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MINERAL INDUSTRIES OF

# AFRICA



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**U.S. GOVERNMENT PRINTING OFFICE**

**WASHINGTON : 1994**

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## Preface

This edition of the Minerals Yearbook discusses the performance of the worldwide minerals and materials industry during 1992 and provides background information to assist in interpreting that performance. Content of the individual Yearbook volumes follows:

Volume I, Metals and Minerals, contains chapters on virtually all metallic and industrial mineral commodities important to the U.S. economy. Chapters on advanced materials, nonrenewable organic materials, and nonferrous metals recycling also were added to the Minerals Yearbook series beginning with the 1989, 1990, and 1991 volumes, respectively. A new chapter on materials recycling has been initiated in this 1992 volume. In addition, a chapter on survey methods used in data collection with a statistical summary of nonfuel minerals and a chapter on trends in mining and quarrying in the metals and industrial mineral industries are included.

Volume II, Area Reports: Domestic, contains chapters on the minerals industry of each of the 50 States, Puerto Rico, Northern Marianas, Island Possessions, and Trust Territory. This volume also has a chapter on survey methods used in data collection, including a statistical summary of domestic nonfuel minerals.

Volume III, Minerals Yearbook—International Review contains the latest available mineral data on more than 175 foreign countries and discusses the importance of minerals to the economies of these nations. Since the 1989 International Review, this volume has been presented as six reports: Mineral Industries of the Middle East, Mineral Industries of Africa, Mineral Industries of Asia and the Pacific, Mineral Industries of Latin America and Canada, Mineral Industries of Europe and Central Eurasia, and Minerals in the World Economy. The reports incorporate location maps, industry structure tables, and an outlook section previously incorporated in our Mineral Perspectives Series quinquennial regional books, which are being discontinued.

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



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## Acknowledgments

The U.S. Bureau of Mines, in preparing these Volume III Minerals Yearbook Reports—International Review, extensively utilized statistics and data on mineral production, consumption, and trade provided by various foreign government minerals and statistical agencies through various official publications. The cooperation and assistance of these organizations is gratefully acknowledged. Statistical and informational material was also obtained from reports of the U.S. Department of State, from United Nations publications, and from the domestic and foreign technical and trade press. Of particular assistance were the routine and special reports submitted by the 10 Regional Resource Officers assigned to minerals and petroleum reporting and by economic and commercial officers and other officials of the Department of State located in U.S. Embassies worldwide. Their contributions are sincerely appreciated.

The text and production, structure of the mineral industry, and reserve tables of this volume were prepared by the respective country authors on the staff of the Division of International Minerals, Information and Analysis Directorate. The mineral export and import trade tables were prepared by the International Data Section of the Division of Statistics and Information Services, Information and Analysis Directorate.

The regimes of some countries reviewed in this volume may not be recognized by the U.S. Government. The information contained herein is technical and statistical in nature and is not to be construed as conflicting with or being contradictory of U.S. foreign policy.

George J. Coakley  
*Chief, Division of International Minerals*



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## THE MINERAL INDUSTRIES OF

# AFRICA

By Staff, Branch of Africa and Middle East

### INTRODUCTION

The 53 countries that constituted Africa in 1992 accounted for a significant portion of total world output of a number of mineral commodities. However, the continent's total output for a number of major mineral commodities declined relative to the volume produced during 1991. (See tables 1 and 2.)

The most conspicuous declines in mineral production from 1991 to 1992 were for cobalt and copper (declines of 28.6% and 23.4%, respectively), which could be partially attributed to mining and metal processing difficulties caused by political and economic disruptions in Zaire and for uranium (12% drop), for which much of the continental production decline was ascribed to Namibian cutbacks in response to lower world prices. The severe regional drought also adversely affected the mineral industry in a number of sub-Saharan nations.

A significant bright spot in Africa was gold production from 25 countries. Gold recovery showed continued growth as new producers started and several existing major producers expanded output. The Republic of South Africa increased production by 13 tons to 614 tons; Ghana, the second largest gold producer in Africa, increased production by 5 tons to 31 tons, the nation's highest gold output to date. Zimbabwe was Africa's third leading gold producer at more than 18 tons.

Liberalization of investment and mining laws continued, as the economic inefficiencies of most state-run mining enterprises became evident. Privatization of many of these enterprises was underway. In Zambia, the state corporation responsible for output of copper and cobalt as well as most other

metal commodities was on the list for privatization and discussions were underway with several major international mining organizations.

Among the most significant mineral commodities produced in Africa were, in alphabetical order: andalusite, antimony, asbestos, bauxite, chromite, coal, cobalt, copper, diamond, fluorspar, gold, lithium minerals, manganese, phosphate, platinum-group metals, the titanium minerals—ilmenite and rutile, vanadium, vermiculite, uranium, and zircon. A number of these, including chromite, cobalt, and manganese, were not mined in the United States and are of continuing strategic interest to the United States industrial economy.

U.S. imports in 1992 from African nations were mainly raw materials. Thirteen African countries were considered to be major import sources for the United States. Among these were: Algeria for natural gas; Angola for petroleum; Gabon for manganese; Guinea for bauxite; Madagascar for graphite; Morocco for barite; Namibia for quartz crystal; Nigeria for petroleum; the Republic of South Africa for andalusite, antimony, asbestos, chromium, diamond, fluorspar, gemstones, manganese, platinum-group metals, pyrophyllite, vanadium, and vermiculite; Zaire for cobalt, copper, and diamond; Zambia for cobalt; and Zimbabwe for chromium and lithium. U.S. exports to Africa were mainly food, equipment and machinery, computers, and aircraft. The Republic of South Africa was the largest market for U.S. products and services in Subequatorial Africa in 1992.

U.S. corporate or banking interests were involved in a number of mineral industry projects in Africa. Many projects emphasized development of crude

petroleum, petroleum refinery products or natural gas facilities, or pipeline construction. Nonfuel projects with U.S. interests included an aluminum plant appraisal in Cameroon, mercury decontamination and sulfur exploration in Egypt, diamond and gold joint ventures in Ghana, a titaniferous sands joint venture in Mozambique, and diamond production and a rutile and ilmenite project in Sierra Leone.

Mineral raw materials play a very important part in the national economies of many African countries. In many cases, the production of minerals is the dominant economic activity in the country, often having the largest and most sophisticated work force. The development of the economic mineral resource base continued to stimulate employment, education and training, improved health facilities, foreign exchange earnings, and infrastructure development. In recent years, African countries have expanded or improved their mining, investment, and tax laws to further such activity. The move toward mineral development continued despite the large initial capital requirements for opening mines, especially for infrastructure, and the long timelag for development.

In several countries, one or two mineral commodities are dominant in a weakly diversified economy. Among these are petroleum and diamonds in Angola, diamonds in Botswana, petroleum in the Congo and Libya, petroleum and manganese in Gabon, gold in Ghana, bauxite in Guinea, uranium in Niger, phosphate in Senegal and Togo, and copper and cobalt in Zaire and Zambia.

In terms of percentage of export earnings, minerals clearly were the

lifeblood of a number of countries throughout the continent. In 12 countries, minerals accounted for more than 50% of foreign exchange earnings. Much of Africa's mineral export sector was developed years ago. Some hard-rock mines, such as gold in Ghana, have recently been reactivated. In Botswana, Namibia, the Republic of South Africa, and Zimbabwe, relatively successful diversification has flourished from the central core of mineral development and its attendant infrastructure.

The most significant mineral economies in Africa in terms of diversity and value of output of nonfuel minerals, in order of importance, were the Republic of South Africa, Zaire, Zambia, Morocco, Zimbabwe, and Namibia. Also important in terms of value of mineral production from several high-valued minerals or those produced in large volume, such as bauxite, diamond, gold, manganese, phosphate rock, and uranium, were Botswana, Gabon, Ghana, Guinea, Niger, and Togo.

In terms of mineral fuels, Nigeria and Libya were the largest producers of crude petroleum, followed by Egypt and Algeria. However, the western coast of Africa remained an attractive target for additional oil and gas resources and in the east, the southern Red Sea and Gulf of Aden were of interest. West coast countries currently producing crude petroleum were Angola, Benin, Cameroon, Congo, Côte d'Ivoire, Gabon, Morocco, Nigeria, Senegal, and Zaire. Equatorial Guinea, Namibia, Niger, the Republic of South Africa, and Zimbabwe were explored for natural gas or crude petroleum. Coal was produced by only a few countries, although reserves were quite large in southern Africa. The main producers, in order of importance, were the Republic of South Africa (which was also the world's third largest exporter of coal), Zimbabwe, and Botswana.

The Republic of South Africa had the highest value of nonfuel mineral production in Africa and ranked among the top five world producers in value of nonfuel minerals. The nation was among the top world producers of andalusite, chromite, diamond, fluor spar, gold,

manganese, platinum-group metals, titanium, uranium, vanadium, vermiculite, and zircon.

The total land area of Africa is about 3.2 times that of the United States. Exclusive of the mineral commodities aforementioned for which there was no U.S. production or which were unique to Africa in terms of dominating world markets, U.S. production of most mineral commodities exceeded that for all of Africa. Two major exceptions were gold and uranium, for which Africa remains a major world supplier.

Although Africa has been a source of minerals for centuries, large areas are under thick vegetative or sand and unconsolidated alluvium cover, which has impeded exploration, as did the lack of infrastructure. Other large areas of the continent are subject to legislation prohibitive to risk investment or conflicts ranging from internal strife to full-fledged combat, which have set back the pace of mineral industry development and even exploration.

Africa has large reserves of a number of minerals, most of which are in south and central regions of the continent. Among these are antimony, asbestos, bauxite, cesium, chromite, cobalt, copper, diamond, fluor spar, gold, hafnium, ilmenite, kyanite, manganese, phosphate, platinum-group metals, tantalum, vanadium, vermiculite, and zirconium. Mining in Africa in many cases involves labor-intensive methods, which permit production from ore bodies of low grade or small size that would not normally be economic. Documentation and interpretation of mineral reserves in such cases may be misleading for normal economic planning. Nonetheless, in the absence of other viable economic activity, and with very low labor costs and capital inputs, these minerals should continue to be marketable. Minerals that can support such small-scale mining activities include cassiterite (tin), clays, columbite and tantalite, natron (soda ash), dimension stone, and salt. Most precious metals, such as gold and platinum, and precious and semiprecious stones, are more likely to be produced on a larger scale, particularly if found in alluvial or eluvial deposits.

The population of Africa is about 700 million compared with 255 million for the

United States. However, Africa's labor force consists for the most part of unskilled or semiskilled labor. Lack of skilled labor remains a significant factor in the slow pace of mineral project development throughout much of Africa. All tons are metric in this report unless otherwise specified.

#### SELECTED GENERAL SOURCES OF REGIONAL INFORMATION

- African Concord Ltd., London: Africa Economic Digest, weekly.
- British Sulphur Corp. Ltd., London: Nitrogen, bimonthly. Phosphorus and Potassium, bimonthly. Sulphur, bimonthly.
- Bureau de Recherches Géologiques et Minières, Paris: Chronique de la Recherche Minière, quarterly.
- Engineering News, Johannesburg.
- Institution of Mining and Metallurgy, London: Transactions, monthly. Bulletin.
- International Lead and Zinc Study Group, London.
- International Monetary Fund, Washington, DC: International Financial Statistics, monthly and annual yearbook.
- Macleay Hunter Publishing Co., Chicago, Illinois: Engineering & Mining Journal, monthly.
- Metal Bulletin Journals Ltd., London: Metal Bulletin, semi-weekly.
- Mining, Financial Mail Survey, Johannesburg.
- Mining Journal Ltd., London: Mining Magazine, monthly. Mining Journal, weekly. Mining Annual Review, July.
- PennWell Publishing Co., Tulsa, Oklahoma: International Petroleum Encyclopedia. Oil & Gas Journal, monthly.
- Society of Economic Geologists, University of Texas, El Paso, Texas: Economic Geology (and Bulletin), bimonthly.
- Standard Bank, Johannesburg, South Africa: Standard Bank Review, monthly.
- United Nations Statistical Office, New York: UN trade statistics.
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TABLE 1  
AFRICA: PRODUCTION OF SELECTED MINERAL COMMODITIES FOR 1992

(Thousand metric tons unless otherwise specified)

	Alumi- num	Ce- ment	Chro- mite	Cobalt, mine (tons), Co content	Copper, mine, Cu content	Diamond (thou- sand carats)	Gold (kilo- grams)	Iron ore (gross weight)	Lead, mine, Pb content	Man- ganese ore	Petroleum crude (thou- sand barrels)	Phosphate rock (gross weight)	Steel, crude	Uran- ium (tons)	Zinc, mine, Zn content
Algeria	—	6,400	—	—	—	—	—	2,350	1	—	275,000	1,136	1,400	—	4
Angola	—	1,000	—	—	—	1,000	—	—	—	—	200,000	—	10	—	—
Benin	—	370	—	—	—	—	—	—	—	—	931	—	8	—	—
Botswana	—	—	—	200	25	15,000	20	—	—	—	—	—	—	—	—
Burkina Faso	—	—	—	—	—	—	5,400	—	—	—	—	—	—	—	—
Burundi	—	—	—	—	—	—	32	—	—	—	—	—	—	—	—
Cameroon	82	620	—	—	—	—	10	—	—	—	50,370	—	—	—	—
Central African Republic	—	—	—	—	—	414	155	—	—	—	—	—	—	—	—
Congo	—	115	—	—	—	—	5	—	—	—	58,035	—	—	—	—
Côte d'Ivoire	—	510	—	—	—	15	1,500	—	—	—	300	—	—	—	—
Egypt	178	17,000	1	—	—	—	—	2,400	—	9	317,805	2,000	2,500	—	—
Ethiopia	—	320	—	—	—	—	2,224	—	—	—	—	—	—	—	—
Gabon	—	115	—	—	—	1	50	—	—	2,060	115,000	—	—	700	—
Ghana	180	1,024	—	—	—	710	31,032	—	—	276	—	—	25	—	—
Guinea	—	—	—	—	—	95	2,113	—	—	—	—	—	—	—	—
Kenya	—	1,508	—	—	—	—	20	—	—	—	—	—	20	—	—
Liberia	—	8	—	—	—	150	700	1,742	—	—	—	—	—	—	—
Libya	—	2,300	—	—	—	—	—	—	—	—	544,945	—	822	—	—
Madagascar	—	60	69	—	—	—	200	—	—	—	—	—	—	—	—
Malawi	—	120	—	—	—	—	—	—	—	—	—	—	—	—	—
Mali	—	20	—	—	—	—	5,700	—	—	—	—	—	—	—	—
Mauritania	—	90	—	—	—	—	—	8,202	—	—	—	—	—	—	—
Morocco	—	6,340	1	461	14	—	—	83	77	44	67	19,145	7	—	23
Mozambique	—	30	—	—	—	—	296	—	—	—	—	—	—	—	—
Namibia	—	—	—	—	35	1,549	2,072	—	15	—	—	—	—	1,986	36
Niger	—	29	—	—	—	—	—	—	—	—	—	—	—	2,970	—
Nigeria	—	3,500	—	—	—	—	—	400	( <sup>1</sup> )	—	695,700	—	140	—	—
Rwanda	—	60	—	—	—	—	1,000	—	—	—	—	—	—	—	—
Senegal	—	601	—	—	—	—	—	—	—	—	4	2,359	—	—	—
Sierra Leone	—	—	—	—	—	296	92	—	—	—	—	—	—	—	—
Somalia	—	25	—	—	—	—	—	—	—	—	—	—	—	—	—
South Africa, Republic of	173	7,361	3,363	350	176	10,156	614,100	28,226	76	2,464	—	3,051	9,061	2,222	72
Sudan	—	250	10	—	—	—	900	—	—	—	—	—	—	—	—
Swaziland	—	—	—	—	—	51	—	—	—	—	—	—	—	—	—
Tanzania	—	540	—	—	—	68	6,000	—	—	—	—	22	—	—	—
Togo	—	350	—	—	—	—	—	—	—	—	—	2,100	—	—	—
Tunisia	—	3,300	—	—	—	—	—	291	1	—	40,259	6,400	181	—	4
Uganda	—	50	—	—	—	—	1,800	( <sup>1</sup> )	—	—	—	( <sup>1</sup> )	—	—	—
Zaire	—	174	—	5,700	168	13,501	7,000	—	—	—	8,698	—	—	—	22
Zambia	—	347	—	7,000	400	—	140	( <sup>1</sup> )	9	1	—	—	—	—	18
Zimbabwe	—	900	522	80	10	41	18,278	1,179	—	—	—	142	547	—	—
Total Africa	613	55,437	3,966	13,791	828	43,047	700,839	44,873	179	4,854	2,307,114	36,355	14,721	7,878	179
Share of world Total, percent <sup>a</sup>	3.5	4.4	36.4	55.6	9.3	40.6	32.3	5.3	5.6	25.8	10.5	25.8	2.0	20.0	2.4
United States	4,000	70,760	—	—	1,720	—	320,000	56,000	410	—	2,602,270	47,000	84,400	2,171	550

<sup>a</sup>Estimated.

<sup>1</sup>Less than 1/2 unit.

