U.S.S.R. and the United States. Table includes data available through June 1, 1983.

[2]In addition to the countries listed, Australia, Belgium, the Federal Republic of Germany, and the U.S.S.R. are known to produce refined tellurium, but output is not reported, and available information is inadequate for formulation of reliable estimates of output levels. Moreover, other major copper-refining nations such as Chile, Zaire, and Zambia may produce refined tellurium, but output in these nations is conjectural.

[3]Refinery output from all sources, including imports and secondary sources.

[4]Reported figure.

[5]Pilot plant production.

TECHNOLOGY

Selenium-tellurium alloys have found increasing use as photoreceptors in electrophotographic devices. In a recent survey of plain paper copiers, 70% used selenium or selenium alloy photoreceptors and 59% of these used selenium-tellurium alloys. These alloys were increasing in usage because they reportedly exhibited the ideal properties of a photoreceptor; long life, high photospeed, wide spectral response, low fatigue, and low copy cost. Selenium-tellurium alloys used in photoreceptors are reportedly 50% harder than pure selenium, and have greater light and spectral sensitivity. The latter property of selenium-tellurium photoreceptors provides for better reproduction of blue subjects than do pure selenium photoreceptors.[20]

THALLIUM[21]

Historically, the commercial source for the production of thallium has been flue dusts and residues from the smelting of certain zinc ores. However, during 1982 no domestic operations recovered thallium.

Domestic Data Coverage.—Domestic production data for thallium are developed by the Bureau of Mines from a voluntary survey of U.S. operations, but no domestic producers were in operation in 1982.

CONSUMPTION AND USES

The uses of thallium included electronic components, gamma radiation detection equipment, additives for changing the refractive index and density of glass, low-temperature mercury switches, photosensitive devices, and radioactive isotopes for cardiovascular diagnostic procedures. Future domestic requirements for thallium were expected to be met by imports and withdrawals from stocks.

PRICES

Metal traders reported that the price of imported thallium metal ranged from $35 to $45 per pound depending on the purity of the metal.

WORLD REVIEW

World production data for thallium were not available. The U.S. reserves in zinc ores were estimated at 75,000 pounds. Rest-of-world reserves were estimated to be 725,000 pounds of thallium.

[1]Prepared by Daniel Edelstein, physical scientist.

[2]Federal Register. Occupational Exposure to Inorganic Arsenic; Supplemental Statement of Reasons for Final Rule. V. 48, No. 10, Jan. 14, 1983, pp. 1864-1903.

[3]Lederer, W. H., and R. J. Fensterheim (ed.). Arsenic—Industrial, Biomedical, Environmental Perspectives. Van Nostrand Reinhold Co. Inc., New York, 1983, pp. 72-88.

[4]Pages 99-107 of work cited in footnote 3.

[5]Engineering and Mining Journal. Cominco's New Arsenic Trioxide Plant Soon to go On Stream in Yellowknife. November 1982, pp. 39, 43.

[6]Pages 10-15 of work cited in footnote 3.

[7]Madsen, B. W., H. Dolezal, and P. A. Bloom. Processing Arsenical Flue Dusts With Sulfur Dioxide and Sulfuric Acid to Produce Arsenic Trioxide. AIME Ann. Meeting, Chicago, Ill., Feb. 23-26, 1981, AIME-TMS Paper Selection A81-63, 12 pp.

[8]Work cited in footnote 5.

[9]Prepared by John A. Rathjen, mineral specialist.

[10]Prepared by Patricia A. Plunkert, physical scientist.

[11]Chemical Engineering. V. 89, No. 15, July 26, 1982, p. 9.

[12]Prepared by James F. Carlin, Jr., physical scientist.

[13]Prepared by Daniel Edelstein, physical scientist.

[14]Selenium-Tellurium Development Association, Inc. Recent Development in Photoreceptor Technology. Bull. 23, pp. 1-2.

[15]American Metal Market. Solar Cells for Utilities is Aim of Boeing Engineering R & D. V. 90, No. 249, Dec. 27, 1982, p. 27.

[16]Selenium-Tellurium Development Association, Inc. A New Type of Photographic Film. Bull. 22, p. 4.

[17]Pages 1-2 of work cited in footnote 16.

[18]Prepared by Daniel Edelstein, physical scientist.

[19]Metal Bulletin. Hoboken Upgrades Refining Plants. Feb. 25, 1983, p. 6.

[20]Pages 1-2 of work cited in footnote 2.

[21]Prepared by Patricia A. Plunkert, physical scientist.

Table 22.—U.S. imports for consumption of thallium in 1982, by country

Country	Compounds			Unwrought and waste and scrap	
	Gross weight (pounds)	Content[e] (pounds)	Value	Gross weight (pounds)	Value
Belgium-Luxembourg	418	334	$14,253	276	$7,285
Canada	--	--	--	3	1,318
Germany, Federal Republic of	923	739	50,451	457	15,617
Netherlands	4	3	255	--	--
Norway	--	--	--	660	9,926
United Kingdom	86	69	4,383	--	--
Total	1,431	1,145	69,342	1,396	34,146

[e]Estimated.

Table 23.—U.S. import duties for thallium

Item	TSUS No.	Most favored nation (MFN)		Non-MFN
		Jan. 1, 1982	Jan. 1, 1983	Jan. 1, 1982-Jan. 1, 1983
Unwrought metal	632.50	3.1% ad valorem	2.5% ad valorem	25% ad valorem.
Compounds	422.00	4.5% ad valorem	4.4% ad valorem	Do.

Other Nonmetals

By Staff, Division of Industrial Minerals

CONTENTS

ASPHALT (NATIVE)[1]

Native asphalt was produced in 1982 by five companies in two States, Texas and Utah. Bituminous limestone, used primarily as a paving material for street and road repair, was produced by White Uvalde Mines and by Azrock Industries, Inc., Uvalde County, Tex.