TABLE 2  
AFRICA: PRODUCTION OF SELECTED MINERAL COMMODITIES FOR 1991-REVISED

(Thousand metric tons unless otherwise specified)

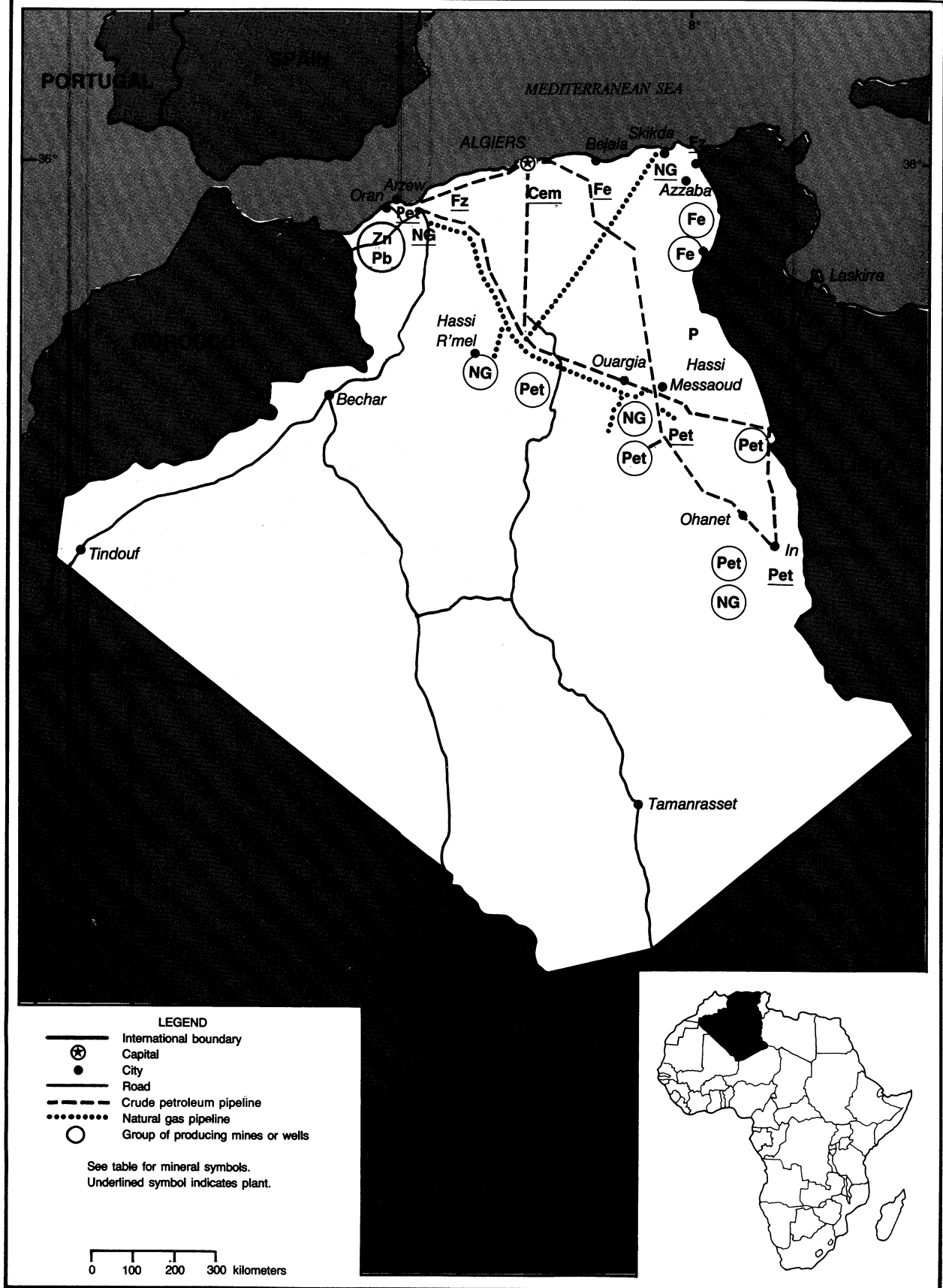
	Alumi- num metal	Ce- ment	Chro- mite	Cobalt, mine (tons) Co content	Copper, mine, Cu content	Dia- mond (thou- sand carats)	Gold (kilo- grams)	Iron ore (gross weight)	Lead, mine, Pb content	Man- gane- se ore	Petroleum crude (thou- sand barrels)	Phos- phate rock, (gross weight)	Steel, crude	Uran- ium, (tons)	Zinc, mine, Zn content
Algeria	—	6,319	—	—	—	—	—	2,344	1	—	203,852	1,090	1,393	—	3
Angola	—	1,000	—	—	—	961	—	—	—	—	184,000	—	10	—	—
Benin	—	320	—	—	—	—	—	—	—	—	1,353	—	8	—	—
Botswana	—	—	—	208	25	16,506	20	—	—	—	—	—	—	—	—
Burkina Faso	—	—	—	—	—	—	5,600	—	—	—	—	—	—	—	—
Burundi	—	—	—	—	—	—	25	—	—	—	—	—	—	—	—
Cameroon	83	622	—	—	—	—	10	—	—	—	55,480	—	—	—	—
Central African Republic	—	—	—	—	—	379	176	—	—	—	—	—	—	—	—
Congo	—	103	—	—	—	—	12	—	—	—	56,575	—	—	—	—
Côte d'Ivoire	—	500	—	—	—	15	1,100	—	—	—	730	—	—	—	—
Egypt	178	16,427	1	—	—	—	—	2,144	—	—	320,470	1,652	2,541	—	—
Ethiopia	—	290	—	—	—	—	3,038	—	—	—	—	—	—	—	—
Gabon	—	117	—	—	—	1	50	—	—	1,620	109,500	—	—	700	—
Ghana	175	750	—	—	—	700	26,311	—	—	320	—	—	27	—	—
Guinea	—	—	—	—	—	97	4,453	—	—	—	—	—	—	—	—
Kenya	—	1,423	—	—	—	—	20	—	—	—	—	—	20	—	—
Liberia	—	2	—	—	—	100	600	1,100	—	—	—	—	—	—	—
Libya	—	2,369	—	—	—	—	—	—	—	—	550,785	—	718	—	—
Madagascar	—	60	63	—	—	—	200	—	—	—	—	—	—	—	—
Malawi	—	120	—	—	—	—	—	—	—	—	—	—	—	—	—
Mali	—	20	—	—	—	—	4,900	—	—	—	—	10	—	—	—
Mauritania	—	90	—	—	—	—	—	10,246	—	—	—	—	—	—	—
Morocco	—	5,770	1	325	16	—	—	99	73	59	83	17,900	7	—	24
Mozambique	—	30	—	—	—	—	394	—	—	—	—	—	—	—	—
Namibia	—	—	—	—	34	1,187	1,857	—	12	—	—	—	—	2,889	33
Niger	—	20	—	—	—	—	—	—	—	—	—	—	—	3,330	—
Nigeria	—	3,500	—	—	—	—	—	398	( <sup>1</sup> )	—	689,800	—	137	—	—
Rwanda	—	60	—	—	—	—	1,000	—	—	—	—	—	—	—	—
Senegal	—	503	—	—	—	—	—	—	—	—	4	1,833	—	—	—
Sierra Leone	—	—	—	—	—	243	26	—	—	—	—	—	—	—	—
Somalia	—	10	—	—	—	—	—	—	—	—	—	—	—	—	—
South Africa, Republic of	169	7,296	5,110	300	185	8,431	601,013	28,958	76	3,146	—	3,050	9,358	2,039	64
Sudan	—	170	10	—	—	—	50	—	—	—	—	—	—	—	—
Swaziland	—	—	—	—	—	57	—	—	—	—	—	—	—	—	—
Tanzania	—	540	—	—	—	100	2,799	—	—	—	—	22	—	—	—
Togo	—	388	—	—	—	—	—	—	—	—	—	2,965	—	—	—
Tunisia	—	3,300	—	—	—	—	—	295	1	—	38,690	6,352	193	—	5
Uganda	—	50	—	—	—	—	—	—	—	—	—	( <sup>1</sup> )	—	—	—
Zaire	—	250	—	9,900	265	17,814	8,800	—	—	—	9,955	—	—	—	42
Zambia	—	367	—	6,991	344	—	136	( <sup>1</sup> )	9	1	—	—	—	—	20
Zimbabwe	—	865	564	105	14	—	17,820	1,136	—	—	—	117	581	—	—
Total Africa	605	53,651	5,749	17,829	883	46,591	680,410	46,720	172	5,146	2,221,277	34,991	14,993	8,958	191
Share of world Total, percent	3.3	4.5	43.4	67.1	10.0	44.6	32.2	5.5	5.3	23.4	10.1	23.8	2.0	20.2	2.6
United States	4,121	66,225	—	—	1,631	—	289,885	56,800	477	—	2,686,765	48,096	79,738	3,060	547

<sup>1</sup>Less than 1/2 unit.

# ALGERIA

AREA 2,381,740 km<sup>2</sup>

POPULATION 26.7 million



## THE MINERAL INDUSTRY OF

# ALGERIA

By Bernadette Michalski

Although Algeria's mineral industry includes a diverse but modest production of metals and industrial minerals, hydrocarbons remained by far the leading mineral sector, providing \$10.9 billion in export earnings in 1992. The growth in the volume of natural gas exports diminished the impact of lower oil prices in 1992. The Government launched an aggressive policy to develop and market hydrocarbons, particularly natural gas. The Government announced its chief priorities as expanding exploration activities; improving recovery rates; augmenting reserves in place; increasing hydrocarbon production, transport, and export capacities; and maintaining the overall level of Algerian hydrocarbon exports at 1.8 Mbbl/d of oil equivalent in the immediate future and increasing to 2.5 Mbbl/d of oil equivalent by the start of the next century.

### GOVERNMENT POLICIES AND PROGRAMS

The stipulation that the Government's Société Nationale pour la Recherche, la Production, le Transport, la Transformation, et la Commercialization des Hydrocarbures (Sonatrach) was to hold a 51% interest in all associations with foreign partners has been relaxed except for equity holding in existing fields where Sonatrach will retain at least 51%. Exploration activity reflected the improved incentives offered under the December 1991 legislation, which modified the terms and conditions of oil exploration in Algeria. Companies awarded exploration contract were able to choose one of four contract types: production-sharing, a partnership, a joint-stock company agreement; or a service contract. Between December 1991 and April 1993, 12 exploration agreements

were signed. Participants included Mobil, Atlantic Richfield, Anadarko Petroleum, Louisiana Land and Exploration, BP Exploration, and Phillips Petroleum.

The Government also has offered foreign companies equity interest in producing fields, an area from which they were previously excluded. At least 10 fields, including the giant Hassi Messaud Field, have been open to foreign companies with expertise particularly in secondary and tertiary recovery.

The Energy Ministry projected \$14 billion on new foreign investment through exploration and development of existing fields, up to \$7 billion in front-end bonuses, and \$2.5 billion annually in oil and gas export revenue by 1996 rising to 5 to 6 billion by the year 2000. These projections appear to be optimistic as the initial bids on equity participation in producing fields were below anticipation.

The new economic program revealed by the High State Council in September 1992 reversed some of the gradual moves toward a market economy, which were undertaken since 1989 by the previous Government. More state control will result from the decision to revise the concessionaire system of wholesale trading, which was one of the more radical reforms of the 1990 law that allowed licensed entrepreneurs to buy hard currency and import goods directly from overseas sources for sale locally.

### PRODUCTION

Although petroleum production remains significant, the nation's more mature wells required gas reinjection to maintain pressures. Other enhanced recovery technology was under consideration.

A variety of nonhydrocarbon minerals were produced in minor amounts, but

only iron ore, mercury, and phosphate rock are produced on a significantly large scale. The entire output of iron ore was consumed by the national iron and steel industry. Phosphate rock production is exported. Mercury output is marginal and because it is produced entirely for export, production fluctuates with the price of this commodity in the world market. (See table 1.)

### TRADE

Natural gas and liquid fuels accounted for about 95% of Algeria's export earnings. Crude oil exports are expected to increase in the mid-decade with the application of enhanced recovery technology.

Western Europe absorbed more than 90% of Algeria's crude oil exports in 1992. The average monthly spot price for Algerian Saharan Blend crude oil ranged from a low of \$18.38 per bbl in March to a high of \$20.96 per bbl in October. The annual average was \$20.03 compared with an annual average of \$21 bbl in 1991 and \$24.22 per bbl in 1990.

Depleting oil reserves in mature fields diverted marketing attention to natural gas, condensates, and refined products. Natural gas exports rose to 35.6 billion m<sup>3</sup> compared with 33.9 billion m<sup>3</sup> in 1991 and 31.4 billion m<sup>3</sup> in 1990. In 1992, 19.7 billion m<sup>3</sup> of natural gas was exported in the form of liquefied methane (LNG) and 15.9 billion m<sup>3</sup> of natural gas was exported in the gaseous state via pipeline to Italy, Tunisia, and for the first time, Slovenia. Italy continued as the principal market for Algerian natural gas importing a total of 15.3 billion m<sup>3</sup>, followed by France at 9.4 billion m<sup>3</sup>, Belgium at 4.4 billion m<sup>3</sup>, Spain at 4.0 billion m<sup>3</sup>, the United States at 1.3 billion m<sup>3</sup>, Tunisia at 1.0 billion m<sup>3</sup>, and



Slovenia at nearly 0.2 billion m<sup>3</sup>. Exports to Slovenia should average 0.6 billion m<sup>3</sup>/a between 1993 and 2007.

Sonatrach has signed a contract with Spain's Enagas for the annual shipment of 6,000 million m<sup>3</sup> of natural gas for 25 years commencing in 1995. The liftings will be in addition to the LNG contract in effect with Enagas covering 4,000 Mm<sup>3</sup>/a.

Other exports, by order of value, are metals and metal products, phosphates, and iron ore.

As a result of a \$600 million credit agreement granted by the Spanish Government, 400,000 to 500,000 tons of rebar is to be imported from Spain commencing in 1993.

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## STRUCTURE OF THE MINERAL INDUSTRY

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The Algerian Government has traditionally controlled all mining and mineral processing industries. However, private capital is being encouraged as Sonatrach's majority participation in all hydrocarbon production contracts has been relaxed except for equity in existing fields where 51% majority participation by Sonatrach is still required.

Local mining companies and agencies are to be amalgamated into the Office de Recherche Geologique & Minières (ORGM), which should open the mining industry to international involvement. Working with both local and international companies, ORGM will become responsible for information distribution relating to the mining sector, as well as the publication of geological maps and the development and evaluation of deposits. (See table 2.)

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## COMMODITY REVIEW

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### Metals

**Aluminum.**—Plans for the construction of a 220,000-mt/a-capacity aluminum smelter at Mostaganem in western Algeria progressed. The proposed \$1 billion aluminum smelter would be a joint

venture between Algeria and the International Development Corp. of Dubai. Financing for the smelter and a 400-MW powerplant is to be secured through purchase agreements.

**Gold.**—Mining is scheduled to commence at the Tirek and Amesmessas deposits in the eastern Hoggar Mountains of southeastern Algeria. The deposits are reported to contain over 500 tons and 1,700 tons respectively.

Black Hole Technologies of the United States, an ore processing and mining equipment manufacturer, has entered a joint-venture agreement with the Government for small-scale, near-surface gold-bearing quartz veins.

**Iron Ore.**—The bulk of Algeria's iron ore output was extracted from the mine at Ouenza. Mining operations were spread over 17 km<sup>2</sup>, with the main seam 2 km long and 500 m wide. Production totaled 2.7 Mmt of hematite ranging from 53% to 60% iron content. Iron ore was also mined at Bou Khadra and shipped with Ouenza ore by rail to the El Hadjar processing plant, near Bejaia, a distance of 170 km. Both mines are operated by Entreprise Nationale de Fer et de Phosphates.

**Iron and Steel.**—Metal-Sider, the nation's first private steelmaker, will begin operation near Arbaa in mid-1993 with an 80-ton electric furnace, a continuous billet caster, and two rolling mills capable of producing 200,000 mt/a of rebar and 100,000 mt/a of merchant bar. The mill will save the country about \$300 million per year in merchant bar imports. Current rebar production from the El Hadjar complex is less than 300,000 mt/a while demand is 1.4 Mmt/a. A second electric furnace is planned for mid-decade with a 500,000-mt/a rod mill and a second 500,000-mt/a rebar mill.

Site preparation for the 2-Mmt/a-capacity Bellara steel complex, east of Algiers, was completed by Algerian firms. No construction contracts had as yet been made for the \$3 billion complex.

Algeria is seeking foreign capital for a hot-briquetted iron project. The plant site selected was the port of Jenjen where ore carriers of up to 180,000 dwt can be accommodated. Plans include the installation of two furnaces with a combined capacity of 1.5 Mmt/a of hot-briquetted iron. About one-half of the output will be consumed domestically.

**Mercury.**—Algeria is a significant world producer of mercury, supplying about 10% of the world's total output. Entreprise Nationale des Nonferreux et Substances Utiles reported the average production cost of mercury in Algeria at \$300 per flask.

### Industrial Minerals

**Cement.**—Available supply was reported at 8 Mmt, including about 2 Mmt of imported cement in 1992. This quantity was far below actual demand. Limited credit availability and import restrictions thwarted additional cement imports, requiring many construction projects to be placed on hold. Major investments are required to modernize and rehabilitate the nation's cement industry before it can sustain the domestic market.

Entreprise des Ciments et Derives de l'Est's (ERCE) installation of raw-grinding mills in Hamma Bouziane, Hadjar Soud, and in El Kebira were completed in 1992. Construction continued on the 1,600-mt/d plant at Elma Labiod, near Tebessa. The Hamma Bouziane plant increased rotary kiln capacity from 3,000 mt/d to 3,600 mt/d. Entreprise des Ciments et Derives de l'Ouest's (ERCO) plant at Zahana was under renovation during the year.

**Kaolin.**—A 50,000-mt/a-capacity kaolin plant is under construction at El Milia, 20 km west of Skikda. Most of the plant's output will be directed to the domestic market. About one-half of the plant's production will be utilized for sanitaryware with much of the remainder divided between the manufacture of tableware and the newspaper industry. Plant

construction was contracted to a consortium of Neyrtec SA, Kaolins d'Arvor of France, and the Gilco Group of Italy.

**Phosphate Rock.**—Production was derived from the Djebel Onk open pit mine 330 km south of Annaba and 22 km from the Tunisian border. Operated by Entreprise Nationale de Fer et de Phosphates, the deposit site covers 2,100 km<sup>2</sup> and produced more than 1 Mmt of processed phosphate. About one-third of the output was utilized at the Annaba fertilizer complex, and the remainder was exported, principally to France and Spain.

### Mineral Fuels

**Natural Gas.**—Gross production of natural gas was about 110 billion m<sup>3</sup>, and almost 50% was reinjected to maintain petroleum reservoir pressure. Liquefaction of natural gas for the export market averages about 90,000 m<sup>3</sup>/d. The gas liquefaction complexes, three at Arzew and one at Skikda, are operating well below the design capacity because of disrepair and lack of funds for replacement parts. Contracts for engineering and other services involved in overhauling and upgrading the complexes were awarded to the Bechtel Corp. and the M. W. Kellogg Co. of the United States and Sofregaz of France. Loan agreements guaranteed by the Export-Import Bank will provide \$348 million for work by Bechtel, \$172 million for M. W. Kellogg and \$53 million for Sofregaz. These guarantees have a 4-year drawdown period. The loans are underwritten by Citicorp with participation by the Arab Petroleum Investments Corp. at \$140 million. Sufficient credits are in place to allow the expansion to proceed.

A \$228 million credit agreement was signed between Sonatrach and French banking interests covering France's share of financing for renovation of the GL1-K gas liquefaction plant at Skikda. The plant operated at about 55% of its 8,500-Mm<sup>3</sup> capacity. Renovation and production augmenting is expected to continue through 1994. Contracts for GL1-Z and

GL2-Z were awarded to Bechtel and M. W. Kellogg. The United States Export-Import Bank guaranteed \$492 million in financing to finance costs related to the projects. The plants are operating at 60% and 85% of their respective capacities of 10,580 Mm<sup>3</sup> and 10,700 Mm<sup>3</sup>. Both plants are at Bethioua near Arzew.