Historically, gilsonite, a solidified hydrocarbon found only in Utah and Colorado, had been mined by American Gilsonite Co. and by Ziegler Chemical and Mineral Corp. from properties near Bonanza, Uintah County, Utah. During 1982, Hydrocarbon Mining Co., a subsidiary of the Oberon Oil Co., entered into a joint venture with Miocene Resources Inc. of Novato, Calif., to form Hydrocarbon Resources Co. for the purpose of mining gilsonite about 50 miles south of Vernal, Uintah County, Utah. Under the agreement, Hydrocarbon Mining contributed gilsonite-bearing properties held by lease or sublease as well as mining equipment to the venture. The property contained leases totaling 760 acres with probable reserves of 268,000 tons of gilsonite. Miocene Resources provided the partnership with a minimum of $200,000 to develop two of the leases and were to be responsible for management of the mining operations.[2]

Gilsonite is used for a variety of purposes including automobile bodysealer, lightweight aggregate for cement used in oil well drilling, asphaltic building board, protective coverings, anticorrosive paints, roofing compounds, etc.[3]

Data on quantity and value of bituminous limestone produced are not available to the Bureau of Mines. Data on gilsonite production and value available to the Bureau of Mines are withheld to avoid disclosing company proprietary data.

GREENSAND[4]

Greensand (glauconite), a natural silicate of potassium, aluminum, iron, and magnesium, was produced in 1982 only by Inversand Co., a subsidiary of Hungerford and Terry, Inc., near Clayton, N.J. Production and sales information is withheld to avoid disclosing company proprietary data. Processed greensand was sold as a filter media for the removal of manganese and iron from drinking water supply systems. Washed and filtered greensand was resold by Zook and Ranck, Inc., as a soil conditioner and source of slowly released potash to organic farmers in North America.

IODINE[5]

Apparent consumption of domestic iodine decreased in quantity and value during 1982. The two established U.S. producers of crude iodine decreased production of iodine for sale on the domestic market. A new company began production of crude iodine in November. The General Services Administration (GSA) announced removal of the domestic restriction on sales of excess iodine from the National Defense Stockpile.

Domestic Data Coverage.—Domestic production data for iodine are developed by the Bureau of Mines from a voluntary survey of U.S. operations. Of the three operations to which a survey request was sent, 67% responded, representing an estimated 80% of the total production. Production for the remaining nonrespondent was estimated using reported prior year production levels adjusted by trends in employment and other guidelines.

Legislation and Government Programs.—The U.S. National Defense Stockpile contained 7,550,898 pounds of crude iodine in inventory at yearend. The stockpile goal remained at 5,800,000 pounds in 1982. In 1981, the U.S. Congress had authorized GSA to sell 2,213,000 pounds of the excess iodine for domestic use. In May 1982, GSA removed the domestic restriction clause. The authorization allowed the sale of 1 million pounds in fiscal years 1982-83, and 213,000 pounds in fiscal year 1984. During 1982, 445,000 pounds of stockpile-grade excess iodine was sold for $2,609,350. This included an award of 35,000 pounds that was bartered in accordance with the terms and conditions of the Memorandum of Agreement between the Government of the United States and the Government of Jamaica for the acquisition of bauxite.

As a result of human exposure to radioactive iodine at the Three Mile Island nuclear powerplant in March 1979, the Food and Drug Administration (FDA) recommended the use of potassium iodide to block thyroid absorption of harmful levels of iodine radioisotopes. Thirty-one of the 37 States with nuclear powerplants included the use of potassium iodide in emergency plans as a means of protecting emergency workers. Seven States decided to use potassium iodide in emergency plans for the general public. The State of Tennessee distributed potassium iodide to 4,000 families living near nuclear facilities. Potassium iodide deteriorates after 3 years and must be replaced; therefore, several companies have petitioned the FDA to allow the sale of potassium iodide as an over-the-counter drug.

The Environmental Protection Agency proposed exempting nearly one-half of the new chemicals developed each year from the premanufacturing review process because the agency considers them to be "low risk." Certain iodine compounds would be included in the following proposed exemption categories: Chemicals produced in volumes of 22,000 pounds per year or less; polymers the agency considers not likely to be absorbed into living tissue; and chemical intermediates used to produce other chemicals.[6]

DOMESTIC PRODUCTION

North American Brine Resources completed three miniplants in Kingfisher County, Okla., capable, when fully operational, of supplying 5% of domestic consumption. The plants are located at oilfield reinjection disposal sites. The brines, containing between 135 and 900 parts per million of iodine, are processed through charcoal absorbers before reinjection into the ground. North American is a joint venture among Beard Oil Co., 40%; Godoe USA, Inc., a wholly owned subsidiary of United Resources Industry Co., 50%; and Inorgchem Development Inc., a wholly owned subsidiary of Mitsui & Co. (USA), 10%.

The Dow Chemical Co. recovered iodine from mineral-rich brines as a byproduct of bromine and other salts such as sodium, magnesium, and calcium-magnesium compounds. Dow's iodine production was reported to have decreased.

Woodward Iodine Operations of Woodward, Okla., also decreased output. Woodward Iodine is a joint venture between Amoco Production Co., 49%, and PPG Industries, Inc., 51%. Iodine of greater than 99.9% purity was recovered by a conventional process with proprietary refinements from brine associated with natural gas. Production was less than the 2-million-pound-per-year design capacity.

CONSUMPTION AND USES

Establishing an accurate pattern of demand by end use is difficult because iodine is frequently converted into intermediate compounds and marketed as such before reaching its ultimate end use. The downstream uses of iodine in 1982 were estimated as animal feed supplements, catalysts, pharmaceuticals, sanitary and industrial disinfectants, stabilizers, inks and colorants, photographic equipment, and other uses. Other uses included the making of high-purity metals, motor fuels, iodized salt, smog inhibitors, and lubricants. Iodine also had application in cloud seeding and radiopaque diagnosis in medicine.