Restoration on GL 4-Z, currently operating at 90% of its 1,400-Mm<sup>3</sup> capacity, is to be carried out by Sofregaz and Sonatrach.

Natural gas exports to Eastern Europe were realized in the first quarter of 1992 via the 35-km Snam spur line connecting the trans-Mediterranean pipeline to Slovenia. Liftings for 1992 were 200 Mm<sup>3</sup> rising to an average of 600 Mm<sup>3</sup> annually until the year 2007.

Financing for the expansion of the trans-Mediterranean pipeline through Algeria, Tunisia, and Sicily to the Italian mainland had been secured. Pipeline capacity is scheduled to be increased from its current 15.5 billion m<sup>3</sup>/a to 23.8 billion m<sup>3</sup>/a by 1995. Access to the Slovenian gas network is achieved through a 35-km spur line near the Italian end of the trans-Mediterranean pipeline.

The Hassi R'Mel Gasfield should be linked with Spain via Morocco and the Straits of Gibraltar by the close of 1995. The agreement covers delivery of 6 billion m<sup>3</sup>/a to Spain and up to 1 billion m<sup>3</sup>/a to Morocco commencing in October 1995. In the second phase of construction, the pipeline will be extended to provide access to Portugal, France, and Germany. Three new gas export contracts were concluded in 1992 for a total volume of 12.1 billion m<sup>3</sup> with Spain's Enagas, Enel of Italy, and the Portugese consortium Natgas. Gas deliveries to Cove Point Trading Co. in the United States commenced in mid-1992, marking Algeria's reentry into the U.S. LNG market.

The Helios Co., a joint venture with Sonatrach involving Air Products & Chemicals, Inc. (APCI) of the United States and L'Air Liquide of France, has been formed to process helium-rich waste gas from Sonatrach's natural gas facilities. The plant, now under construction, should produce 16 Mm<sup>3</sup>/a of

liquid helium, which would represent 20% of world output, and 33,000 mt/a of liquid and gaseous nitrogen. The selected plant site will be in the GL 2-Z natural gas liquefaction complex in Bethious, near Arzew. Total plant cost is projected at \$96.2 million. Construction commenced in 1991 and should be completed by 1994. The plant will use the APCI's production process and will retreat by cooling and distillation the residual gas produced by the GL 2-Z liquefaction complex, because the gas contains on average 10% helium and 45% nitrogen. The helium produced is to be exported to Europe. The nitrogen will be sold in Algeria and other north African markets. Algeria enjoys the advantage of proximity to the European market, which has relied on the United States for its helium requirements.

**Petroleum.**—Exploration.—A sizable international licensing round was launched in 1992 to increase exploration and eventually hydrocarbon reserves. Offered for bidding were 19 blocks, which the Government anticipated would bring in 7 billion in front-end bonuses.

**Production.**—Crude oil production averaged 750,000 bbl/d. Most of the production was derived from Hassi Messaoud-Haoud el Hamra Fields in the Sahara, the Zarzaitine-Edjeleh Field near Ohanet, and In Amenas near the Libyan border. Algeria operated more than 970 wells, of which 728 were flowing and 242 were under artificial lift. Field condensate production averaged 410,000 bbl/d. To boost crude oil production, Sonatrach is carrying out major enhanced recovery programs. It has installed 15 water injection systems. Gas injection systems are installed at the Hassi Messaoud Field and at the Gassi Touil Field. Gas injection systems are planned for Ait-Kheir and Masdor Fields. A study on the feasibility of using chemical injection in the Tin Gouye Field will be submitted in 1996. The Government has offered foreign participation in Algeria's maturing fields. Equity interest is offered in the following fields: Hassi Messaoud,

Haoud Berkaoui, Ben Kahla, Guellala, Rhourde El Baguel, El Gassi, Zarzaitine, El Adeb Larache, Hasi R'Mel, and Rhourde Nous. About 15 companies submitted bids for 8 fields. However, as of mid-1993 no awards were made as the Government reported that the bids were lower than expected and that revised bids were anticipated. The Export-Import Bank of Japan has signed a \$98 million loan cofunded with \$100 million from the World Bank to Sonatrach for a project to increase petroleum production capacity and efficiency.

**Petrochemicals.**—Plans to construct a 600,000-mt/a methyl tertiary butyl ether (MTBE) unit, an unleaded fuel component, at Arzew took form with the awarding of the process engineering contract to Italy's Snamprogetti SpA. Partners in the \$400 million project with Sonatrach are Total of France and Ecofuel of Italy.

Entreprise Nationale de le Petrochimie (ENIP) plans to increase capacity of a low-density polyethylene plant (LDPE) at the Skikda petrochemicals complex from 48,000 mt/a to 65,000 mt/a. A contract for the engineering work on a high-density polyethylene plant at Skikda was awarded to a Spanish consortium. The plant's total cost is estimated at \$120 million. The 130,000-mt/a-capacity plant started production in 1992.

## Reserves

Hydrocarbon reserves as reported by the Ministry of Mines and Industry as of January 1993 were 3.65 trillion m<sup>3</sup> of natural gas. Unassociated natural gas accounted for 85% of these reserves. Recoverable petroleum reserves were reported at 9.24 billion bbl of light, low-sulfur crudes.

Iron ore reserves were reported at 35 Mmt averaging 53% Fe; however, an estimated 970 Mmt of ore grading 53% Fe was identified at the undeveloped Gara Djebilit deposit.

## INFRASTRUCTURE

Algeria's railroad system totals 4,060

km of track, of which only 2,616 km is standard gauge or 1.435 m. The nation's road network spreads over 80,000 km, of which 60,000 km is concrete or bituminous surfaced. Virtually all of the railway and road network is in the northern section of the country. About 10,000 km of pipeline serves the hydrocarbon industries. A network involving nearly 1,500 km of pipeline is the conduit for natural gas from Hassi R'Mel to the Mediterranean Ports of Arzew and Skikda. Nine lines carry dry gas. Four lines carry condensates and LPG. A pipeline network totaling another 1,500 km transports natural gas from Alrar, Rhourde Nouss, and Gassi Touil to Hassi Messaoud and Hassi R'Mel. Major crude petroleum pipelines exceed 5,800 km in length, serviced by another 800 km of feeder lines. Petroleum product pipelines exceed 300 km.

Algeria employs seven marine terminals for the export of hydrocarbons, including La Skhirra in Tunisia. The largest terminal is Arzew-Bethioua, which accommodates 40% of all hydrocarbon exports. Port capacity at Skikda is limited to 90,000-m<sup>3</sup> liquid-natural-gas carriers. Efforts are under way to augment facilities to permit the accommodation of 125,000-m<sup>3</sup> carriers.

The Government has canceled plans to build a 300-kW hydroelectric dam at Mexna due to strong criticism of the dam's environmental impact in Tunisia. The program was abandoned after 12 years of work costing \$19 million.

## OUTLOOK

Algeria's huge sedimentary basins may very likely contain larger reserves of crude oil than present estimates suggest. Improved geochemical, petrophysical, and reservoir studies and the installation of enhanced recovery systems would most likely enable much of the probable reserve base to be reclassified as proven reserves. Stimulating foreign investment interest in Algeria's aging energy industries is vital to the economy because the nation does not have cash or access to sufficient credit to sustain economic activity. In pursuing this course of action,

the Algerian Government has not only encouraged exploration agreements but has offered a portion of production rights in existing oilfields and gasfields to private companies with capital and enhanced recovery capabilities. This action represents the most significant change in oil policy since nationalization in 1971. Although exploration agreements have been concluded with a significant number of foreign companies, less interest was registered in buying into secondary recovery operations from productive fields. The Government expressed disappointment in the bonus offers and reopened the bidding. Investors are hesitant while the political situation remains unclear at a time when the injections of funds into the economy remains most urgent. Without sufficient foreign capital to refurbish the natural gas extraction and processing facilities, as well as the transport infrastructure, Algeria may be unable to satisfy demand within a few years. Natural gas exports to Italy alone will double to 30 billion m<sup>3</sup>/a when the trans-Mediterranean pipeline is expanded. The demand for natural gas may be outstripping Algeria's capacity to supply it. Therefore, one of Algeria's top priorities must be to revamp and expand its processing and export facilities, both for gaseous and liquefied natural gas, to attain the export goal of 60 to 65 billion m<sup>3</sup> by the year 2000.

Increased political instability could jeopardize Algerian plans to refinance \$23.4 billion of external debt. Algeria's debt services remain high, more than \$6,000 million in 1992 and more than \$7,000 million in 1993. Plans to persuade foreign companies to buy into existing oilfields have faltered. The Government forecasts a \$7.7 billion budget deficit in 1993, more than double the 1992 deficit of \$3.4 billion.

The economic programs introduced in September 1992 advocated austerity. New import controls and moves to protect local industry were an apparent reversal of trade liberalization policies introduced since 1989. The new program appeared primarily aimed at political and social problems with no reference to monetary restraint such as curbing inflation,

currently about 30%. The IMF may not agree with the Government's new economic programs and may constrain funding in 1993.

Algerian relations with neighboring Tunisia have improved with the cancellation of construction of the 300-kW hydroelectric dam at Mexna. Algeria's action should afford it a more favorable position with the World Bank and the EC as both groups attach increasing importance to environmental issues when considering financing programs.

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<sup>1</sup>Where necessary, values have been converted from Algerian dinars (AD) to U.S. dollars at the rate of AD21.862=US\$1.00.

#### **OTHER SOURCES OF INFORMATION**

##### **Ministry of Mines**

80 Avenue Ahmed Ghermoul  
Algiers, Algeria

##### **Ministry of Industry**

Le Colise Rue Ahmed-Bey de Constantine  
Algiers, Algeria

##### **Société Nationale des Matriaux de Construction**

90 Rue Didouche Mourad  
Algiers, Algeria

##### **Société Nationale pour la Recherche, la Production, le Transport, la Transformation, et la Commercialisation des Hydrocarbures (Sonatrach)**

10 Rue du Sahara, Hydra  
Algiers, Algeria

##### **Société Nationale de Siderurgie**

Ravin Sidi Yahia  
Boite Postale 54  
Hydra, Algeria  
Telephone: 213-8-830999

Fax: 213-8-843020

##### **Entreprise Nationale de Sel (ENASEL)**

127 Boulevard Salah Bouakouir  
Algiers, Algeria  
Telephone: 213-2-946767

TABLE 1  
ALGERIA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992*
<b>METALS</b>					
Cadmium, refined	55	46	65	78	75
Iron and steel:					
Iron ore, gross weight      thousand tons	3,118	2,748	2,941	2,344	2,350
Metal:					
Pig iron      do.	1,500	1,300	1,037	877	900
Steel, crude      do.	1,300	943	836	1,393	1,400
Lead, concentrate, Pb content <sup>o</sup>	1,900	1,400	1,100	900	900
Lead, refined	3,900	2,700	4,500	4,500	4,500
Mercury	662	587	637	431	3476
Silver <sup>o</sup> kilograms	3,000	2,800	2,500	2,500	3,500
Zinc:					
Concentrate, Zn content	6,348	6,263	4,160	2,610	4,000
Metal, smelter output	37,000	28,000	23,600	24,917	31,000
<b>INDUSTRIAL MINERALS</b>					
Barite, crude	43,000	49,000	53,078	44,361	45,000
Cement, hydraulic      thousand tons	7,195	6,819	6,337	6,319	6,400
Clays:					
Bentonite	25,600	39,200	33,700	25,803	30,000
Fuller's earth <sup>o</sup>	3,500	3,500	4,000	4,526	4,550
Kaolin	17,800	18,000	18,000	21,460	21,500
Diatomite	3,087	4,400	4,156	3,629	3,800
Gypsum <sup>4</sup> thousand tons	275	275	250	152	150
Lime, hydraulic	32,000	27,000	32,000	61,345	62,000
Nitrogen: N content of ammonia	196,900	131,500	*150,000	*150,000	150,000
Phosphate rock:					
Gross weight      thousand tons	1,332	1,124	1,128	1,090	<sup>3</sup> 1,136
P <sub>2</sub> O <sub>5</sub> content      do.	404	371	333	322	340
Salt      do.	237	229	222	211	210
Sodium compounds: Caustic soda <sup>o</sup>	700	700	700	700	700
Strontium minerals: Celestite, gross weight <sup>o</sup>	5,400	5,400	5,400	5,400	5,400
Sulfur, elemental <sup>o</sup>	20,000	20,000	20,000	20,000	20,000
<b>MINERAL FUELS AND RELATED MATERIALS</b>					
Gas, natural:					
Gross      million cubic meters	109,903	108,000	110,000	126,270	127,000
Dry <sup>5</sup> do.	44,900	48,400	48,500	54,760	55,800
Natural gas plant liquids      thousand 42-gallon barrels	55,400	56,492	56,000	55,000	52,855
Petroleum:					
Crude      do.	236,800	253,675	290,175	203,852	275,000
Condensate      do.	175,000	170,000	154,075	151,575	150,000
Refinery products:					
Gasoline      do.	15,610	17,760	18,604	18,980	18,800
Kerosene and jet fuel      do.	4,058	3,903	3,850	3,100	3,000

See footnotes at end of table.

TABLE 1—Continued  
ALGERIA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992*	
<b>MINERAL FUELS AND RELATED MATERIALS—Continued</b>						
<b>Petroleum—Continued:</b>						
<b>Refinery products—Continued:</b>						
Distillate fuel oil	thousand 42-gallon barrels	60,105	57,233	57,546	56,400	56,400
Residual fuel oil	do.	40,050	37,660	38,235	37,376	37,300
Lubricants	do.	735	959	840	835	825
Other <sup>3</sup>	do.	47,100	47,300	47,000	43,000	42,000
<b>Total</b>	<b>do.</b>	<b>167,658</b>	<b>164,815</b>	<b>166,075</b>	<b>159,691</b>	<b>158,325</b>

\*Estimated.

<sup>1</sup>Table includes data available through June 30, 1993.

<sup>2</sup>In addition to the commodities listed, secondary aluminum, secondary lead, and secondary copper may be produced in small quantities, and crude construction materials presumably are produced for local consumption, but output is not reported, and available information is inadequate to make reliable estimates of output levels.

<sup>3</sup>Reported figure.

<sup>4</sup>Includes approximately 50,000 tons of plaster each year.

<sup>5</sup>Excludes gas used in reinjection, flaring, venting, transmission losses, and natural gas liquids extraction.

TABLE 2  
ALGERIA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

(Thousand metric tons unless otherwise specified)

Major commodities	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Cement	Entreprise des Ciments et Derives de L'Est (Government, 100%)	Setif, near Bejaia	1,000.
		Batna, 60 kilometer south of Skikda	1,000.
		Constantine, west of Skikda	1,000.
Do.	Entreprise des Ciments et Derives de L'Ouest (Government, 100%)	3 plants at Oran	2,900.
Do.	Cimenterie de Oued Sly (Government, 100%)	El-Asnam, 80 kilometer west of Algiers Djelfa	2,000. 500.
Do.	Entreprise des Ciments et Derives du Centre (Government, 100%)	Blida, 5 kilometer southwest of Algiers Bouira, near Algiers Algiers	1,000. 1,000. 500.
Fertilizer	Entreprise Nationale des Engrais (Asmidal) (Government, 100%)	Arzew	495 ammonium nitrate, 660 ammonia, 132 urea, 395 nitric acid.
		Annaba	330 ammonium nitrate, 330 ammonia, 254 nitric acid, 495 sulfuric acid, 165 phosphoric acid, 550 compound fertilizers.
Iron ore	Entreprise Nationale de Fer et de Phosphates (Government, 100%)	Ouenza and Bou Khadra	4,000.
Iron and steel	Entreprise Nationale de Siderurgie (Government, 100%)	El Hadjar, near Bejaia	1,500.

See footnotes at the end of table.

TABLE 2—Continued  
ALGERIA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

(Thousand metric tons unless otherwise specified)

Major commodities	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Mercury metric tons	Entreprise Nationale des Nonferrous et Substances Utiles (Government, 100%)	Azzaba	500.
Natural gas million cubic meters	Societe Nationale pour la Recherche, la Production, le Transport, la Transformation, et la Commercialisation des Hydrocarbures (Government, 100%)	Hassi R'Mel and Hassi Messaoud natural gas gathering center Liquefaction plants at Arzew Liquefaction plant at Skikda	112,000. 22,900. 7,900.
Natural gas liquids thousand barrels	do.	Hassi R'Mel	200.
<b>Petroleum:</b>			
Crude	do.	Hassi-Messaoud and others (El Borma, Stah, Al Agreb, Amassak, Tabankort, Nezla North, Haoud Berkaoui, Zemlet Ennous, Zarzaitine, Rhourde El Baguel, Edjeleh, Tin-Fouye and others)	440,000.
Do.	Total, Compagnie Francaise des Petroles (French Government, 34.1%; Abu Dhabi Investment Authority, 8.4%; Caisse des Depots et Consignations, 5.2%; other diverse shareholders, 52.3%)	Mereksen	2,000.
Refinery products thousand barrels	Entreprise Nationale de Raffinage des Produits Petroliers (Government, 100%)	Refinery at Skikda Refinery at Arzew Refinery at El Harrach, near Algiers Refinery at Hassi Messaoud Refinery at In Amenas	118,000. 21,000. 21,200. 9,800. 2,400.

TABLE 3  
ALGERIA: EXPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1991	Sources	
		United States	Other (principal)
<b>METALS</b>			
Aluminum: Metal including alloys, scrap	643	—	France 615; Morocco 28.
Copper: Metal including alloys:			
Scrap	9,389	—	Morocco 4,469; France 2,161; Netherlands 1,483.
Unwrought	222	—	All to France.
Iron and steel:			
Iron ore and concentrate, excluding roasted pyrite	13,300	—	Albania 6,650; Tunisia 6,650.
Metal:			
Scrap	30,889	—	Germany 12,553; Italy 10,431; Spain 6,136.
Pig iron, cast iron, related materials	273,625	—	Italy 167,550; Japan 53,200; Singapore 19,455.
Steel, primary forms	30,838	—	Thailand 19,000; United Kingdom 3,095; Egypt 3,000.
Semimanufactures:			
Universals, plates, sheets	15,857	—	China 5,000; Tunisia 3,278; United Kingdom 2,942.
Wire	726	—	Morocco 612; Tunisia 94.
Tubes, pipes, fittings	12,328	500	Italy 6,749; Switzerland 4,500.

See footnotes at tables.