Iodine was used as a stabilizer in nylon cord and tall oil. During 1982, demand for nylon in carpeting and automotive tires decreased. U.S. producers of nylon filament provided approximately one-third of the world's nylon production. The tall oil industry experienced temporary shutdowns during 1982 as a result of decreased demand in the paper sizing industry.

Iodine in globaline tablets has been used for disinfecting small water supplies since World War II. In a 15-year study of a Florida prison community, no ill effects were observed on the users of iodine as a water disinfectant.[7] Iodoforms were used for disinfecting meat packing, dairy, and hospital operations.

Catalyst Research Corp., which held the original patents on lithium-iodine batteries, reported that approximately 90% of all implanted heart pacemakers were lithium-iodine powered; an estimated 1.5 million people had implants of lithium-iodine powered pacemakers. In 1982, four companies manufactured this system, Catalyst Research, Wilson Greatbatch Ltd., Cardiac Pacemakers, Inc., and Medtronic, Inc. The latter three were under license to Catalyst Research.[8]

Tennessee Eastman Co. planned to bring onstream a coal-to-methanol-to-acetic acid-to-acetic anhydride plant in Kingsport, Tenn. Similar plants were reportedly planned for Canada, Taiwan, and Yugoslavia. The process involves the Texaco coal gasification process to produce gaseous products and the Lurgi process to produce methanol from the gaseous products. RSA Corp. reported sales of a methyl iodide catalyst to produce the acetic acid from methanol.

Table 1.—Crude iodine consumed in the United States, by product

Product	1981			1982		
	Number of plants	Consumption: Thousand pounds	Consumption: Percent of total	Number of plants	Consumption: Thousand pounds	Consumption: Percent of total
Reported consumption:						
Resublimed iodine	9	697	13	4	117	3
Potassium iodide	8	931	17	5	987	19
Sodium iodide	5	691	13	4	215	4
Other inorganic compounds	10	1,163	21	9	1,136	22
Ethylenediamine dihydriodide	4	562	10	4	737	14
Organic compounds	17	1,421	26	14	1,990	38
Total	[1]32	[2]5,466	100	[1]28	5,182	100
Apparent consumption	XX	8,800	XX	XX	6,900	XX

XX Not applicable.
[1]Nonadditive total because some plants produce more than one product.
[2]Data do not add to total shown because of independent rounding.

PRICES

During 1982, listed U.S. iodine prices remained between $14 and $16 per kilogram. The discounted market prices were reported by industry sources to be $5.50 per pound at yearend. Custom values of iodine imported from Japan ranged from $5.96 to $6.58 per pound; the average price was $5.84 per pound. Custom values for iodine imported from Chile ranged from $6.12 to $6.21 per pound; the average price was $6.16 per pound. GSA sold iodine during 1982 from stockpile excesses for prices that ranged from $5.67 and $5.96 per pound.

The quoted yearend U.S. prices for iodine and its primary compounds were as follows:

	Per pound[1]
Iodine, crude, drums	$6.53-$7.26
Resublimed iodine, U.S.P., granular, 100-pound drums, works	12.16-12.94
Calcium iodate, drums, delivered	7.38
Calcium iodide, 35-pound drums, works	5.98
Iodoform, N.F., 300-pound drums, f.o.b. works	21.50-21.75
Potassium iodide, U.S.P., granular, crystals, drums, 1,000-pound lots, delivered	9.32- 9.54
Sodium iodide, U.S.P., crystals, 300- to 500-pound lots, drums, freight equalized	9.10-11.85

[1]Conditions of final preparation, transportation, quantities, and qualities not stated are subject to negotiation and/or somewhat different price quotations.

Source: Chemical Marketing Reporter, v. 222, No. 26, Dec. 27, 1982, pp. 24-33.

FOREIGN TRADE

The United States continued to be dependent on imports primarily from Japan and Chile to supplement domestic production. Imports of crude iodine decreased in 1982 as a result of decreased demand owing to the poor state of the economy. Table 2 details the imports for consumption of crude iodine by country.

In August, Chilean Nitrate Sales Corp., the U.S. subsidiary of Sociedad Química y Minera de Chile (SOQUIMICH) moved the corporate headquarters for industrial-grade nitrate and iodine from New York City to Norfolk, Va.

In November, Olin Corp., the sole U.S. producer of sodium nitrate, filed a complaint with the U.S. International Trade Commission to investigate dumping of sodium nitrate imports from Chile. SOQUIMICH operated two nitrate mines that are the sole Chilean producers of crude iodine. One-third of SOQUIMICH output of 700,000 tons per year of sodium nitrate is marketed in the United States. Production of nitrates, and therefore iodine as a coproduct, was expected to decrease if Chile is found guilty of selling nitrates below fair market value.

Table 2.—U.S. imports for consumption of crude iodine, by country

(Thousand pounds and thousand dollars)

Country	1980		1981		1982	
	Quantity	Value	Quantity	Value	Quantity	Value
Canada	--	--	68	291	2	8
Chile	1,124	5,669	1,014	6,239	793	4,887
Germany, Federal Republic of	(1)	(1)	--	--	--	--
Japan	5,062	22,894	4,929	29,153	3,931	22,800
Korea, Republic of	42	253	--	--	--	--
Mexico	--	--	--	--	2	14
New Zealand	--	--	88	548	--	--
United Kingdom	6	31	--	--	--	--
Total	6,234	[2]28,848	6,099	36,231	4,728	27,709

[1]Less than 1/2 unit.
[2]Data do not add to total shown because of independent rounding.

Source: U.S. Department of Commerce, Bureau of the Census.

WORLD REVIEW

Chile.—At the beginning of 1982, Chile published new rules for mineral exploration, development, and expropriation. The changes in the law included the following provisions: Exploration rights were extended to a maximum of 4 years; mining rights, except for hydrocarbons and strategic minerals, are available to anyone; the Government can explore or develop a deposit through a state-owned deposit; the owner of the mining rights also controls the water rights; and mineworkers are considered temporary workers.