TABLE 3—Continued  
ALGERIA: EXPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1991	Sources	
		United States	Other (principal)
Lead: Metal including alloys, scrap	390	—	Netherlands 285; France 71; Morocco 34.
Mercury	679	14	Netherlands 276; Belgium-Luxembourg 190; France 84.
Nickel: Metal including alloys, unwrought	39	—	All to France.
Zinc: Metal including alloys:			
Scrap	26	—	All to Germany.
Unwrought	12,984	—	Hungary 4,566; Morocco 3,085; Tunisia 3,079.
Other:			
Ashes and residues	2,491	—	Spain 1,625; France 866.
Base metal including alloys, all forms	46	—	All to Belgium-Luxembourg.
<b>INDUSTRIAL MINERALS</b>			
Clays, crude	7,425	—	Jordan 2,700; Italy 2,470; Tunisia 2,170.
Diatomite and other infusorial earth	452	—	Jordan 300; Morocco 92; Tunisia 60.
Feldspar, fluorspar, related materials	395	—	All to Tunisia.
Fertilizer materials: Manufactured:			
Ammonia	218,625	—	France 66,400; Italy 64,000; Spain 43,200.
Nitrogenous	66,697	—	France 32,715; Spain 22,982; Tunisia 4,600.
Phosphatic	1,700	—	All to France.
Gypsum and plaster	300	—	All to Morocco.
Phosphates, crude	thousand tons	1,044	— Austria 353; U.S.S.R. 153; France 135.
Salt and brine	16,160	—	Spain 12,400; Niger 3,760.
Stone, sand and gravel:			
Dimension stone:			
Crude and partly worked	823	—	France 273; Tunisia 232; Morocco 185.
Worked	66	25	U.S.S.R. 25; France 16.
Gravel and crushed rock	4,799	—	Tunisia 4,189; Italy 610.
Sulfur: Elemental, sulfuric acid	30,904	7,552	Turkey 13,683; Portugal 6,657; Spain 3,012.
<b>MINERAL FUELS AND RELATED MATERIALS</b>			
Gas, natural:			
Gaseous	value, thousands	\$1,449,238	— Italy \$1,386,775; Tunisia \$62,462.
Liquefied	million cubic meters	25,672	2,760 France 11,649; Belgium-Luxembourg 4,392; Spain 3,865.
Petroleum:			
Crude	thousand 42-gallon barrels	245,183	63,868 Italy 38,242; France 28,036; Netherlands 18,715.
Refinery products:			
Gasoline	do.	36,905	254 France 10,728; Netherlands 10,621; Italy 3,393.
Kerosene and jet fuel	do.	333	— Netherlands 193; France 116.
Distillate fuel oil	do.	33,031	213 Netherlands 10,208; Italy 9,758; France 4,741.
Lubricants	do.	143	— Greece 93; Tunisia 31; France 19.
Residual fuel oil	do.	37,949	26,093 Italy 6,237; France 3,402; Netherlands 1,147.

<sup>1</sup>Comparable data are not available for 1990. Table prepared by Virginia A. Woodson.



TABLE 4  
ALGERIA: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1991	Sources		
		United States	Other (principal)	
<b>METALS</b>				
Alkali and alkaline-earth metals	value, thousands	\$10	\$3	France \$3; Germany \$2; United Kingdom \$2.
<b>Aluminum:</b>				
Oxides and hydroxides		2,092	921	Turkey 762; Yugoslavia 400.
<b>Metal including alloys:</b>				
Unwrought		5,574	—	Spain 3,863; Germany 1,699.
Semimanufactures		7,940	1	Egypt 2,239; Italy 1,446; France 1,401.
Chromium: Oxides and hydroxides		69	—	U.S.S.R. 59; Germany 6.
Cobalt: Oxides and hydroxides		2	—	All from France.
<b>Copper: Metal including alloys:</b>				
Unwrought		112	2	Germany 58; France 51.
Semimanufactures		24,824	2	Spain 11,945; Turkey 9,540; France 1,603.
<b>Gold: Metal including alloys, unwrought and partly wrought</b>				
	value, thousands	\$8	\$7	Germany \$1.
<b>Iron and steel:</b>				
Iron ore and concentrate, including roasted pyrite		151	—	All from Belgium-Luxembourg.
<b>Metal:</b>				
Scrap		38	—	Do.
Pig iron, cast iron, related materials		7,698	—	Germany 6,926; Canada 600.
<b>Ferroalloys:</b>				
Ferrosilicon		4,323	—	Norway 2,510; Yugoslavia 1,674.
Unspecified		1,853	—	Spain 1,500; Brazil 255.
Steel, primary forms		23,380	—	Spain 19,624; Italy 2,247; Tunisia 300.
<b>Semimanufactures:</b>				
Bars, rods, angles, shapes, sections		655,981	77	Italy 186,650; Spain 102,817; Turkey 73,017.
Universals, plates, sheets		102,978	4	Germany 42,631; Italy 34,420; Belgium-Luxembourg 13,419.
Hoop and strip		74,810	( <sup>2</sup> )	Spain 54,392; Hungary 13,461; Germany 5,239.
Rails and accessories		15,062	—	Austria 14,831; Ireland 40.
Wire		21,807	11	Italy 11,314; Tunisia 4,791; Greece 2,151.
Tubes, pipes, fittings		153,562	35,627	France 40,116; Japan 24,368; Germany 19,032.
<b>Lead:</b>				
Oxides		3,865	—	Italy 3,759; Spain 73.
<b>Metal including alloys:</b>				
Unwrought		19,332	100	Morocco 12,609; Belgium-Luxembourg 2,700; United Kingdom 2,020.
Semimanufactures		30	—	France 29.
<b>Manganese:</b>				
Ore and concentrate: Metallurgical grade		68	—	All from France.
Oxides		2,384	—	Brazil 954; Spain 500; Belgium-Luxembourg 350.
Mercury	value, thousands	\$4	—	France \$2; Germany \$1; United Kingdom \$1.
Molybdenum: Metal including alloys, unwrought	do.	\$18	—	All from Germany.
<b>Nickel:</b>				
Matte and speiss	do.	\$4	—	All from Italy.
Metal including alloys, semimanufactures		50	3	Germany 30; France 6; Italy 7.

See footnotes at end table.

TABLE 4—Continued  
ALGERIA: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1991	Sources		
		United States	Other (principal)	
<b>METALS—Continued</b>				
Platinum-group metals: Metals including alloys, unwrought and partly wrought, platinum	value, thousands	\$18	—	France \$15; Belgium-Luxembourg \$3.
Silver: Metal including alloys, unwrought and partly wrought	do.	\$1,948	—	Belgium-Luxembourg \$1,081; France \$695; Germany \$96.
<b>Titanium:</b>				
Oxides		7,932	—	Australia 3,185; Spain 1,650; Belgium-Luxembourg 1,549.
<b>Metal including alloys:</b>				
Unwrought		60	—	All from Malaysia.
Semimanufactures		35	—	Belgium-Luxembourg 25; France 8.
Tungsten: Metal including alloys, unwrought	value, thousands	\$1	—	All from Switzerland.
<b>Zinc:</b>				
Oxides		608	—	France 550; Germany 35; Netherlands 21.
Blue powder		3	—	Belgium-Luxembourg 1; France 1; Italy 1.
<b>Metal including alloys:</b>				
Unwrought	value, thousands	\$4	—	All from Italy.
Semimanufactures		294	—	Belgium-Luxembourg 280; France 12.
<b>Other:</b>				
Ores and concentrates		26	—	All from France.
Oxides and hydroxides		473	—	France 431; Tunisia 25; Germany 11.
<b>INDUSTRIAL MINERALS</b>				
<b>Abrasives, n.e.s.:</b>				
Natural: Corundum, emery, pumice, etc.		308	—	Italy 290; France 17.
Artificial: Corundum		584	—	Italy 330; Austria 158; France 96.
Dust and powder of precious and semiprecious stones including diamond	value, thousands	\$3	—	All from France.
Grinding and polishing wheels and stones		320	8	Austria 138; Italy 122; France 25.
Asbestos, crude		15,726	—	Canada 12,571; Republic of South Africa 2,650; United Kingdom 505.
<b>Boron materials:</b>				
Crude natural borates		1	—	All from Italy.
Oxides and acids		152	—	Turkey 75; Italy 63; Belgium-Luxembourg 10.
Bromine, iodine, fluorine		6	—	France 4; Chile 2.
Cement	thousand tons	1,558	—	Spain 696; Tunisia 625; Turkey 199.
Chalk		10,030	—	France 5,339; Jordan 2,500; Germany 893.
Clays, crude		16,071	90	United Kingdom 14,134; Germany 1,000; Spain 661.
Cryolite and chiolite		6	—	All from Italy.
Diatomite and other infusorial earth		100	—	All from France.
Feldspar, fluorspar, related materials		5,201	—	Turkey 3,000; Norway 1,800; Germany 218.
<b>Fertilizer materials: Manufactured:</b>				
Ammonia		3	—	Spain 2; Germany 1.
Nitrogenous		7,027	—	Germany 4,511; Italy 2,460.
Phosphatic		14,385	—	Tunisia 14,355; France 30.
Potassic		49,057	—	France 21,501; Spain 16,900; Germany 10,562.

See footnotes at end of table.

TABLE 4—Continued  
ALGERIA: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1991	Sources	
		United States	Other (principal)
<b>INDUSTRIAL MINERALS—Continued</b>			
Graphite, natural	70	—	Mainly from Germany.
Gypsum and plaster	559	—	France 554; West Germany 5.
Lime	thousand tons 1,560	—	Spain 696; Tunisia 625; Turkey 199.
Magnesite, crude	1,334	—	Austria 1,320; France 6.
<b>Mica:</b>			
Crude including splittings and waste	4	—	All from Belgium-Luxembourg.
Worked including agglomerated splittings	1	—	Mainly from France.
Phosphates, crude	2,001	—	Tunisia 2,000; France 1.
Pigments, mineral: Iron oxides and hydroxides, processed	461	—	Italy 184; Spain 149; Belgium-Luxembourg 70.
Salt and brine	44	—	Germany 24; France 10; Italy 10.
Sodium compounds, n.e.s.: Soda ash, manufactured	18,200	—	France 14,008; Bulgaria 2,906.
<b>Stone, sand and gravel:</b>			
Dimension stone: Worked	1,755	—	France 1,704; Belgium-Luxembourg 37.
Dolomite, chiefly refractory-grade	1,367	—	France 662; Italy 620; Spain 60.
Gravel and crushed rock	1,880	—	Belgium-Luxembourg 1,406; France 389; West Germany 85.
Quartz and quartzite	84	—	France 54; Germany 30.
Sand other than metal-bearing	726	19	Belgium-Luxembourg 700.
<b>Sulfur:</b>			
<b>Elemental:</b>			
Crude including native and byproduct	71,949	—	France 40,650; Spain 17,466; Iran 10,993.
Colloidal, precipitated, sublimed	900	—	All from France.
Sulfuric acid	11	—	France 4; Germany 3; Spain 2.
Talc, steatite, soapstone, pyrophyllite	612	—	Spain 338; France 274.
Other: Crude	168	—	France 141; Austria 20.
<b>MINERAL FUELS AND RELATED MATERIALS</b>			
Asphalt and bitumen, natural	142	44	France 98.
Carbon black	2,343	—	United Kingdom 688; Spain 549; France 534.
<b>Coal:</b>			
Anthracite	24	—	All from France.
Unspecified	thousand tons 1,000	600	Australia 400.
Coke and semicoke	30,000	—	All from Poland.
<b>Petroleum refinery products:</b>			
Liquefied petroleum gas	42-gallon barrels 12	—	Mainly from United Kingdom.
Gasoline	do. 7,404	—	Belgium-Luxembourg 5,500; France 1,904.
Mineral jelly and wax	do. 24,728	14,072	Spain 10,522.
Kerosene and jet fuel	do. 8,339	78	Belgium-Luxembourg 8,223; Spain 31.
Distillate fuel oil	do. 15	—	All from France.
Residual fuel oil	do. 4,401,647	7	Greece 3,339,990; Spain 1,002,223.
Bitumen and other residues	do. 400,566	8,205	Spain 392,361.
Bituminous mixtures	do. 5,381	182	France 3,042; Austria 2,157.
Petroleum coke	do. 325	—	All from Germany.

<sup>1</sup>Comparable data are not available for 1990. Table prepared by Virginia A. Woodson.

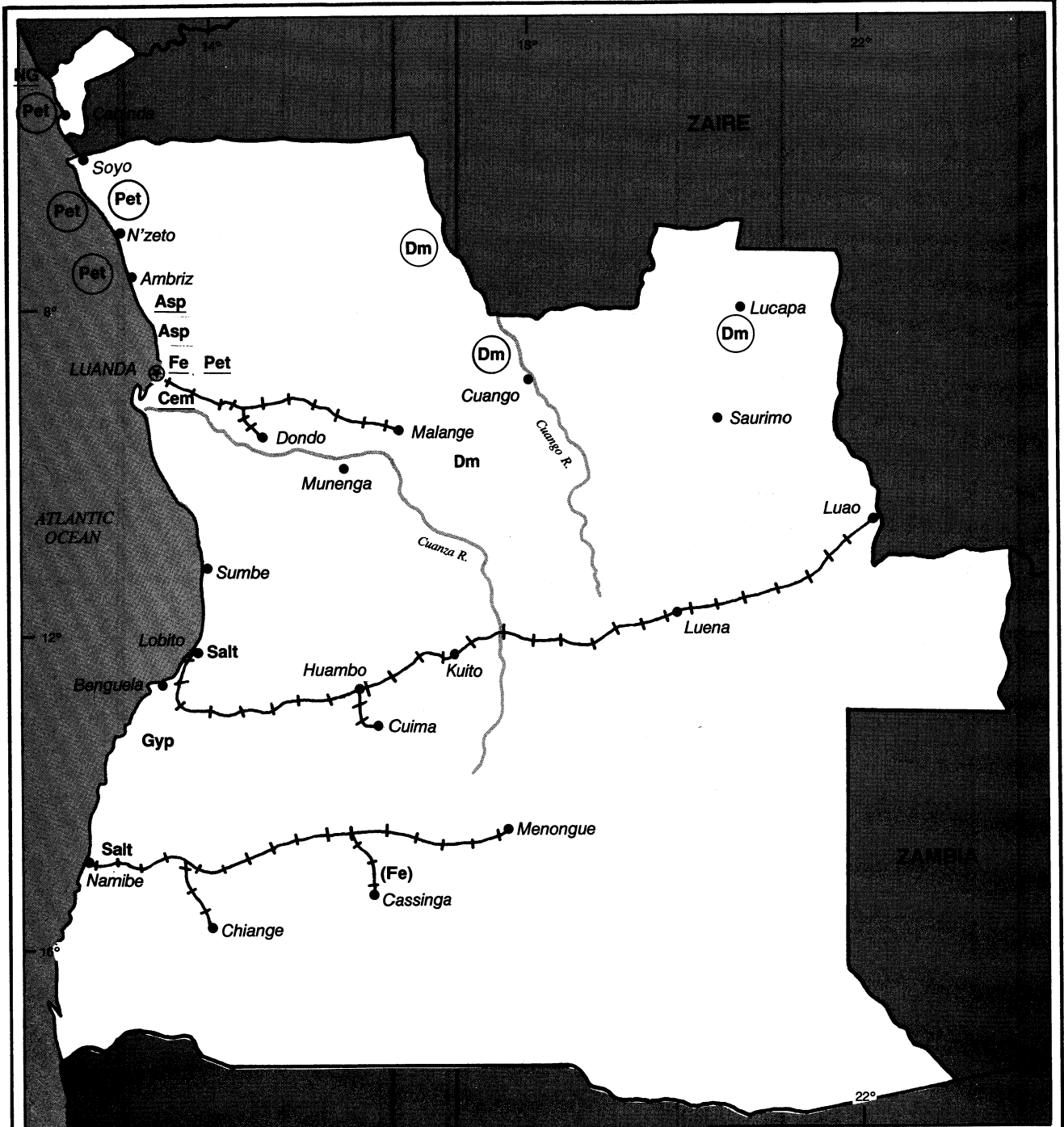
<sup>2</sup>Unreported quantity valued at \$1,000.



# ANGOLA

AREA 1,246,700 km<sup>2</sup>

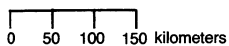
POPULATION 8.9 million



**LEGEND**

- International boundary
- Capital
- City
- Railroad
- River
- Group of producing mines or wells
- Undeveloped significant resource

See table for mineral symbols.  
Underlined symbol indicates plant.



## THE MINERAL INDUSTRY OF THE

# ANGOLA

By Philip M. Mobbs

The mineral industry, dominated by petroleum and diamonds, was a significant contributor to the economy of Angola. The petroleum industry alone provided more than 50% of the Government's revenues. The prospect for developing Angola's rich and varied mineral resources waned in October 1992 when the civil war reignited after a 16-month respite.

All mineral resources were the property of the state. Foreign oil companies operated in joint ventures or under production-sharing agreements with the Government's Sociedade Nacional de Combustíveis de Angola. Diamonds were mined legally by the state-owned Empresa Nacional de Diamantes de Angola (Endiama) and its contractors, and illegally by small-scale miners (garimpéiros). All other minerals were mined or processed by Government enterprises; however, foreign company

mining activity was authorized by the 1991 mining law revision.

Most of Angola's official diamond production of approximately 1 million carats, worth \$100 million,<sup>1</sup> was marketed through De Beers Centenary AG's Central Selling Organization. The world market was disrupted when a massive oversupply of rough diamonds, estimated at \$500 million, was smuggled out of the country. More than 50,000 garimpéiros worked the Cuango River between Cuango and the Zairian border from mid-1991 to late 1992. The resumption of hostilities initially dispersed the garimpéiros and shut down Endiama's subcontractors.

Crude oil exports, primarily to the United States, accounted for about 90% of the country's official export earnings. Most Angolan petroleum operations were offshore, with the offshore Cabindan fields producing approximately one-half

of Angola's 550,000 bbl/d output. With the resumption of hostilities, the National Union for the Total Independence of Angola (Unita) attacked the Soyo oil terminal and associated facilities hoping to eliminate them as sources of Government funding.

Petroleum should continue to dominate Angola's economy for the foreseeable future. Renewed garimpéiro operations, which remove primarily high-grade diamonds, could damage Angola's ability to restore the alluvial segment of the industry. The minerals industry may slowly revive once the security issue is resolved; however, there are substantial transportation problems and generally weak world markets for many of Angola's mineral products.

<sup>1</sup>Where necessary, values have been converted from Angolan kwanzas (AK) to U.S. dollars at the average annual rate of AK420=US\$1.00.