Hungary.—During 1981, Hungary imported 75,000 pounds of crude iodine, 99% from the U.S.S.R., and 1% from Japan, for domestic consumption.

Japan.—In 1982, Japan accounted for approximately three-fifths of the world production of crude iodine and maintained its place as the world's largest producer. Production was estimated at 15.2 million pounds from a capacity of 19 million pounds. Five companies produced iodine from subsurface brines in 14 plants as a coproduct of natural gas production. Eighty percent of the iodine was produced in the Kanto Gasfield of Chiba, Tokyo, and Kanagawa Prefectures. Recoverable iodine reserves were estimated at 22 billion pounds, located primarily in the Kazusa Group of late Pliocene to middle Pleistocene Age.

Nippon Natural Gas Industry Co. used a sloping fluidized bed process (SFB) to recover iodine from brine associated with natural gas wells. Nippon operated five SFB adsorption towers during 1982 at Yokoshib, Koji, and Saginuma. The iodine content was between 55.0 and 93.5 milligrams per liter. Four of the plants were situated in the Kujiukuri Gasfield and produced from the Kiwada and Otadai Formations. Another plant was located in the Umegase and Otadai Formations of the Saginuma Gasfield.

United Kingdom.—In 1982, the British Government announced plans to sell Amersham International Ltd. to the public by the fall of 1983. Amersham manufactures 2,500 types of radioactive chemicals and supplies 25% of the world market for radioactive isotopes. Iodine 131 and 125 are major isotopes produced for use in diagnostic medicine.[9]

The Royal Society of Chemists, under their Effect of Chemicals Assessment Program, began a study on the effects of iodomethane on industrial chemists in the United Kingdom. The study started in 1979 when 20% of the chemists surveyed indicated exposure to iodomethane. Followup surveys were conducted in 1980 and 1982. The study will provide valuable epidemiological information on the effects of dangerous chemicals on humans.[10]

Table 3.—Crude iodine: World production, by country[1]

(Thousand pounds)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Chile	4,237	5,313	5,734	5,926	5,700
China[e]	1,000	1,000	1,000	1,000	1,000
Indonesia	15	55	64	53	55
Japan	13,228	13,779	14,332	15,137	15,200
U.S.S.R.[e]	4,400	4,400	4,400	4,400	4,000
United States	W	W	W	W	W
Total	22,880	24,547	25,530	26,516	25,955

[e]Estimated. [p]Preliminary. W Withheld to avoid disclosing company proprietary data.

[1]Table includes data available through June 25, 1983.

[2]In addition to the countries listed, the Federal Republic of Germany is known to have produced elemental iodine in 1976 and may have continued to do so during 1978-80, but output is not officially reported, and available information is inadequate for formulations of reliable estimates of output levels. New Zealand also produces elemental iodine, but production data are not available.

TECHNOLOGY

A disadvantage for computers of the complementary metal-oxide semiconductor-random access memories (CMOS-RAM) is memory loss during power fluctuations or outages. A long-life, reliable, backup power source is the lithium-iodine battery designed for printed circuit boards. The cell consists of a thin disk of lithium metal joined to a pelletized cathode in a sealed case containing iodine and organic material to make the iodine conductive. A battery of this type was used in the space shuttle Columbia.[11]

A new medical diagnostic tool is based on activated iodine-based crystals that scintillate, or give off tiny flashes of light, when exposed to radiation. By recording the scintillation of thallium-activated sodium iodide crystals, changes in blood flow through the brain can be tracked. Harshaw Chemical Co. introduced multiprobe analysis, a regional cerebral blood flow analysis system that measures changes in blood flow through the brain. After a radioactive gas is administered to the patient by inhalation, the sodium iodide scintillators are converted to electrical signals and transmitted to a computer. A detailed computer picture, or printout, of the brain's condition is more reliable than X-rays as a physician's aid in diagnosing brain tumors, strokes, and abcesses.[12]

A pure thermochemical cycle, which could be used as an energy source, used iodine, water, and sulfur dioxide to produce iodine and hydrogen. Heat derived from nuclear high-temperature gas reactors, fusion reactors, or central receiving solar facilities could drive the reaction.[13]

Studies funded by the University of California and the U.S. Department of Energy proposed that the high-level radioactive waste of "spent" fuel discharged from commercial nuclear power reactors be reprocessed into a solidified mixture of most of the radioactive components. However, iodine 129, a fission product, requires separate recovery of its lengthy half-life of 1.7 by 10^7 years and a storage time of 104 to 107 years.[14]

MEERSCHAUM[15]

Imports of crude or block meerschaum in 1982, 87% from Somalia and the balance from the United Kingdom, totaled 10,176 pounds with a customs declared value of $39,848. The unit value, $11.53, of the British imports was over four times greater than that of the Somalian material, $2.81. The imports from the United Kingdom probably consisted of shaped or formed meerschaum blocks. No crude or block meerschaum was imported in 1981. The Federal Republic of Germany had been the previous major supplier to the United States. Crude or block meerschaum was mined chiefly in Somalia, Tanzania, and Turkey. Turkish production in 1981 was 352 unit boxes, 44 pounds each, of block meerschaum.

Although Turkey has been a major producer of crude or block meerschaum, state laws have prohibited exports of uncarved material since 1975. The block material was used by companies in New York and Ohio for manufacturing of smokers' pipes.

QUARTZ CRYSTAL[16]

Estimated 1982 production of natural quartz crystal increased 14%, whereas reported production of cultured quartz crystal decreased 28%. Consumption of both natural and cultured electronic- and/or optical-grade quartz crystal decreased significantly in 1982. Exports of natural quartz declined sharply while exports of cultured quartz decreased only slightly in 1982. Imports of natural quartz crystal increased slightly.

Domestic Data Coverage.—Domestic production and consumption data for quartz crystal are developed by the Bureau of Mines by means of a voluntary survey of U.S. operations. Of the seven operations canvassed for production of cultured quartz, 100% responded, representing the total production shown in table 4. Of the 32 operations that consumed quartz crystal, 27 responded, representing 97% of total consumption, also shown in table 4. For the nonrespondents, data were estimated using prior year reported figures adjusted to 1982 trends from other reported producers and consumers.

Legislation and Government Programs.—At yearend 1982, the National Defense Stockpile total inventory of natural electronic-grade quartz crystal was 2.1 million pounds, of which 1.47 million pounds of stockpile-grade quartz crystal was excess to the stockpile goal. Total 1982 sales of natural quartz crystal by the GSA were 16,000 pounds.

Table 4.—Salient electronic- and optical-grade quartz crystal statistics in the United States

(Thousand pounds and thousand dollars)

	1978	1979	1980	1981	1982
Production:					
Mine[1]	317	314	e400	e175	e200
Cultured quartz	329	575	757	660	478
Exports:					
Natural:					
Quantity	NA	NA	91	127	69
Value	NA	NA	$366	$490	$380
Cultured:					
Quantity	NA	NA	219	125	115
Value	NA	NA	$3,209	$4,600	$3,500
Total:					
Quantity	NA	NA	310	252	184
Value	NA	NA	$3,575	$5,090	$3,880
Imports of natural quartz crystal:[2]					
Quantity	165	428	816	389	417
Value	$459	$216	$402	$233	$245
Consumption of quartz crystal	NA	NA	r895	r765	585
Natural (electronic and optical grade)	24	15	17	14	16
Cultured (lumbered)	NA	NA	393	282	99
Cultured (as grown)	237	269	485	469	470

eEstimated. rRevised. NA Not available.
[1]Includes lasca and some specimen and jewelry material.
[2]Includes electronic grade, optical grade, and lasca (a feedstock for growing cultured quartz).

DOMESTIC PRODUCTION

In 1982, various grades of natural quartz were produced in Arkansas by Coleman Crystal, Inc., at Jessieville, and by Ocus Stanley and Son, and Burrows Mining Co. both at Mount Ida. Estimated total production of natural quartz increased 14% from the 1981 estimate.

In 1982, U.S. production of cultured quartz crystal for use in the quartz-cutting industry decreased 28% compared with that of 1981. Seven companies produced cultured quartz in five States: Motorola, Inc., Chicago, Ill.; Electro Dynamics Corp. and Thermo Dynamics Corp., both in Shawnee-Mission, Kans.; Western Electric Co., Inc., North Andover, Mass.; Sawyer Research Products, Inc., Eastlake, Ohio; Bliley Electric Co., Erie, Pa.; and P. R. Hoffman Co., Carlisle, Pa.

CONSUMPTION AND USES

U.S. consumption of lasca (a grade of nonelectric natural quartz primarily used as a feedstock for growing cultured quartz crystal) by seven crystal growers was 533,000 pounds, a 37% decrease from 852,000 pounds reported in 1981.

In 1982, 32 companies in 11 States consumed quartz crystal. Of the 1982 total, 26 companies consumed only cultured quartz crystal, 2 consumed only natural quartz crystal, and 4 consumed both natural and cultured material.

Reported total consumption of both natural and cultured electronic- and/or optical-grade quartz in 1982 was approximately 24% less than the total consumption in 1981. Natural quartz consumption increased 14%. Lumbered-cultured quartz crystal consumption declined 65% from the 1981 level, whereas as grown cultured crystal consumption remained essentially unchanged.

STOCKS

Reported industry cultured and natural electronic- and optical-grade stocks of quartz crystal totaled approximately 122,000 pounds at yearend 1982. This total included 48,000 pounds of natural and 74,000 pounds of cultured crystal. Compared with yearend 1981 stocks, natural quartz crystal stocks decreased by 13,000 pounds, and cultured quartz stocks increased by 10,000 pounds.

PRICES

The average reported value of lasca consumed for production of cultured quartz crystal in 1982 was $0.64 per pound, 3 cents per pound above that of 1981. The average value for cultured quartz crystal, based on reported sales of 157,681 pounds in 1982, was $44.34 per pound, up $1.00 per pound from that of 1981, which had total sales of 199,297 pounds. Of the total sales, the value of as grown crystal was $30.02 per pound in 1982, compared with $38.15 per pound in 1981, and that for lumbered crystal was $45.94 per pound in 1982 compared with $44.68 in 1981.

FOREIGN TRADE

U.S. exports of cultured electronic- and/or optical-grade quartz crystal decreased 8% from those of 1981. The unitized U.S. Customs value of 1982 exports was $30.43 per pound. The Federal Republic of Germany and Japan remained the principal importers of high-quality U.S. cultured quartz crystal, receiving 102,000 and 46,000 pounds, respectively.

U.S. exports of natural electronic- and/or optical-grade quartz crystal decreased approximately 46% compared with those of 1981. The unitized U.S. Customs value of 1982 exports was $5.51 per pound. Leading countries receiving natural electronic-grade crystal were, in descending order, Switzerland, the Republic of Korea, Hong Kong, and the Federal Republic of Germany. Approximately 881,000 pounds of lower grade quartz crystal with an average U.S. Customs value of $3.17 per pound was also exported in 1982 under the classification of natural quartz crystal.

In 1982, U.S. imports of natural quartz, all designated as "Crude Brazilian Pebble," increased 7%. The unitized U.S. Customs value of these imports was $0.59 per pound.

STAUROLITE[17]

Staurolite is a naturally occurring, complex, hydrated aluminosilicate of iron having a variable but uncertain composition. Its formula can be generalized as $Fe_2Al_9Si_4O_{22}(OH)_2$. The mineral most commonly occurs as opaque reddish-brown to black crystals with specific gravity ranging from 3.74 to 3.83 and Mohs' hardness between 7 and 8.