TABLE 1  
ANGOLA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons, unless otherwise noted)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992 <sup>5</sup>
Asphalt and bitumen, natural <sup>6</sup>	13,000	13,000	13,000	13,000	13,000
Cement, hydraulic <sup>6</sup> thousand metric tons	<u>1,000</u>	<u>1,000</u>	<u>1,000</u>	<u>1,000</u>	<u>1,000</u>
Diamond: <sup>3</sup>					
Gem <sup>6</sup> thousand carats	<sup>7</sup> 994	1,165	1,060	899	935
Industrial <sup>6</sup> do.	50	80	73	62	65
Total                                      do.	<u><sup>7</sup>1,044</u>	<u>1,245</u>	<u>1,133</u>	<u>961</u>	<u>1,000</u>
Gas, natural: <sup>6</sup>					
Gross <sup>4</sup> million cubic meters	2,790	<sup>5</sup> 2,820	<sup>2</sup> 2,605	2,870	2,800
Dry    do.	<sup>5</sup> 512	<sup>5</sup> 427	<sup>5</sup> 538	<sup>4</sup> 460	580
Gypsum <sup>6</sup>	57,000	57,000	57,000	57,000	57,000
Iron and steel: Steel, crude <sup>6</sup>	10,000	10,000	10,000	10,000	10,000
Natural gas plant liquids, propane and butane <sup>6</sup> thousand 42-gallon barrels	2,790	2,480	2,500	2,500	2,500
Petroleum:					
Crude    do.	165,000	167,000	174,000	184,000	200,000
Refinery products                              do.	9,855	10,800	11,700	<sup>6</sup> 12,000	12,000
Salt <sup>6</sup>	70,000	70,000	70,000	70,000	70,000

<sup>6</sup>Estimated. <sup>7</sup>Revised.

<sup>1</sup>Table includes data available through May 22, 1993.

<sup>2</sup>In addition to the commodities listed, a variety of crude construction materials (clays, sand and gravel, and crushed stone) presumably is produced for local consumption, but information is inadequate to make reliable estimates of output levels.

<sup>3</sup>Does not include smuggled artisanal production.

<sup>4</sup>Angola has no natural gas distribution system; most gas is vented except for a small fraction from which natural gas liquids are processed. Propane and butane canisters are filled at the well site. See "Natural gas plant liquids" in table.

<sup>5</sup>Reported figure.

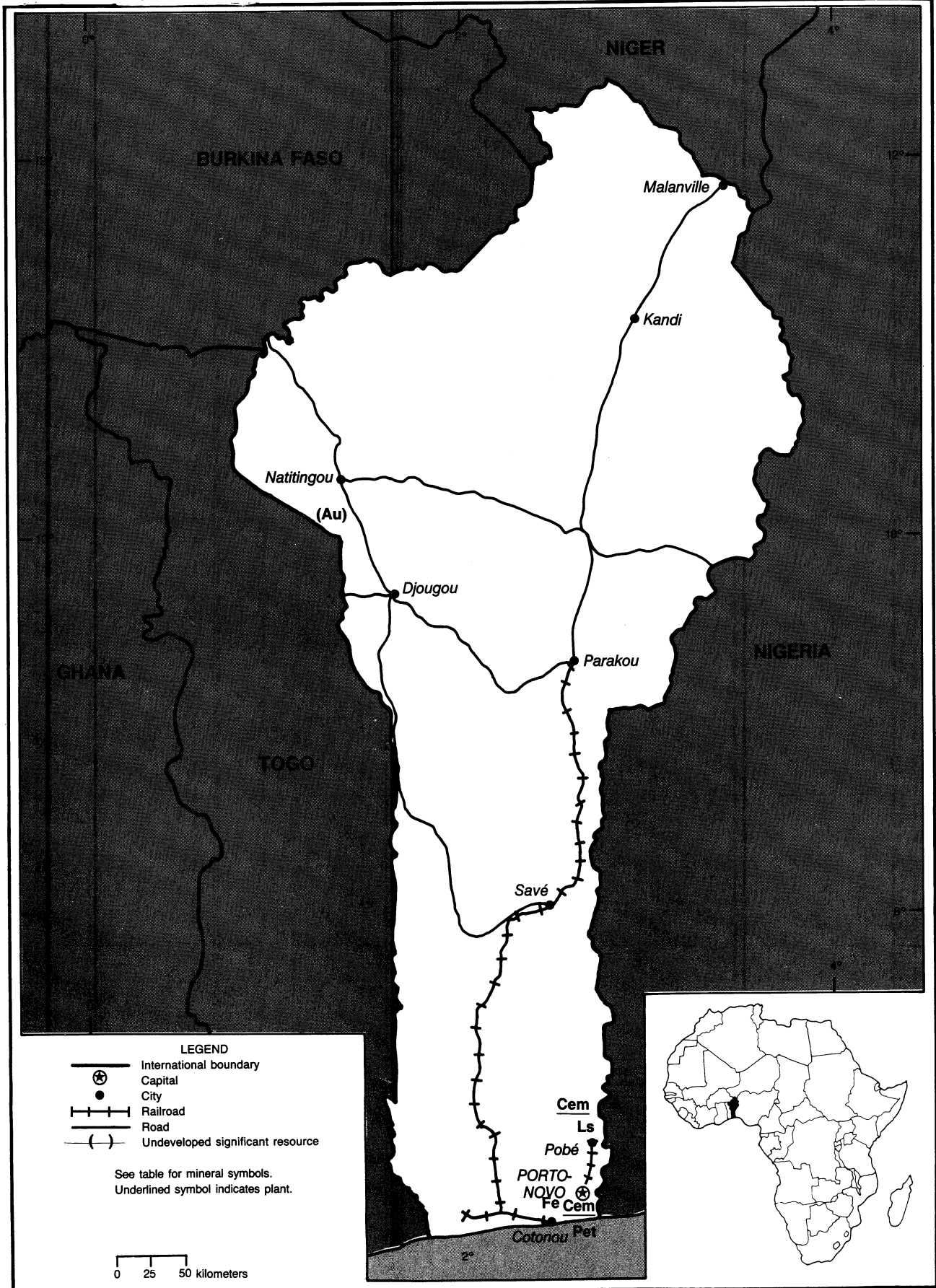




# BENIN

AREA 112,620 km<sup>2</sup>

POPULATION 5.0 million



## THE MINERAL INDUSTRY OF

# BENIN

By Hendrik G. van Oss

The production of mineral commodities was a small but important part of the economy of Benin and was dominated by the production of modest quantities of crude petroleum and cement (see table 1). Sales of mineral commodities in 1992 were estimated to have amounted to \$55 million, as compared with the GDP for the year of about \$2.16 billion.<sup>1</sup> Exports of mineral commodities amounted to about \$25 million or almost 7% of Benin's total exports. Crude petroleum sales, all as exports, were worth about \$16 million, and cement exports were estimated to have been worth about \$9 million. Cement sales to the domestic market were estimated to have been worth about \$23 million.

Benin's imports of mineral commodities were dominated by refined petroleum products and clinker for cement, worth \$45.3 million and an estimated \$14 million, respectively. Benin imported about 95% of its electricity needs, all from Ghana, at a cost of an estimated \$10 million. Total imports of goods and services for the year amounted to about \$700 million.

The Government continued to enact various facets of a World Bank structural

adjustment program. This has resulted in liberalization of the country's investment regulations and the adoption of a market economy. Privatization of state-run industries was a major goal. The Office Béninoise des Mines (OBEMINES), under the Ministry of Industry, Mines, and Energy, oversees mineral developments in Benin. A new mining law was being drafted, under UN sponsorship, and a draft of the proposed new legislation was submitted to the Government late in the year. Although production and sales data were limited, it appeared that Benin's cement sector improved its importance significantly during the year. This was largely due to an almost 60% increase in output by CIMBENIN to 140,000 tons following its early 1991 privatization. About 20% of CIMBENIN's production was exported, to Niger and Burkina Faso. Société des Ciments d'Onigbolo (SCO), the country's largest cement plant and the only integrated facility, continued to produce well below capacity but, reportedly, returned to exporting much of its production rather than competing on the domestic market with the other two producers. The Governments of Benin and Nigeria agreed during the year to

privatize their shares in the company, but disagreement remained as to the valuation method for their respective holdings.

Output of crude oil in 1992 was all from the Sèmè Field. Production during the year fell significantly owing to the wells making a lot of water and the depletion of reserves. The Government reported recoverable reserves at Sèmè to be about 41 Mbbl, about 25 Mbbl of which was as condensate. However, according to the operating company, the field's useful production life was limited to a further 2 years only, because of production problems. Operational management of the field was assumed in early July by the Government, following the failure to reach a renewal agreement with the former operator. Onshore exploration rights covering about 4,350 km<sup>2</sup> in southern Benin were controlled by Trilogy Resources Corp. of Canada. The company was seeking a partner to finance drilling exploration wells; no exploration work was conducted during the year.

<sup>1</sup>Where necessary, values have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF264.69=US\$1.00.

TABLE 1  
BENIN: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990 <sup>3</sup>	1991 <sup>3</sup>	1992 <sup>3</sup>
Cement, hydraulic <sup>3</sup>	200,000	250,000	<sup>3</sup> 300,000	<sup>3</sup> 320,000	370,000
Iron and steel: Steel, crude <sup>3</sup>	—	2,000	8,000	8,000	8,000
Petroleum, crude thousand 42-gallon barrels	1,825	1,460	<sup>3</sup> 1,416	<sup>3</sup> 1,353	<sup>3</sup> 931
Salt, marine <sup>3</sup>	100	100	100	100	100

<sup>3</sup>Estimated. <sup>2</sup>Revised.

<sup>1</sup>Includes data available through Apr. 9, 1993.

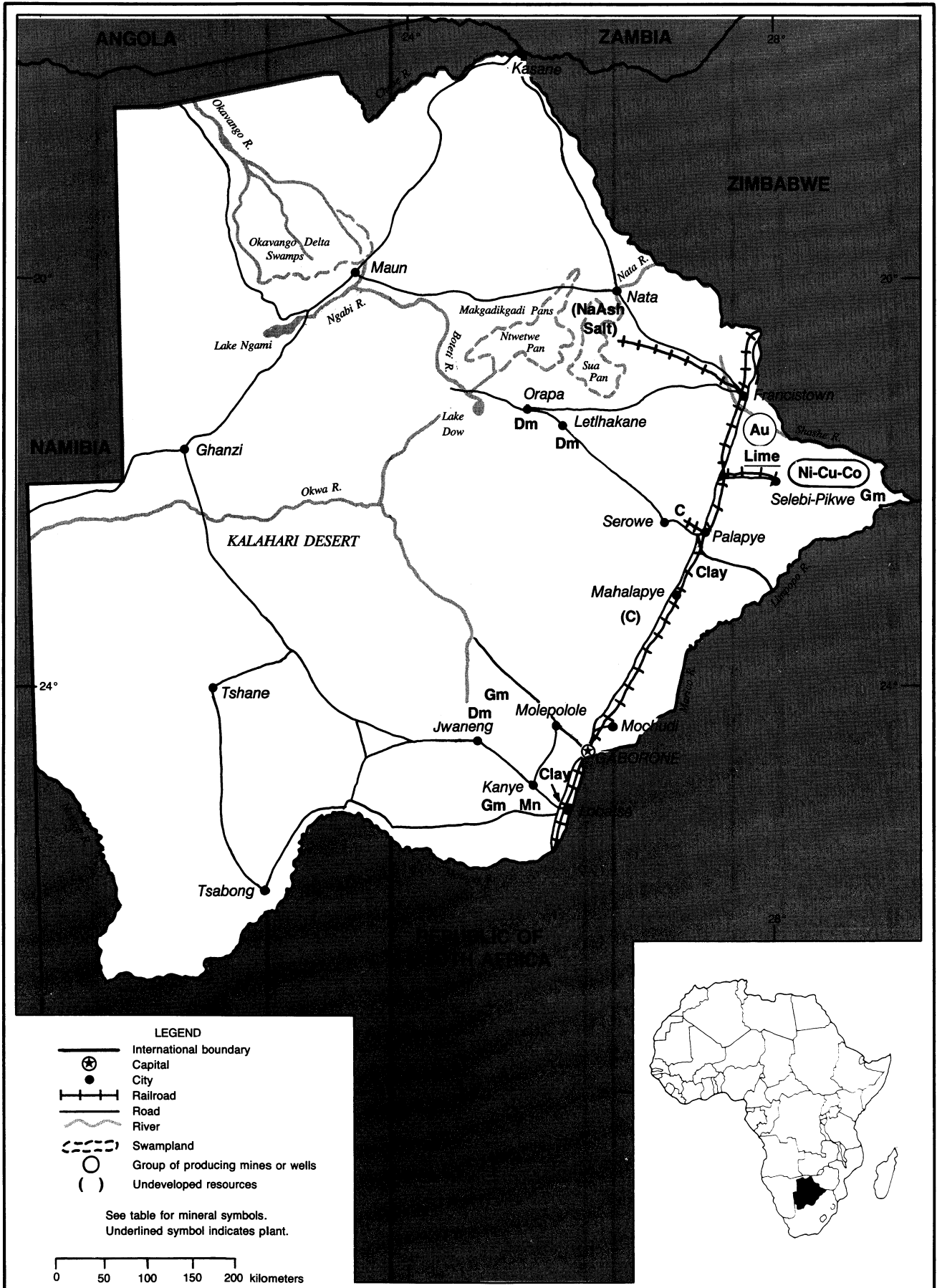
<sup>2</sup>In addition to the commodities listed, unreported quantities of stone and sand and gravel are believed to be produced, but information is inadequate to make reliable estimates of output levels.

<sup>3</sup>Reported figure.

# BOTSWANA

AREA 600,370 km<sup>2</sup>

POPULATION 1.3 million



## THE MINERAL INDUSTRY OF

# BOTSWANA

By Lloyd E. Antonides

Minerals continued to be the base of Botswana's economy during 1992 as they had for nearly 20 years since the start of diamond production. Diamonds were the principal source of revenue, and the country was the world's leading producer by value and third by weight. Nickel and copper also played a significant though smaller role in the economy. Coal production was an important source of energy, and soda ash and salt production began having an impact on the economy as well. Other valuable minerals produced included gold and silver, manganese, semiprecious stones and construction stone, sand, and clay. A number of occurrences of most produced minerals remained unworked. Platinum-group metals and petroleum were exploration possibilities.

The mineral industry typically accounted for more than 40% of a GDP estimated for 1992 at more than \$3.5 billion<sup>1</sup> and more than 85% of exports totaling about \$2.2 billion in 1992, as well as about 50% of Government revenue. Yet, in 1992, the domestic mining industry's 13,000 wage earners<sup>2</sup> were only about 5% of total formal (wage earning) employment of about 250,000. Of the total labor force, estimated to be at least 440,000, apparently less than 3% were in mining versus more than 35% in agriculture, 40% in other industry and commerce, and 20% in Government. However, not included in mining but presumably included at least in the total labor force, possibly as other industry, were 10,000 to 15,000 (2% to 3%) that worked in South African mines. Nevertheless, it was primarily the domestic mineral bounty that provided a high per capita GDP and normally a surplus in the balance of payments.

During 1992, the Botswana mining

industry was adversely affected by the general worldwide economic recession. According to the Department of Mines Annual Report, prices for copper and nickel and soda ash reached alltime lows because of oversupply and competitive pressures. Depressed market conditions adversely affected diamond sales after September when quotas for deliveries to the Central Selling Organization (CSO) of the DeBeers group were reduced to 75%. However, in May 1993, the quota was raised to 80% and in July to 85%. Because of the low metal price trends, in June 1993, AMAX Inc. (AMAX) finally sold its substantial loan interest and 29.8% equity share in BCL Ltd. (BCL), the nickel-copper-cobalt producer, to the Government at a very small fraction of book value. AMAX had been disenchanted with the troubled firm for a number of years.

Geographically, Gaborone, the capital of the landlocked, Texas-sized country, was about 800 km (mapline) from the Indian Ocean and 1,100 km from the Atlantic. In general, the country was a flat to gently rolling, dry and sparsely vegetated land above 1,000 meters in elevation, with some rocky hills and savannah woodland in the east and north. In the north, streams from further north in Angola, emptied into a broad interior river delta swamp and eventually, together with intermittent streams draining the country's central desert region, discharged into an extensive evaporative salt flat depression in the northeast. Boundary streams on the south and southwest, usually intermittent, drained southwesterly, eventually into the Atlantic Ocean. Boundary streams, mostly permanent, on the north and east drained easterly, eventually to the Indian Ocean. Warm winters and hot summers,

both generally dry and dusty, characterized the semiarid, subtropical climate. Rainfall was limited in the east (about 20 inches per year) and considerably less in the center and especially in the southwest, with specific area coverage erratic and regional droughts occurring periodically. There were three broad ecological areas: the east, which had generally arable land, though rather limited, some savannah woodland, and most of the population and infrastructure; the north, which was dominated by the large swampy delta and had some savannah woodland; and the center and southwest, which was semidesert, much of it sandy, that was sparsely covered with grass and thornbush and extended northeasterly into salt flats.

Geologically, the main structural feature was an ancient depositional basin, about 400 km wide by 1,600 km long, elongated along a northeast-southwest line through the center of the country. Much of that area was covered with sand. On the east, in a zone roughly 100 to 200 km wide along the border, the underlying rocks were pre-Cambrian formations of the Basement Complex consisting of Archean cratons in the north and south with the younger Limpopo mobile belt in the middle. In the northwest corner, later pre-Cambrian formations of the Damaran mobile belt were exposed.

Botswana's mineral resources remained largely unexplored. Principal areas of interest for metals were considered to be the northeast for copper, nickel and precious metals; the northwest for copper and silver; and the south for base and precious metals. Many areas with potential for precious stones were open to prospecting, and other industrial mineral deposits were available for

leasing. Huge coal reserves were also known in the east and central regions, and a petroleum potential in the west remained to be explored. The country's basic geology was fairly well known and continued mapping was providing greater detail. Results of several geophysical surveys were available. However, in general, there were infrastructure restraints on exploration, particularly road access and water supply especially in the west. Another restraint in the western half of the country was the frequent thick cover of Kalahari Desert sand. A perennial shortage of sufficiently capable local and expatriate employees was also claimed as a restraint on exploration efforts by some minerals companies.

The economy of Botswana was one of Africa's strongest, having experienced a steady high growth for many years. In 1992, with a per capita GDP of almost \$3,000, it was one of the richest countries in southern Africa, being about even with South Africa. However, the annual rate of increase in GDP began declining from more than 10% to less than 10% in about 1989, and some estimates indicate it may have fallen to below 6% in 1992. At the same time, the consumer price inflation rate began rising from about 10% to more than 15%, and the rate of new jobs creation went down from more than 10% to about 2% per year in 1992. But Government officials for sometime had shown their awareness of the economic trends and the possibility of budget deficits in coming years and were taking steps to change the outlook and seeking expert advice from international agencies.