A limited rock-shop trade in cruciform twinned staurolite crystals ("fairy crosses") exists, notably from deposits in Georgia, North Carolina, and Virginia. Staurolite in the United States was produced commercially in 1982 by E. I. du Pont de Nemours & Co. and by Associated Minerals (U.S.A.) Ltd., Inc.

Staurolite is a byproduct of heavy-mineral concentrates recovered from a glacial-age beach sand in Clay County, north-central Florida. The staurolite is removed by means of electrical and magnetic separation after the concentrates have been scrubbed and chemically washed with caustic, rinsed, and dried. The resulting fraction produced is comprised of about 77% clean, rounded, and uniformly sized grains of staurolite, with minor proportions of tourmaline, ilmenite and other titanium minerals, kyanite, zircon, and quartz. A nominal composition of this staurolite sand is 45% Al_2O_3 (minimum), 18% Fe_2O_3 (maximum), 3% ZrO_2 (maximum), 5% TiO_2 (maximum), and 5% SiO_2.

Although originally marketed only as an ingredient in some portland cement formulations, staurolite is now marketed as a specialty sand under the trade name Biasill for use as a molding material in iron and nonferrous foundries, owing to its low thermal expansion, high thermal conductivity, and high melting point. It is also used as an abrasive for impact finishing metals and sandblasting buildings under the trade names Starblast (80 mesh) and Biasill (90 mesh), as well as a coarse grade (55 mesh).

Quantitative production data are not released for publication, but the 1982 production of staurolite decreased 22% from that of 1981; shipments decreased 6% in tonnage and increased 26% in price per ton from that of 1981. Domestic productive capacity remained at about 135,000 tons per year, and there were no plans to increase capacity. However, an improvement in the proportion recovered was considered to be possible.

Staurolite has been produced in India in small quantities and sometimes by other nations as well.

STRONTIUM[18]

The United States continued as the world's largest producer of strontium compounds, although strontium minerals have not been mined domestically since 1959. Japan was the second largest producer of strontium compounds. Based on preliminary production estimates, Spain overtook Mexico for the first time as the largest producer of strontium minerals. Domestic consumption of primary strontium on a carbonate equivalent basis ($SrCO_3$) decreased 22% to 22,104 short tons in 1982. Imports of strontium minerals and refined products experienced even greater decreases of 33% and 58%, respectively.

Domestic Data Coverage.—Domestic consumption data for strontium minerals are developed by the Bureau of Mines by means of a voluntary survey of U.S. operations. For consumption of strontium minerals, all four of the canvassed operations to which a request was sent responded, representing 100% of the primary domestic consumption data.

The Strontium survey is also used to calculate the distribution of primary strontium compounds by end use, as shown in table 6. Of the 13 operations canvassed for end-use data, 92% responded, representing 98% of the end-use data. For the one nonrespondent, data were estimated using prior year reported figures adjusted to 1982 trends evident from other reported users.

Table 5.—Major producers of strontium compounds in 1982

Company	Location	Compounds
Barium and Chemicals, Inc	Steubenville, Ohio	Various.
Chemical Products Corp	Cartersville, Ga	Carbonate.
FMC Corp	Modesto, Calif	Carbonate and nitrate.
Mallinckrodt, Inc	St. Louis, Mo	Various.
Milwhite Co., Inc	Houston, Tex	Sulfate.
Mineral Pigments Corp	Beltsville, Md	Chromate.

DOMESTIC PRODUCTION

Strontium minerals have not been produced commercially in the United States since 1959. However, a number of firms produced strontium compounds from imported celestite.

CONSUMPTION AND USES

In 1982, domestic consumption of strontium in the manufacture of various primary strontium compounds decreased by 6,084 tons to 22,104 tons of $SrCO_3$ equivalent. Distribution of primary strontium compounds by end use is shown in table 6. The slack demand was most evident in the color television picture tube manufacturing industry, the largest consumer of $SrCO_3$. A large domestic manufacturer revealed plans to close one of its major color television tube plants in early 1983.[19] Company officials blamed the anticipated closing on overcapacity and the rise of imports, largely from Asia.

Pyrotechnics and signals continued as the second largest end use. Strontium compounds, in particular strontium nitrate, but also strontium peroxide and oxalate, impart a characteristic brilliant red color to a flame. Strontium pyrotechnics were used in military and civilian signal flares as well as in fireworks for entertainment.

A recent growth area has been $SrCO_3$ use in ferrite ceramic magnets. These magnets, which have a high magnetic coercivity in terms of unit weight, size, and cost, are used for automobile windshield wiper motors, heater motor fans, and electric window motors.[20] The magnets are also widely used in home appliance motors and loudspeakers. In descending order of consumption, miscellaneous uses included drilling mud, fluorescent lights, toothpaste, plastics, electronic components, pharmaceuticals, and welding fluxes. Small quantities of strontium metal were produced by research companies.

Table 6.—Distribution of primary strontium compounds, by end use

(Percent)

End use	1980	1981	1982
Electrolytic production of zinc	5	4	3
Ferrite ceramic magnets	5	5	7
Pigments and fillers	4	4	4
Pyrotechnics and signals	12	15	15
Television picture tube faceplates	67	65	62
Unidentified	7	7	9
Total	100	100	100

PRICES

Yearend 1982 prices quoted in the Chemical Marketing Reporter were as follows: Strontium carbonate—glass grade, bags, truckloads, works, 32.75 cents per pound; and strontium nitrate—bags, carlots, works, $24 per 100 pounds.[21] Prices for strontium minerals are usually determined by direct negotiations between buyer and seller and are seldom published. The average value of imported strontium minerals at U.S. ports was $62.19 per ton in 1982, or $2.32 less than that of 1981.

FOREIGN TRADE

Imports of strontium minerals decreased by one-third from 1981 to 1982. Almost all of the material was imported from Mexico in both years.

Imports of strontium compounds and metal decreased 58% to 3,886,280 pounds in 1982. However, the Federal Republic of Germany increased its share of the U.S. import market from 49% in 1981 to 74% in 1982, despite the decline in actual tonnage of West German material.

On a $SrCO_3$ basis, an estimated 500 tons of strontium materials was exported in 1982.

Table 7.—U.S. imports for consumption of strontium minerals, by country

Country	1981		1982	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Canada	--	--	74	$7
Mexico	48,046	$2,937	32,992	2,042
Spain	1,653	269	9	8
Total	49,699	3,206	33,075	2,057

Source: U.S. Department of Commerce, Bureau of Census.

Table 8.—U.S. imports for consumption of strontium compounds and metal, by country

Country	1981		1982	
	Pounds	Value	Pounds	Value
Strontium carbonate, not precipitated:				
Germany, Federal Republic of	11,023	$2,571	--	--
United Kingdom	58	2,275	34	$1,745
Total	11,081	4,846	34	1,745
Strontium carbonate, precipitated:				
France	1,596,117	365,442	--	--
Germany, Federal Republic of	4,485,345	1,117,482	2,864,676	797,280
Netherlands	39,682	9,826	3,120	3,010
United Kingdom	3	886	12	1,864
Total	6,121,147	1,493,636	2,867,808	802,154
Strontium chromate:[1]				
Canada	867,750	1,041,755	462,815	634,893
France	6,070	7,939	27,006	27,714
Germany, Federal Republic of	--	--	14,318	10,427
Poland	--	--	35,274	21,199
United Kingdom	--	--	228	2,073
Total	873,820	1,049,694	539,641	696,306
Strontium nitrate:				
Germany, Federal Republic of	2,334	7,920	1,228	5,774
Italy	2,124,681	766,236	363,200	136,160
Spain	--	--	41,887	14,007
United Kingdom	5	886	13	874
Total	2,127,020	775,042	406,328	156,815
Strontium compounds, n.s.p.f.:				
France	--	--	4,000	5,040
Germany, Federal Republic of	51,749	16,501	8,973	16,523
Japan	68,342	49,475	44,092	32,693
United Kingdom	1,705	10,484	771	1,273
Total	121,796	76,460	57,836	55,529
Strontium metal, unwrought: Canada	33,382	330,571	14,633	137,070
Grand total	9,288,246	3,730,249	3,886,280	1,849,619

[1]Imported as strontium chromate pigment (TSUS 473.19).

Source: U.S. Department of Commerce, Bureau of the Census.

WORLD REVIEW

Deposits of strontium minerals are found in many parts of the world, but more than 90% of known world production in 1982 was from Spain, Mexico, Turkey, and the United Kingdom. Based on production estimates, Spain overtook Mexico for the first time as the largest producer of strontium minerals.

Consumption of strontium compounds was estimated in the following percentages: 80% as carbonate, 15% as nitrate, and 5% for compounds such as chromate, phosphate, chloride, and many others in smaller quantities.[22] Distribution of strontium compounds by end use was reported as color television picture tubes, 50%; ferrite magnets, 20%; pyrotechnics, 15%; and other uses, 15%.[23]

Germany, Federal Republic of.—Kali Chemie AG is the world's largest producer of $SrCO_3$, with an annual maximum production capacity of 200,000 tons. This figure includes both strontium and barium carbonate capacity because the production facilities are interchangeable.[24]

Japan.—The Ministry of International Trade and Industry was developing a 5-year national stockpiling program for strategic materials, including strontium materials. The program was expected to begin on April 1, 1983.[25]

Mexico.—Compañía Minera La Valenciana S.A., the largest celestite producer in the world, mined the San Augustin deposit, which has proven reserves of 830,000 tons of celestite.

Table 9.—Strontium minerals: World production, by country[1]

(Short tons)

Country[2]	1978	1979	1980	1981[p]	1982[e]
Algeria	6,418	[e]6,000	[e]6,000	[e]6,000	6,000
Argentina	1,317	134	295	342	[3]358
Iran[e 4]	[r]16,500	[r]8,800	5,500	5,000	4,500
Italy	402	1,866	1,161	[e]1,100	1,100
Mexico	37,725	43,562	44,931	45,574	35,000
Pakistan	239	[r]747	276	317	300
Spain	[r]15,432	[r]19,842	20,944	39,683	38,600
Turkey	[r]19,300	[r]19,800	17,600	16,500	16,500
United Kingdom	4,740	[r]6,724	7,386	16,500	19,800
Total	[r]102,073	[r]107,475	104,093	131,016	122,158

[e]Estimated. [p]Preliminary. [r]Revised.
[1]Table includes data available through May 16, 1983.
[2]In addition to the countries listed, China, the Federal Republic of Germany, Poland, and the U.S.S.R. produce strontium minerals, but output is not reported quantitatively and available information is inadequate for formulation of reliable estimates of output levels.
[3]Reported figure.
[4]Year beginning Mar. 21 of that stated.

TECHNOLOGY

A lead-strontium sulfide alloy was being studied for use as a semiconductor material. This alloy may find application in solar cells.[26]

A technique was developed using strontium isotopes to trace mineral nutrients trapped in windblown fir and spruce needles. These nutrients are subsequently washed into the soil and absorbed by the tree roots. The Yale University study showed that more than 75% of the minerals from mountain vegetation samples originated as airborne material trapped by the needles. This technique may become an important procedure for certain nutrient balance studies.[27]

WOLLASTONITE[28]

Wollastonite is a natural calcium metasilicate, usually white or light-colored, and has a theoretical composition of $CaO \cdot SiO_2$, equivalent to 48.3% lime combined with 51.7% silica. Over the years, wollastonite has become a useful filler in ceramics, plastics, paints, and various other applications.

Domestic production data for wollastonite are developed by the Bureau of Mines by means of a voluntary domestic survey. All of the four active mines responded, representing 100% of the total production data.