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## GOVERNMENT POLICIES AND PROGRAMS

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Having been a multiparty, parliamentary democracy since independence from Britain in 1966, Botswana had a history of a stable political environment with a development-oriented Government demonstrating fiscal prudence, free market philosophy, and flexibility and fairness in dealing with investors. These conditions were a major

basis for continued interest in the country by the mining industry and others.

Private sector growth and job creation, especially in manufacturing and agriculture, were emphasized as development objectives by the Government. It recognized and actively promoted the existence of a very attractive mineral potential. However, at the same time, there was a desire for diversification away from the economy's heavy dependence on diamonds.

Botswana encouraged foreign investment. There were no restrictions on reinvestments or repatriation of earnings and capital, and exchange controls were liberal. Botswana had never nationalized or expropriated any foreign business. It carefully followed its established rules for investment, and its courts repeatedly upheld contracts. Government corruption was rare, and penalties severe. An investment guarantee agreement with the United States was signed in 1968, and Botswana also was a member of the Multilateral Investment Guarantee Agency (MIGA), the World Bank's political insurance unit.

To aid the private sector's participation in the economy, the Government took measures to better the human resources aspect in the areas of training, education, and health. Planned infrastructure improvements were being implemented in transportation, power, communication, and water supply. Increased availability of capital for small- to medium-size ventures was to come through expansion of Botswana's Development Corp.'s operations. Being especially aware of the adverse impact that lack of infrastructure had on potential mineral projects, the Government stated its willingness to assist in securing funding for such work.

The Ministry of Mineral Resources and Water Affairs had responsibility for the mining sector. The Ministry granted reconnaissance permits (for 1-year general prospecting) and prospecting licenses (for 3 years plus two 2-year extensions with minerals and area specified) and negotiated mining leases (for 25 years with project plans, financial aspects, and lease extension conditions specified). Subunits of the Ministry also

carried out geological surveys, made mine safety and environmental inspections, and collected mineral production information.

Mineral rights, vested in the state, were separate from surface rights. On significant mineral ventures, the Government normally exercised its legal right to acquire, free, an equity interest of 15% to 25%. Royalties were also collected on certain mineral sales such as 3% on base metals, 5% on gold, and 10% on diamonds. Though also subject to corporate income tax, reduction of the basic rate of 40% was typically part of overall lease negotiation.

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## PRODUCTION

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Botswana's production of its dominate mineral commodity, diamonds, declined in volume (carat weight) 3.4% in 1992 as compared to that of 1991. (See table 1.) This was attributed to lower grades at the Orapa and Letlhakane mines and lower throughput at Jwaneng. Although purchases by the CSO were cut 25% starting in September, the surplus was stockpiled. The sales value was reported to be 11% less. Nickel-copper-cobalt in smelter matte was not significantly lower in volume, although revenue was sharply down because of an adverse market with weak prices. In spite of adverse markets, soda ash and salt production continued to climb as startup problems were resolved. Gold output had an eightfold increase compared to 1991 as the Monarch mine continued to raise production since startup in November 1991. Semiprecious gemstones sales may have indicated a rise in production even though a second licensed dealer's new processing plant did not start up until late in the year. Brick clay output also increased as a result of the start up of a new brick plant in late 1991. Crushed stone production rose very slightly, mainly for Government road projects, even though the construction industry in general was in a slump. Sand output dropped a large amount.

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## TRADE

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For 1992, exports and imports were

roughly in balance, according to International Monetary Fund data, which showed total exports were \$2.185 billion f.o.b., and total imports were \$2.210 billion c.i.f.

Exports continued to be mainly mineral commodities. Other than reports that diamond exports declined 11% in value and sales of smelter matte containing nickel-copper-cobalt were 20% less in value, specific data were not available for 1992. In prior recent years, 75% to 80% of total export value was diamonds, and 7% to 14% was nickel, copper, and cobalt contained in smelter matte. About 1990, textiles rose abruptly to about 10%, while animal-derived commodities had declined to less than 5% of export value. Europe was the destination of 85% to 90% or more of exports. The United States took less than 1%.

Imports were mostly mechanical and electrical products and equipment that, including vehicles, accounted for nearly 40% of total value annually starting about 1988. The petroleum and other chemicals, foodstuffs, and wood and metal products groups were each in the 10%-to-15% range. The immediate source of 75% to 80% of imports was effectively South Africa but officially the Southern Africa Customs Union (SACU). Presumably, the ultimate sources were largely the industrialized nations and the Middle East. SACU, of which Botswana continued to be a member since 1910, included Lesotho, Namibia, and Swaziland as well as South Africa and its related homelands. Zimbabwe, with which Botswana had a bilateral trade agreement, was a major source of food, more than 80% of which was imported. Available data showed the United States as the source of less than 3% of annual imports though 1989, but the full extent was probably masked by the need to ship through other countries. Union provisions provided for common external tariff and excise tax schedules and rights of transit across South Africa for imports of the landlocked members.

## STRUCTURE OF THE MINERAL INDUSTRY

The Government of Botswana (GOB) and Anglo American Corporation of South Africa Ltd. (AAC) were very significant participants in Botswana's mineral industry. (See table 2.) AAC was one of the world's three largest companies in regard to controlling share of the total value of nonfuel minerals produced, omitting consideration of companies in the former U.S.S.R.

Although the GOB had the legal right to negotiate receiving a free grant of 15% to 25% equity in ventures when issuing mining leases, it sometimes also acquired additional interest. It originally held only a 15% share of BCL, the major nickel-copper-cobalt producer, but, in June 1993, bought another 29.8% share from AMAX, who wanted to withdraw from the troubled venture. It also held 15% of Shashe Mines Ltd., Phelps Dodge (Africa) (Pty.) Ltd.'s 85% held company that opened the Map Nora gold mine near Francistown in 1989. The operation had been expected to be the country's largest gold producer but closed in early 1991 when the gold price dropped and expected reserves failed to develop.

The Government initially received a 50% ownership in the diamond mining entity that became Debswana Diamond Co. (Pty.) Ltd. (Debswana) in 1990 plus a small additional interest resulting from an agreement in 1987 when Debswana was apparently given a 5% share of the other 50% owner, at that time, De Beers Consolidated Mines Ltd. (De Beers Consol). The 1987 agreement also gave Debswana two seats on De Beers Consol's board of directors, with the Government gaining the right to make the appointments. Later, the seat agreement applied to De Beers Centenary AG, a unit formed during restructuring by the De Beers group in 1990 and to which De Beers Consol's ownership of Debswana was transferred. Apparently, Debswana and the Government continued to retain the two seats on De Beers Consol's board.

The GOB had a 48% equity share in

Soda Ash Botswana (Pty.) Ltd. (SAB), but a substantial portion was actually a financial investment for which buyers were sought. The Botswana Development Corp. (BDC), a Government agency, also provided funding and guidance to small, nascent private enterprises. It was seeking to expand its role in mining.

AAC had substantial financially beneficial interests and often controlling or management interests in all the larger Botswana mining operations. It was very closely related to the De Beers group and was a major participant in BCL and SAB and, in 1991, acquired a 51% share of Tati Nickel Mining Co., the only other active source of nickel-copper-cobalt ores in Botswana, for which BCL was the contract miner and toll smelter.

Gold operations were active at the Monarch mine and Shamrock Ltd.'s tailings retreat plant, but several other rather small ventures that had some production in 1991 were closed throughout 1992. All operations were near Francistown.

Jacomar Manganese (Pty.) Ltd. began production, and some other mining ventures, generally smaller size, were again reported to be planning to open mines in 1993. Thakudu Mining (Pty.) Ltd. was to produce copper and silver in the Masitama Copper District, about 75 km west-northwest of Francistown. A Falconbridge unit, the original lease holder, transferred the lease to Thakudu in return for a royalty. Thakudu was a subsidiary of a South African mining consulting firm, G.S.E. Mining.

The semiprecious gemstone segment of the industry consisted of many small individual miners, but only two licensed dealers. One of the dealers, Agate Botswana (Pty.) Ltd., was newly licensed in 1992. Both dealers apparently had plants to process rough stones, presumably into polished stones at least. Agates were the principal product.

At least nine rock quarries, two clay pits, and undoubtedly a number of sand and gravel pits operated in various parts of the country. During 1992, a lease was issued to Manyana Granite (Pty.) Ltd. to produce dimension stone and by products from granite hills near Manyana village.

The location was not otherwise identified, but it was most likely in the granite area extending out about 50 km to 100 km, around Gaborone, although some scattered granite occurrences were also reported in the Selebi-Phikwe area.

Total employment in the mining and quarrying sector in 1992 averaged more than 13,000. The industry included the country's largest private-sector employers: Debswana with more than 5,700 employees, including those in related units doing sorting, cutting, polishing, and other downstream work connected with diamonds; and BCL with about 5,200 working in nickel-copper-cobalt production. SAB employed just less than 700 and was expected to drop to about 600 after full production was achieved. Morupule Colliery (Pty.) Ltd. employed more than 350. Gold operations had about 300 workers, and the clay mines and rock quarries about 600. About 1,100 expatriates were working in the mineral sector. Citizen labor at the major mines, except SAB, was unionized. Obviously, the aforementioned figures did not include an estimated 10,000 to 15,000 workers in South African mines.

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## COMMODITY REVIEW

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### Metals

**Copper.**—Thakadu Mining delayed development of the Thakadu-Makala copper deposit pending completion of archeological studies. Located in the Masitama Copper District, about 75 km west-northwest of Francistown, the deposit was earlier said to consist of about 8 Mmt of 3.5% copper ore containing some silver. Development was expected to start in 1993. Plans called for a solvent extraction/electrowin plant to annually produce 6,000 tons of copper and 2,000 kg of silver.

No further information was available on Falconbridge's exploration further north in that area or on AAC's work in an area north of Ghanzi. Mineralization in the latter area was reportedly similar to the Zambian copper belt. Starting in the spring of 1993, a 10-month aeromagnetic survey to locate stratiform copper

deposits in the Ghanzi-Chobe area was planned by the Department of Geological Survey.

**Gold-Silver.**—The reopened Monarch mine increased production during the year since the new plant started up in November 1991. The goal for end of 1992 was about 50 kg/month of gold bullion recovered at 4 g/mt from 12,500 mt/month of ore. Originally, it was to be 25 kg from 7,000 mt/month of ore. Higher grade ore was said to occur to the north and south of the existing mine. Bullion Recoveries, an entity identified as being from South Africa, was managing operations under contract from the joint-venture owners who reportedly spent about \$3 million on exploration, equipment, and plant facilities.

Shamrock Ltd.'s nearby tailings retreatment plant continued to operate during the year, producing 8 kg gold bullion. However, other small companies working small pits or old tailings in the vicinity of Francistown were closed because of water shortage, erratic ore occurrence, improper processing methods, and financial problems.

Bullion (Pty.) Ltd. was reevaluating the Map Nora gold prospects that were acquired from Phelps Dodge in early 1992. There were no press reports regarding exploration work being done in 1991 by Falconbridge or Phelps Dodge in the general Francistown area.

**Manganese.**—Jacomar began producing during the year, shipping ore to South Africa starting in August.

**Nickel-Copper-Cobalt.**—The financial position of Botswana RST Ltd. (BRST) and its 85% held BCL, which owned and operated the nickel-copper-cobalt mines and processing facilities at Selebi-Phikwe in the northeast, continued to erode in 1992. It was attributed to lower metal prices due to oversupply and to increasing costs due to strength of local currency, declining ore grades, and deeper mining. The result was operating income before interest charges showing a loss of about \$6 million versus a surplus of \$22 million

in 1991. For some time, revenues had covered operating costs even when metal sales prices were low, but, except for a few years when prices were high, owners failed to earn a return on their investment, which was largely in loans. Amount of such loans, including accrued unpaid interest, from principal stockholders were more than \$900 million at yearend 1992, according to BRST's Annual Report. It also showed other loans with interest owed at yearend as totaling more than \$150 million. However, another press report gave a much lower figure of \$313 million for total debt.

AMAX of the United States held the largest single interest in the troubled venture and had been looking for a buyer even before the 3-year period of good operating profits ended in 1991. BRST was its last investment in Africa and in nickel, and disposal was part of its corporate revamping program. In the fall of 1992, AMAX called for liquidation of the venture as unviable because of heavy debt, depleting reserves, environmental problems, and poor outlook for market prices compared to operating costs. Finally in June 1993, after lengthy negotiations, AMAX sold its 29.8% equity share of BRST to the Government of Botswana for a nominal price. The Government also paid AMAX \$8 million for notes covering AMAX's loans to BRST/BCL said to total \$84.2 million, including accrued unpaid interest.

Ore production tonnage schedules were met and mill throughput was slightly higher than in 1991, but feed grades were slightly lower (0.66% Ni/0.70% Cu vs. 0.68% Ni/0.72% Cu). Planned work progressed at the three underground mines: providing access to higher grade and deeper ores, and improved ventilation at Phikwe; and exploration and providing access to ore at Selebi North and at deeper zones in Selebi. Consultants were engaged to help improve operating efficiency and productivity to reduce costs. At the processing plant, defective electrostatic precipitators were rebuilt and some problems were experienced with startup of the electric furnaces after a scheduled plant shutdown in April. Contracts for shipment of matte beyond

1999 were renewed in 1992 with the Falconbridge refinery in Norway and with Centametal AG for refining at RTZ's Empress facility at Eiffel Flats in Zimbabwe.

Tati Nickel Mining Co. (TNMC) continued to have BCL manage mining at their underground Selkirk mine. The 1992 output was 75,597 tons versus a budget of 62,000. The sulfide ore, reportedly about 2.5% nickel and 1.8% copper, was trucked to BCL's facilities at Selebi-Phikwe 80 km (mapline) south for toll processing into granulated smelter matte. Nominally, the Selkirk operation resulted in an output of metal in matte of about 1,400 mt/a of nickel and 1,100 mt/a of copper.

At the Phoenix deposit of TNMC, 15 km north of Selkirk, a 9-month open pit mining trial began in March 1992. A South African company, Basil Read Mining, was awarded a contract for delivering 154,000 tons of nickel-copper ore for metallurgical testing. A decision on full production was to be made by the end of 1993. Overburden stripping was completed in August 1992, and selective mining proved successful. Earlier studies had indicated full production would be about 300,000 mt/a of 2% nickel/0.8% copper ore. Presumably, output would be about 2,800 mt/a of nickel in matte because another report stated planned output would triple Tati's production to 4,000 to 4,200 mt/a of nickel in ore (more likely should have been as nickel in matte). However, low metal prices were said to likely delay development.

**Platinum-Group Metals.**—No information was available in regard to local units of Goldfields and Inco, which were to separately do some exploration in 1992 for platinum-group metals on areas in southern Botswana licensed to a subsidiary of Molopo Australia Ltd. Goldfields also had its own license in the area. The underlying rocks, called the Molopo Farms Complex, were extensively faulted and covered with up to 200 m of Kalahari sand. They were similar in age, sequence, and chemistry to the nearby but separate Bushveld Complex to the east in South Africa.

## Industrial Minerals

**Cement.**—Bureau Recherches Geologiques et Minieres (BRGM) of France reported having contracted in 1991 to do a technical and economic assessment of cement production possibilities, as well as of deposits of limestone, ornamental stone, and clay. BDC had been searching for a foreign, technical, 30% partner on a new cement plant. Presumably, this was the 250,000-mt/a plant mentioned in 1990, to be located at Morupule and to use up to 25% fly ash from the nearby powerplant.

**Clays.**—The brick plant of Lobatse Clay Works (Pty.) Ltd. suspended operations in October 1992 because of a continuing construction industry slowdown. Production was expected to resume in 1993 as building picked up. The \$12 million plant had been started up in November 1991 by the joint venture of Interkiln Corp. of the United States and the BDC. Source material was the Woodhall clay deposit at Lobatse, about 70 km south-southwest of Gaborone. Plant capacity was in excess of 24 million bricks per year, but 1992 output was limited to 12.7 million.

**Diamond.**—Exploration by the De Beers group continued in several areas, and new kimberlite discoveries were said to have been made. But the timing was not stated other than that they were being further investigated during 1992. No results were available from the several other companies active in prospecting for diamonds in 1991, including Canada's Corona Corp. and Goldfields Botswana (Pty.) Ltd., mostly in the central and southern regions.

The combined output of the three Debswana mines was 16.3 Mmt of ore that yielded 15,945,486 carats of diamond versus 16.3 Mmt and 16,506,461 carats in 1991. The yield was on budget. Reportedly, about 55% were normally of gem quality. Orapa produced 5.98 M carats from mining in the A/K1 pit down to 100 m below surface. A higher-than-budgeted ore grade gave results 6% more

than budget in carats. Some ore was sent through the metallurgical test plant for evaluation to be applied to future production plans. At Letlhakane, output was 0.90 M carats from mining within the D/K1 pit to 119 m deep with waste stripping of 8.5 Mmt. At Jawngeng, production was 9.07 M carats with waste stripping totaling 13.7 Mmt. Some minor recovery problems cut output 3% below budget. Construction of a fourth treatment stream started. At full production in mid-1995, the \$180 million plant was expected to increase tonnage treated by one-third and boost carat output by 20% with a work force of 300 employees.

Orapa and Letlhakane mines won honored safety awards, and Jwaneng retained its high safety rating.

Mining leases for Orapa and Letlhakane expired in 1992. The latter's lease was renewed for another 25 years, but Orapa's was extended to the end of 1994 to allow studying future production options.

Debswana maintained production by stockpiling some output after purchases of rough diamonds from Debswana and all other suppliers were cut 25% below the normal quota by the CSO starting in September 1992. The basis for the cut was given as a need to stabilize a weakening market resulting from reduced demand and increased supply. Respectively, this was due to an unanticipated continuing decline in world economic growth rate, especially in Japan, and to a greater-than-expected surge in illicit production and theft of diamonds in Angola. The CSO also held back on sales of diamonds with qualities in weak demand and made substantial purchases on the open market. A market balance was reached early in 1993 and, in February, an average 1.5% price increase (but mostly in larger sizes that were more in demand) was absorbed. Subsequent cuts in supply from Angola and Russia and increased demand in India and the United States led to further strengthening in the market, and quotas were raised to 80% in April and 85% in July.

The cutting and polishing factory of Teemane Manufacturing Co. (Pty.) Ltd.,



with the same ownership as Debswana and possibly a subsidiary, opened late in 1992 at Serowe according to a press report. A second such factory, owned 85% by Lazare Kaplan International Inc. of New York and 15% by the GOB, was to open early in 1993 at Molepolole. Teemane was to buy rough stones from the CSO.

The largest diamond found in Botswana, 446 carats, was reported in April 1993 to have been just recovered at the Jwaneng mine.

**Semiprecious Gemstones.**—Only two licensed dealers were active in semiprecious gemstones in 1992. Masa Semi-Precious Stones continued to be active, selling 348 kg of processed stones. Agate Botswana (Pty.) Ltd. was a new company that received a dealer's license and built a processing plant 45 km north of Gaborone. It began production toward yearend. A Government publication gave annual capacity as 66 tons of rough stones to yield about 33 tons of processed stones.

**Soda Ash-Salt.**—SAB's production remained constrained by depressed market conditions, although operational problems were mostly solved during 1992. However, in June 1993, SAB advised of stockpiling some product to cover sales during some forthcoming unspecified production difficulties. Markets were hurt by the worldwide economic recession resulting in an oversupply and consequential price reduction. Although soda ash production was only 19% below budget in 1992, salt production was 42% below budget because of an operating problem with soft floors in the harvesting ponds. Specialized vehicles were required.

#### Mineral Fuels

**Coal.**—Morupule Colliery increased production from its underground mine to meet the growing needs of SAB.

To exploit some of the enormous coal resources, a mine-mouth electrical generating project for export power

reportedly was still under consideration for the Mmamabula coalfield about 140 km north-northeast of Gaborone. Early in 1993, rather than the 250,000-MW capacity mentioned earlier, 600 MW was cited in the press. The report also said a new prefeasibility study was to start early in 1993, although Bechtel was previously reported to have completed a prefeasibility study in 1992. The Government continued to look for partners and mentioned the possibility of new rail links for exporting coal.

Early in 1992, Amoco Oil was investigating the possibility of extracting methane from Botswana coal beds, but no results have been announced.

#### Reserves

Coal reserves considered proven and indicated were estimated at 17 billion tons. Diamond reserves were reported by the Government to be equivalent to 20 years of current production, or about 300 M carats. Nickel-copper ore minable, in-place reserves as of the end of 1992 were stated by BCL as 97.1 Mmt at 0.71% nickel and 0.75% copper. Soda ash reserves are stated as being sufficient for 1,000 years at current plant capacity.

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### INFRASTRUCTURE

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Transportation facilities, both highway and railroad, were fairly adequate in the eastern fringe of the country. To the northeast, the main routes entered Zimbabwe. To the south, the main routes led into the Republic of South Africa. A main highway ran northwest across the country from Francistown in the northeast to Zambia on the north. Since 1991, the main north-south rail line of Botswana Railways had a new 165-km spur running northwesterly from Francistown to Sua Pan. Work continued on improving roads to and in the western regions and on a new road west to Namibia across the Kalahari Desert.

Electrical generating capacity of the Botswana Power Corp. (BPC) was more than ample for the demand, although cost to consumers was considered relatively high. The Morupule coal-fired plant had

a capacity of 132 MW. A station at Selebi Phikwe was rated at 60 MW. About 15 MW of this capacity used waste steam from BCL, and the balance was coal fired. SAB had a 22-MW generating plant using steam from its coal-fired boilers needed for producing soda ash. However, about 6% of Botswana's electricity needs were imported from the Republic of South Africa at relatively lower cost. Some electric power was exported to Zimbabwe. Concessionary rates were extended to BCL to maintain mining operations. About two-thirds of BPC's sales was to the mining industry, of which two-thirds went to BCL and one-third to Debswana.

Main airports were at Gaborone, Francistown, Selebi-Phikwe, and Maun. Air Botswana was the major airline. Charter companies provided service in and out of the Gaborone hub.

Telecommunications were considered very good and expanding.

Water availability was a major issue in Botswana, even though perennial rivers were along most of the southern and eastern borders and on the north. The mining sector used both mine water and drilled wells for its water needs. A number of studies had been made or were underway to assess supply and demand for water.

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### OUTLOOK

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The economic outlook was clouded. Because of the economy's dependence on diamonds and mining company plans to level off output, the Government expected slower economic growth and coincident problems with inflation, balance of payments, Government revenues, and unemployment during the next several years. Nickel-copper-cobalt operations offered little to offset that expectation because of the problems of high existing debt load, the normal need for reinvestment, and lower market volume and prices. But Government concessions probably would help avoid much reduction in the mining labor force, while existing efforts at faster industrial development in nonmining sectors would be amplified.

Exploration activity should continue, and this gives promise of new mineral ventures. The international mining sector ranked Botswana very highly attractive for exploration compared to other developing countries, considering geologic environment and mineral investment climate. In investment climate alone, considering political and economic factors, Botswana was ranked first in Africa. However, conditions in landlocked Botswana's neighboring countries would probably affect any decision.

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<sup>1</sup>Where necessary, values have been converted from Botswana pula (P) to U.S. dollars at the rate of P2.2568=US\$1.00 for 1992 and P2.0725=US\$1.00 for 1991. These were Bank of Botswana official rates at yearend as published by International Monetary Fund in International Financial Statistics.

<sup>2</sup>Mining Commissioner, Annual Report 1992, Mar. 1993, pp. 23. Department of Mines, Republic of Botswana, Gaborone, Botswana.

#### **OTHER SOURCES OF INFORMATION**

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TABLE 1  
BOTSWANA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992
Coal, bituminous	612,873	663,045	794,041	783,873	901,452
Cobalt: Smelter output, Co content of matte <sup>3 4</sup>	291	215	205	208	208
Copper:					
Mine output, Cu content of ore milled	27,300	24,700	25,300	24,800	24,400
Smelter output, Cu content of matte <sup>3 4</sup>	24,428	21,709	20,612	20,576	20,413
Diamond:					
Gem and near gem <sup>5</sup> thousand carats	10,660	10,680	12,150	11,550	11,160
Industrial stones <sup>6</sup> do.	4,570	4,570	5,200	4,950	4,790
Total <sup>5</sup> do.	15,229	15,252	17,352	16,506	15,946
Gemstones, semiprecious <sup>6</sup> kilograms	38,600	146,000	500	205	400
Gold <sup>7</sup> do.	21	67	46	20	165
Lime	226	—	55	6	50
Manganese ore <sup>8</sup>	—	—	—	—	1,318
Nickel:					
Mine output, ore milled, gross weight      thousand tons	3,330	3,338	3,369	3,451	3,490
Mine output, Ni content of ore milled	26,000	23,700	23,200	23,500	23,000
Smelter output, matte, gross weight <sup>3</sup>	57,530	49,754	47,959	48,319	48,071
Smelter output, Ni content of matte <sup>4</sup>	22,539	19,759	19,022	19,294	18,873
Salt <sup>9</sup>	—	—	—	2,600	53,708
Sand, construction <sup>10</sup> cubic meters	179,936	147,300	164,978	340,825	190,305
Soda ash, natural	—	—	—	62,000	123,593
Stone, crushed, not further described      cubic meters	337,677	458,900	589,999	783,487	804,242

<sup>1</sup>Estimated. <sup>2</sup>Revised.

<sup>3</sup>Table includes data available through Sept. 1, 1993.

<sup>4</sup>In addition to commodities listed, the following were produced, but information was inadequate to reliably estimate output: silver (estimated about 2% of reported gold bullion production) and clay for brick and tile (brick output reported for 1992 was 12.7 million units, which is estimated to be about 25,000 metric tons of clay assuming 2 kilograms per brick).

<sup>5</sup>Smelter product was granulated nickel-copper-cobalt matte.

<sup>6</sup>Figures also used for recoverable mine output in world production tables appearing in Volume I of the Minerals Yearbook. Included some product from direct smelting ore, i.e., ore not reported as milled.

<sup>7</sup>Only total reported; assumed to contain about 70% gem and near gem. Data may not add to total shown because of independent rounding.

<sup>8</sup>Presumably, principally agates and carnelians. Reported as export sales. Reported as rough through 1989 and as polished or processed thereafter. Only cut or polished stones could be legally exported after 1989. Reported as agates only for 1992.

<sup>9</sup>Reported as bullion; historically included silver estimated at about 2%.

<sup>10</sup>Production commenced in 1992.

<sup>11</sup>From natural soda ash production.

<sup>12</sup>Additional production of sand and gravel from small local operations was periodically reported, but information was inadequate to reliably estimate output.

**TABLE 2**  
**BOTSWANA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992**

(Metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity	
Clay, brick/tile	Lobatse Clay Works (Pty.) Ltd. <sup>1</sup> Botswana Development Corp. (BDC)/Interkiln Corp. joint venture)	Lobatse, 70 kilometers south-southwest of Gaborone	*50,000.	
Do.	Makoro Brick and Tile (Pty.) Ltd. (NA)	Makoro, 10 kilometers south of Palapye, 260 kilometers north-northeast of Gaborone	*20,000.	
Coal	Morupule Colliery (Pty.) Ltd. (Anglo American Corp. of South Africa Ltd. (AAC) and related firms, at least 90%.)	Morupule, 270 kilometers north-northeast of Gaborone	1,000,000.	
Cobalt <sup>2</sup>	BCL Ltd. (Government, 15%; Botswana RST Ltd., 85%, itself owned by AAC and related firms, at least 20%, and AMAX Inc., 29.8%) <sup>3</sup>	Selebi-Phikwe, 350 kilometers northeast of Gaborone	*300 in matte.	
Copper <sup>2</sup>	BCL Ltd. (Government, 15%; Botswana RST Ltd., 85%)	do.	20,000 in matte.	
Copper ore	Tati Nickel Mining Co. (Pty.) Ltd. (AAC, 51%)	Selkirk Mine, 23 kilometers east of Francistown, 425 kilometers north-northeast of Gaborone	60,000 @*2.0% Cu.	
Diamond	million carats	Debswana Diamond Company (Pty.) Ltd. (Government, 50%; De Beers Centenary AG, 50%, itself owned by AAC and related firms, at least 40%.)	Orapa, Letlhakane, and Jwaneng, respectively 375 kilometers north, 350 kilometers north, and 115 kilometers west of Gaborone	*17.5.
Gemstones, semiprecious <sup>4</sup>	kilograms	Agate Botswana (Pty.) Ltd. (NA)	Processing plant at Pilane, 45 kilometers north of Gaborone	33,000.
Do.	Masa Semi-Precious Stones (NA)	NA	400.	
Gold bullion <sup>5</sup>	kilograms	Mining and Development (Pty.) Ltd. <sup>1</sup> (Hosken Corp. Finance/IGI Botswana/Canadian mining syndicate joint venture)	Monarch Mine, just north of Francistown, 420 kilometers north-northeast of Gaborone	600.
Do.	Shamrock (Pty.) Ltd. (NA)	Tailings Retreat Plant, just north of Francistown	*20.	
Manganese ore	Jacomar Manganese (Pty.) Ltd. <sup>6</sup> (NA)	Kwagwe near Kanye, 75 kilometers southwest of Gaborone	30,000.	
Nickel <sup>2</sup>	BCL Ltd. (Government, 15%; Botswana RST Ltd., 85%)	Selebi-Phikwe, 350 kilometers north-east of Gaborone	22,000 in matte.	
Nickel ore	Tati Nickel Mining Co. (Pty.) Ltd. (AAC, 51%)	Selkirk Mine, 23 kilometers east of Francistown, 425 kilometers north-northeast of Gaborone	60,000 @*2.4% Ni.	
Salt	Soda Ash Botswana (Pty.) Ltd. <sup>7</sup> (Government, 48%; AECI Chlor-Plastics Ltd., 26.5%, itself owned by AAC and related firms, at least 25%, and by Imperial Chemical Industries PLC, at least 20%; AAC, 12.75%; De Beers Centenary AG, 12.75%, itself owned by AAC and related firms, at least 40%.)	Sua Pan, 450 kilometers north of Gaborone	650,000.	
Soda ash	Soda Ash Botswana (Pty.) Ltd. <sup>7</sup> (Government, 48%; AECI Chlor-Plastics Ltd., 26.5%; AAC, 12.75%; De Beers Centenary AG, 12.75%)	do.	300,000.	

<sup>4</sup>Estimate. NA Not available.

<sup>1</sup>Production started Nov. 1991.

<sup>2</sup>In nickel-copper-cobalt smelter matte.

<sup>3</sup>In June 1993, Amax sold interest to Government of Botswana.

<sup>4</sup>Reported as "processed semiprecious stones."

<sup>5</sup>Botswana bullion typically had silver content estimated at 2%.

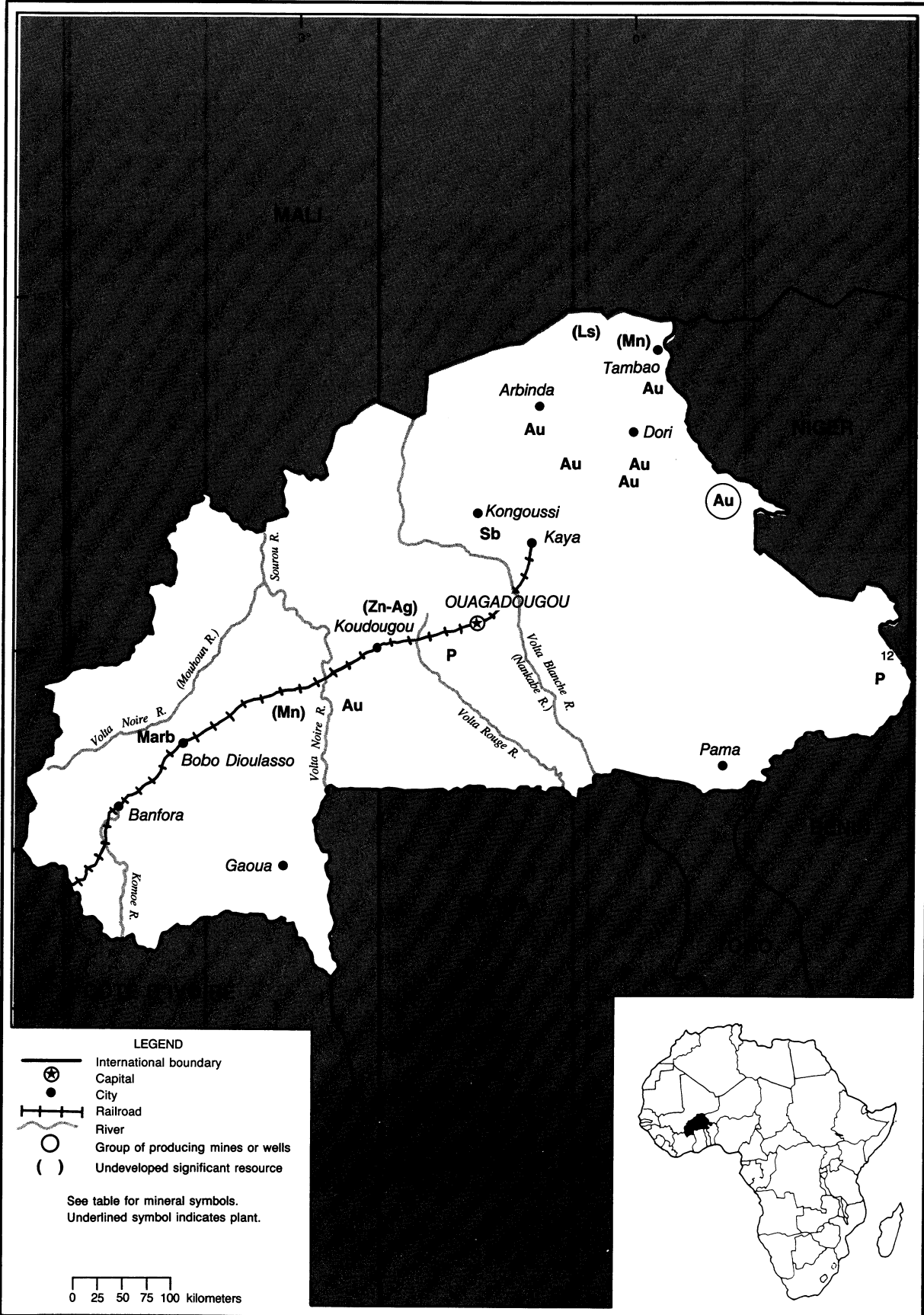
<sup>6</sup>Production started first half of 1992.

<sup>7</sup>Production started Mar. 1991.

# BURKINA FASO

AREA 274,200 km<sup>2</sup>

POPULATION 9.7 million



# THE MINERAL INDUSTRY OF BURKINA FASO

By Hendrik G. van Oss

Mineral production levels in Burkina Faso in 1992 were substantially unchanged from those of the previous year (see table 1). Mining revenues remained completely dominated by gold, which was produced by one formal mine, a few semi-industrial operations, and by several thousand artisanal miners. Data for gold output were incomplete because, despite a legal requirement for all gold to be sold to the Government, it was generally acknowledged that 40% to 60% of artisanal output in recent years had been smuggled out of the country. Formal gold output in 1992, virtually all of which was exported, was worth about \$29 million;<sup>1</sup> estimates of the value of smuggled gold ranged from about \$15 million to \$30 million. Data on Burkina Faso's other mineral production were unavailable but the value of the output was estimated to be insignificant by comparison with that of gold. Burkina Faso's 1992 GDP was reported to be \$2.94 billion, and total legal exports (goods and services) amounted to almost

\$297 million.

The total value of imports of goods and services in 1992 were reported to have amounted to \$675 million (f.o.b.). Mineral commodity import data were unavailable for 1992, but were estimated to have been at about 1991 levels, or about \$110 million. Of this trade, refined petroleum products accounted for about \$70 million and cement and fertilizers most of the rest.

A revision of Burkina Faso's mining law, drafted with UN assistance, was submitted to the Government during the year, although the new code had not been formally adopted as of yearend. The goal of the new law was both to bring the country's regulations more in line with those in other west African countries and to encourage foreign mining investment in Burkina Faso. Toward this last goal, the Government released a new brochure<sup>2</sup> in 1992; however, the document does not describe the proposed new mining law.

Apart from a small output from a few semi-industrial operations, formal gold

production during the year continued to be from the parasatatal Poura Mine, southwest of Ouagadougou. The reportedly debt-plagued operation experienced a number of technical difficulties during the year and was unable to significantly improve output above the 1991 level of 1,067 kg. The Government was attempting to privatize its share of the mine. Government purchases of artisanal gold reportedly fell during the year, in part reflecting declining surficial reserves. A number of gold prospects were being explored in the country, mostly in the north and northeast. A concession for the Arbinda deposit was being negotiated by a major international mining company.

<sup>1</sup>Where necessary, values for Burkina Faso have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF264.69=US\$1.00.

<sup>2</sup>Government of Burkina Faso: Burkina Faso—Guide for the Mining Investor, 1992, 34 pp.

TABLE 1  
BURKINA FASO: ESTIMATED PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Thousand metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992
Gold <sup>3</sup> kilograms	9,300	7,600	7,800	5,600	5,400
Phosphate rock	4	4	4	4	—
Pumice and related volcanic materials	10	10	10	10	10
Salt	6,500	6,500	6,500	6,500	6,500
Stone: Marble	100	100	100	100	100

<sup>1</sup>Revised.