The tonnage of wollastonite sold or used in the United States in 1982 was 1% less in 1981. Actual data are withheld to avoid disclosing company proprietary data. The three producers were NYCO, a division of Processed Minerals, Inc., Essex County, N.Y.; R. T. Vanderbilt Co., Inc., Lewis County, N.Y.; and Pfizer, Inc., Riverside County, Calif.

Wollastonite production and its end use in wall tile, glass, and fiberglass was briefly described in a journal article.[29]

Wollastonite is one of several fillers used in engineering plastics. Another journal article described engineering plastics and their uses and predicted a healthy growth rate for the next decade. Also discussed were new types of engineering plastics, ultrahigh-performance plastics, and projected end-use growth patterns.[30]

In Finland, Oy Partek AB, Europe's only wollastonite producer, modernized its plant at Lappenranta, although production capacity of wollastonite remained at 22,000 tons per year, and actual production was about 13,000 tons in 1982. Construction of a new plant, which would raise capacity to 44,000 tons per year, was postponed until 1984 or 1985.

In India, Wolkem Private Ltd., opened a major wollastonite deposit in Rajasthan State, Jodhpur region, with reported reserves of about 50 million tons. The company was reportedly building new milling facilities and expected to produce approximately 75,000 tons per year by 1984.[31]

Chemical Marketing Reporter, at yearend 1982, quoted the price of paint-grade wollastonite, 400-mesh, bagged, in carload lots, f.o.b. works, as $106 per ton, and 325-mesh material as $90 per ton. The American Paint & Coatings Journal, December 27, 1982, quoted the price of paint-grade wollastonite, 400-mesh, in carload lots, f.o.b. plant, as $116 per ton, and 325-mesh material as $90 to $100 per ton.

ZEOLITES[32]

Production of natural zeolites in the United States in 1982 remained at about 5,000 tons. The large increase in 1981 production reported last year was incorrect. Market development activities remained high, but sales were mostly sporadic and to diverse markets. The largest single sale during 1982 was by Occidental Petroleum Co. from its Barstow, Calif., mine, to British Nuclear Industries Inc.

An international minerals magazine reviewed some of the papers presented at the Zeo-Agriculture '82 meeting held in June at Rochester, N.Y.[33] The article repeated the contention by some that certain high technology markets will continue to require the exact customized structures available in synthetic zeolites but not in the natural varieties. One author at the meeting seriously questioned the natural zeolite industry's ability to provide a consistent product over any length of time. Another author contested this and gave a long list of tested areas in which the natural material proved effective and economical.

Among the test data reported for the natural zeolites in agricultural areas were a use of clinoptilolite to raise the pH of inherently acidic soils in Japan to increase the rice yield, a report from China that zeolite applications increased the growth rate of rice, wheat, and grapes by 3% to 15%, and a report from Bulgaria that claimed that use of natural zeolites gave yield increases of 20% to 150% and a 30% increase of vitamin C content in tomatoes and strawberries.

Dr. Richard A. Sheperd of the U.S. Geological Survey warned at the meeting that, if the zeolite agriculture researchers did not use more rigor in the characterizations of the zeolite-rich rocks in their studies, then interpretation of experimental results, reproducibility, and credibility could be questioned. He said that the usually reported zeolite species, suppliers' name and code, and material particle size were insufficient and indicated that the required information included mineral content and chemical composition, crystallite size, homogeneity, cation-exchange and/or adsorption properties where appropriate, description of any chemical modifications made by the supplier and/or researcher, and the geographic location of the deposit.

A chemical industry magazine described the zeolites market.[34] After a 25% growth to 37,500 tons between 1975 and 1980, a new market suddenly appeared that represented a 400% increase in 1982. This was the 150,000 tons for detergent builders. The article attributed the opening of this market to the lapse of the Union Carbide Corp. patents and the entry of Ethyl Corp. and PQ Corp. as synthesizers. Both companies sold zeolites at 28 to 30 cents per pound in 1982 and this made them competitive with phosphates. The end-use pattern in the United States in 1975 for the 29,000-ton market was 69% in catalysts and 31% in adsorbents and/or desiccants. In 1980, detergents had 76% of the 162,500-ton market, catalysts, 14%, and adsorbents and/or desiccants, 10%. The 247,500-ton projected market in 1985 indicated 81% for detergents, 11% for catalysts, and 8% for adsorbents and/or desiccants.

An engineering magazine reported on a new zeolite plant.[35] Without giving specifics on capacity or products, the report said that W. R. Grace & Co.'s new molecular sieve plant at Valleyfield, Quebec, Canada, had begun production. In a later issue, the magazine reported that the Engelhard Corp. had started a multimillion-dollar expansion project at its Attapulgus, Ga., fluid-cracking-catalyst production facility.[36]

Reported research in 1982 was mainly on the synthetic zeolites. One report, however, was concerned with natural zeolites and health.[37] The report stated that hitherto unreported asbestos was found in the natural geology of an area of very high mesothelioma deaths. Both asbestos and the zeolite erionite had been found in lung tissues of mesothelioma victims so the erionite is no longer the sole suspect mineral.

A variation of the Mobil Corp.'s methanol-to-gas process was reported.[38] A Purdue University team, using a zeolite catalyst similar to Mobil's ZSM-5, reported the ability to convert 74% of the ethanol in an optimum 72% aqueous solution to gasoline.

A practical approach to solving a difficult zeolite catalyst problem was described.[39]

Early zeolite catalyst research had shown that new catalysts had per-unit-volume hydrocarbon cracking activities that were two to four or more orders of magnitude above the most active then in use. These catalysts were useless because of the engineering problems associated with the high activity. No large-scale, practical reactor design could accommodate the mass flow, diffusion, and heat transfer rates needed to match the catalytic conversion rates. Dilution of the active solid in a matrix provided a reduction of per-unit-volume activity to a useful range.

If the definition of zeolites is restricted to aluminosilicates, substitutes exist. Union Carbides's Tarrytown, N.Y., laboratories had developed a family of at least 20 aluminophosphate crystalline solids, 14 of which were microporous and called molecular sieves.[40]

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