<sup>2</sup>Includes data available through Apr. 20, 1993.

<sup>3</sup>In addition to the commodities listed, Burkina Faso produced clay, and sand and gravel for local constructional uses; however, information is inadequate to make reliable estimates of output levels.

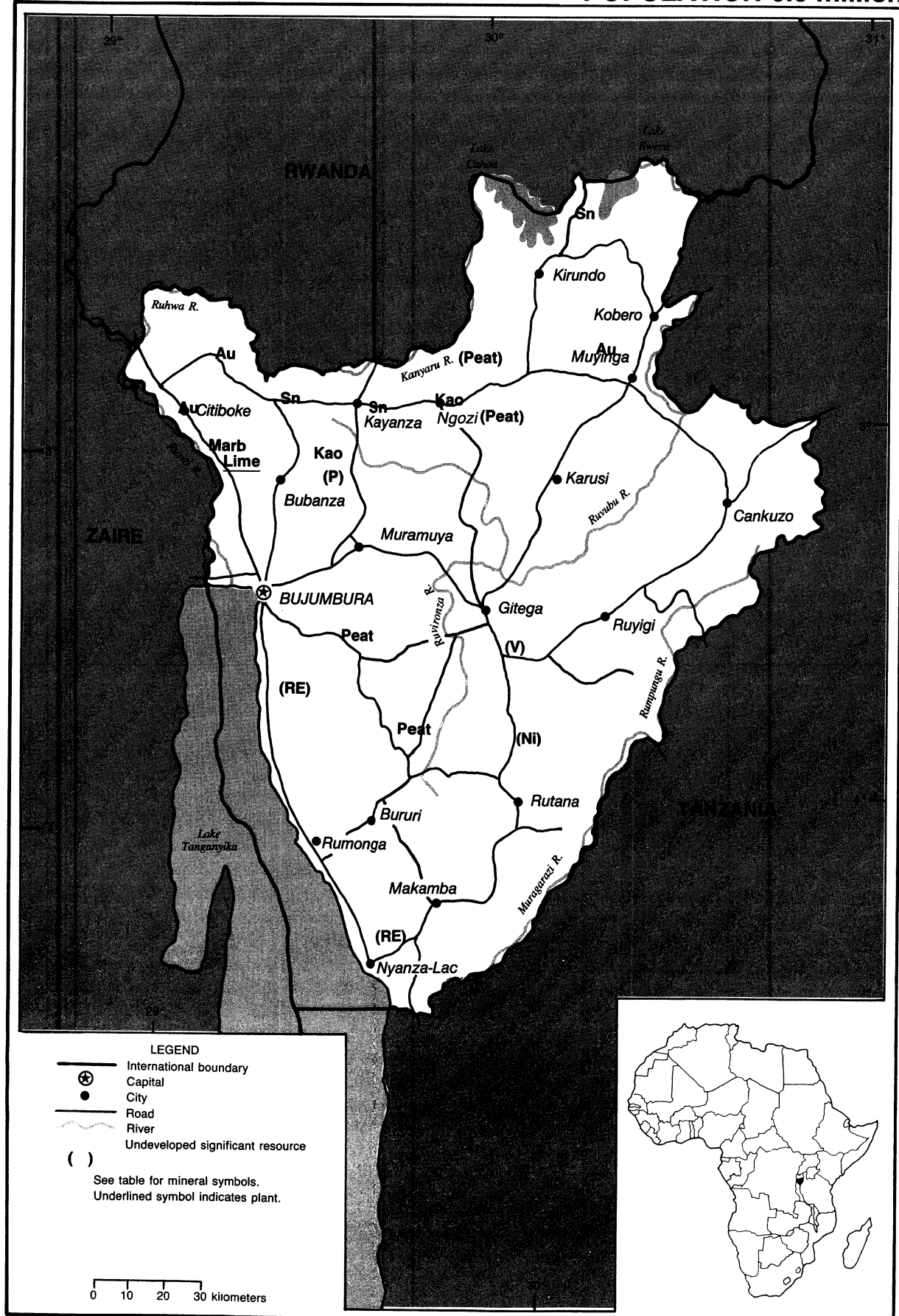
<sup>4</sup>Estimate based on reported doré production, assumed to be 90% gold, and an estimate of smuggled artisanal production. Reported doré production was as follows, in kilograms: 1988—3,860; 1989—3,013; 1990—4,002; 1991—2,953; and 1992—2,604.

<sup>5</sup>Revised to zero.

# BURUNDI

AREA 27,830 km<sup>2</sup>

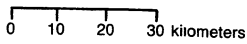
POPULATION 6.0 million



**LEGEND**

- International boundary
- ⊗ Capital
- City
- Road
- ~ River
- ( ) Undeveloped significant resource

( ) See table for mineral symbols.  
     Underlined symbol indicates plant.



# THE MINERAL INDUSTRY OF BURUNDI

By Lloyd E. Antonides

Minerals remained a small factor in Burundi's economy during 1992, but the Government maintained active efforts toward promoting a good potential for a more substantial contribution. Production was limited to relatively small quantities of gold and tin minerals; kaolin, limestone, construction stone, sand and gravel; and peat for fuel. Both Government and private industry continued to give special attention to expansion of gold output. There was refocusing of interest on the lateritic nickel resources, especially those with associated platinum-group metals content. A carbonatite-apatite phosphate deposit apparently became a lower priority because there was no news regarding the detailed feasibility report due for completion in early 1992.

Burundi's GDP remained about \$1 billion,<sup>1</sup> which was one of the world's lowest per capita. Agriculture contributed 50% to 60% of GDP and employed more than 80% of the population. Manufacturing accounted for about 15% of GDP. The economy was heavily dependent on coffee exports. Since 1986, the Government pursued a structural adjustment program with IMF/World Bank assistance.

Laws and regulations were designed to attract private investment, particularly by foreign entities. A free-trade zone system covering the entire country, announced in September 1992, offered many benefits to industrial and commercial ventures. Mining laws and regulations were similarly attractive.

A gold mining study funded by the African Development Bank (AfDB) was awarded by the Government to a U.S. consultant, M.E.G.A. International, Inc. of Golden, Colorado, early in 1992. Apparently, it was sufficiently

encouraging to move the Government, with AfDB backing, to tender a further detailed study of an area in the northeast early in 1993.

Lateritic nickel was the principal known resource contained in a large exploration concession negotiated by RTZ during the year and concluded in April 1993. But many other metallic mineral occurrences were also known in the concession area. Previous Government drilling with UN financing showed platinum-group metals in the nickeliferous laterite deposit area. In 1991, the Government had been trying to find financing for a multi-million dollar final feasibility study on a nickel deposit encompassed by the concession.

With continued political stability and good Government financial management, the mineral potential should attract the interest of additional international mining companies. Although the long transport distance to ocean ports is an obstacle,

particularly for low-unit-value minerals, other infrastructure elements are reasonably good. These factors give rise to a rather optimistic outlook for the development of a larger mineral industry.

<sup>1</sup>Where necessary, values have been converted from Burundi francs (BF) to U.S. dollars at the official annual average rate of BF208.30=US\$1.00 for 1992 values and BF181.51=US\$1 for 1991. The official 1992 yearend rate was BF236.55=US\$1.00.

TABLE 1  
BURUNDI: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992
Clays: Kaolin	4,021	4,305	5,281	6,682	9,688
Gold <sup>3</sup> kilograms	14	18	9	25	32
Lime	96	202	188	86	182
Peat	17,589	14,200	11,984	10,026	12,000
Tin, mine output, ore (*60% SnO <sub>2</sub> ):					
Gross weight	50	106	115	124	183
Sn content <sup>3</sup>	24	50	54	74	110

<sup>1</sup>Estimated.

<sup>2</sup>Includes data available through June 15, 1993.

<sup>3</sup>In addition to commodities listed, the following were produced but information is inadequate to reliably estimate output: columbium-tantalum ore and concentrate officially reported as 8,527 kilograms gross weight in 1992 (last prior report was 2,100 kilograms in 1979); and mostly locally produced and used crushed stone (47,282 cubic meters known and reported in 1992), and presumably other crude construction materials (clays, sand and gravel, et al.).

<sup>3</sup>Prior to 1991 some additional gold production, mostly in the northwest, was illegally exported and not officially recorded, but information is inadequate to reliably estimate such output. This unrecorded production was reported to be substantial in 1990 especially. Starting in 1991 production data reported are considered realistic although only estimates because statistics are no longer obtained.



## **OTHER SOURCES OF INFORMATION**

### **Agencies**

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Fax: 212-963-4340

### **Publications**

Atlas du Burundi, Universite de Bordeaux,  
1979, 96 pp.

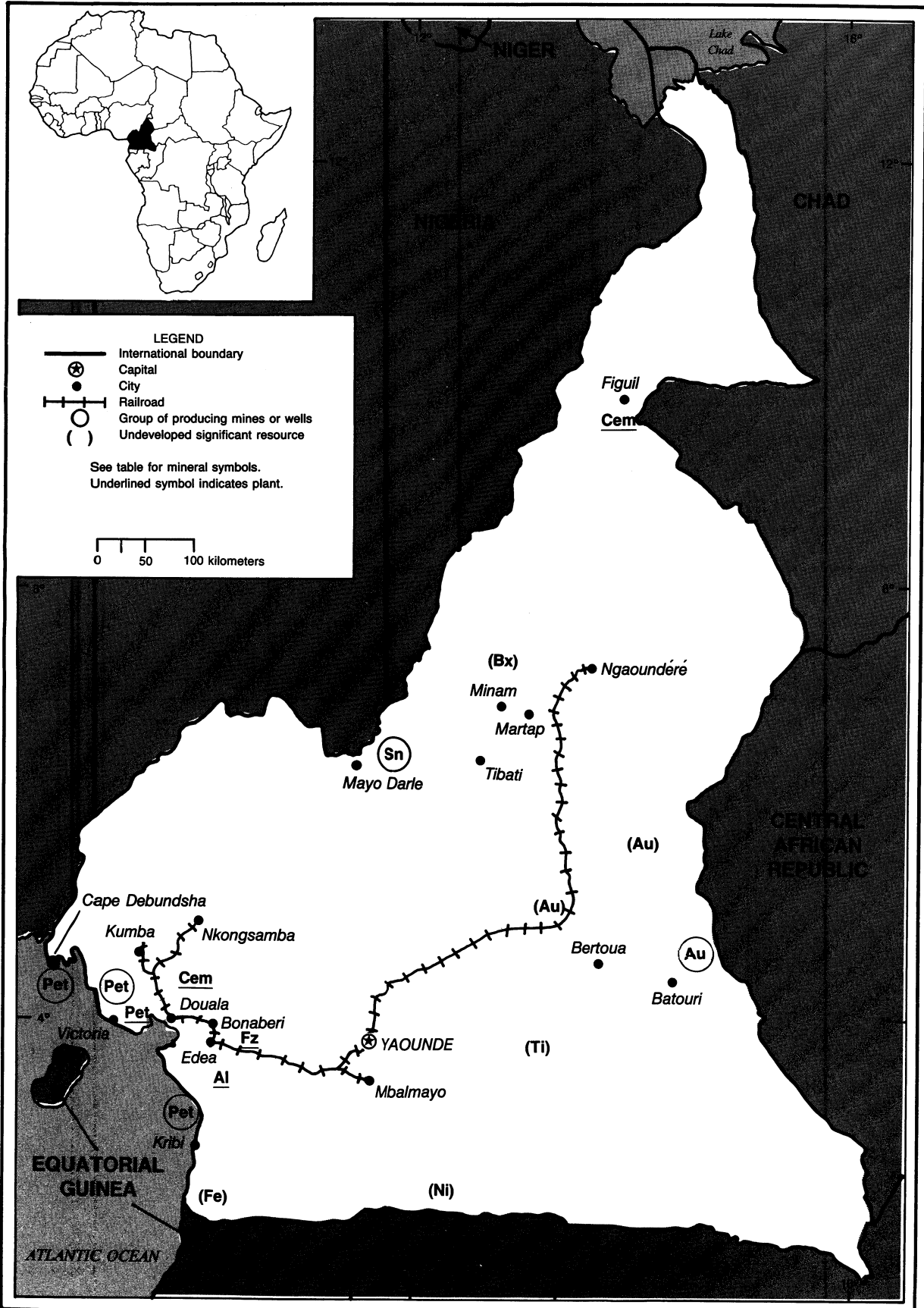
Papers, Round Table on the Development of  
the Mining Sector in Burundi, Ministry  
of Energy and Mines, Bujumbura, 1991,  
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


# CAMEROON

AREA 475,440 km<sup>2</sup>

POPULATION 11.4 million



**LEGEND**

-  International boundary
-  Capital
-  City
-  Railroad
-  Group of producing mines or wells
-  Undeveloped significant resource

See table for mineral symbols.  
Underlined symbol indicates plant.

0 50 100 kilometers

# THE MINERAL INDUSTRY OF CAMEROON

By Thomas P. Dolley

Reduced petroleum production and the global decline in oil prices had negatively affected the economy of the Republic of Cameroon in 1992. In general, the Cameroonian economy has been shrinking since the mid-1980's, with the petroleum industry playing a major role. Oil production and export typically contribute about 10% of the GDP. The 1991 GDP for Cameroon was \$11.6 billion.<sup>1</sup> Cameroon's foreign debt totaled about \$6.3 billion in 1991. Cameroon's domestic market for petroleum products is narrowing, primarily because of the general economic downturn. Illegal fuel smuggling from Nigeria also remained a significant problem during 1992.

The mineral industry notwithstanding, the country has a well established agricultural sector and other sectors to which the Government would like to attract foreign investment. These sectors include fishing, forestry, manufacturing, and mining. Political stability for Cameroon would appear to be an important precursor to international investment. Owing to political unrest in Cameroon, the United States suspended a \$20 million financial aid package at yearend 1992.

## GOVERNMENT POLICIES AND PROGRAMS

Cameroon gained independence from France on January 1, 1960. The legal system of Cameroon is based on French civil law. The mineral policy and legislation of Cameroon is based on the Mining Code, law 64-LF-3 of April 6, 1964, and Decree 64-DF-163 of May 26, 1964. Other pertinent legislation is the Mining Taxation Code, law 64-LF-13 of November 18, 1968, and the decree regulating oil companies, law 82-20 of

November 26, 1982.

Initiated in 1991, the revised petroleum code has had success in attracting foreign operators to further explore Cameroon's oil resources. Revisions in the petroleum code were intended to allow foreign petroleum exploration companies greater operational freedom, thus stimulating further capitalization in the petroleum sector. Formerly, the older law provided for production-sharing guidelines stipulating 30% of the output to the foreign operator and 70% of the output to Cameroon's Société Nationale des Hydrocarbures (SNH). Additionally, the Government took 87% of net profits in the form of fees and taxes. The revised code mandates that reimbursable exploration and production costs rise from 22% to 30%. Guaranteed aftertax mining allowances also rise from 22% to 33%. Crude petroleum production that is reserved for SNH was also reduced to 60%. Production expenses between a foreign oil company and SNH remain equal. Under the terms of the revised code, Pecten International Co. (Pecten), a subsidiary of Shell Petroleum of the United States, and France's Société Nationale Elf Aquitaine (Elf) may take an equivalent share of Government oil in lieu of late payments by SNH. By law, SNH holds a 20% share of both Pecten and Elf.

The new law allows for hydrocarbon exploration permits lasting 4 years, with up to three renewals allowed for each permit. The exploration acreage covered by the permit is reduced at the time of the first renewal. Production permits and concessions are valid for 4 years and 25 years, respectively, from the date of first production.

As of yearend 1992, Cameroon's

Structural Adjustment Program (SAP) has had a limited effect on the economy. The SAP was implemented by the Government to help qualify the nation for further financial aid from international donors. Reform and improvement of certain Government functions were the targets of the SAP; however, cancellation of the publication of Government statistics has been a negative result.

## PRODUCTION

Petroleum production averaged 130 kbb/d from offshore wells in 1992. With the exception of 1990, petroleum production in Cameroon has declined steadily since 1988. As a reflection of the Cameroonian economy, the mineral industry has declined as a whole, to include aluminum production and cement. Limestone is quarried by Cimencam to produce cement at Bonaberi and Figuil. Total cement production capacity is 950 kmt/a. (See table 1.)

## TRADE

Crude oil exports provide approximately 40% to 50% of Cameroon's export earnings each year. Virtually all domestic petroleum production is exported by SNH. Cameroon exported approximately 45.4 Mbbl of crude oil in 1992, principally to France, the Netherlands, and Spain. This export amount represented about a 2-Mbbl increase over the previous year. The value of U.S. exports to Cameroon in 1992 was \$57 million. The value of U.S. imports from Cameroon in 1992 was \$83.8 million, down by more than \$40 million from the previous year. U.S. crude oil imports in 1992 from Cameroon, at about 4.1 Mbbl, were

down from the previous year.

## STRUCTURE OF THE MINERAL INDUSTRY

The primary mining organization in Cameroon is the Government's Ministry of Mines, Water Resources and Power. The Government actively promotes investment in the mining sector, and foreign operators are usually involved in joint ventures with Cameroonian partners.

SNH is the state-owned company involved in hydrocarbon exploitation. SNH consults with the Ministry of Mines, Water Resources and Power in the awarding of exploration permits and production concessions. In 1992, a new Government entity, Fonds de Soutien aux Hydrocarbures, was formed to aid oil exploration and production. Compagnie Camérounaise de l'Aluminium (Alucam) and the Société Nationale de Raffinage (Sonara) are the state-owned companies that manage the aluminum smelting and oil refining facilities, respectively. SNH holds a 20% equity share of the Sonara refinery. (See table 2.)

## COMMODITY REVIEW

### Metals

A variety of metal resources exists in Cameroon, but few have been commercially exploited. Small-scale eluvial tin mining has been conducted since 1933 from the cassiterite deposits of Mayo Darle. The parastatal Société des Etains du Cameroun is responsible for tin production. Gold production in Cameroon exists, but some production is clandestine, and accurate statistics are not maintained. Société d'Etudes de Rutile d'Akonolinga and Société d'Etudes de Fer du Cameroun are both parastatals charged with examination of Cameroon's titanium and iron deposits, respectively. These deposits will probably await development when a more favorable global market exists.

**Aluminum.**—The extant smelter at Edea is managed by Alucam and has a

production capacity of 85 kmt/a. Alucam's equity ownership is by Pechiney of France (58%) and the Government (42%). The plant utilizes alumina imported from Guinea.

By midyear, Kaiser Aluminum of the United States was expressing interest in building a \$1 billion aluminum plant in Cameroon. The proposed plant would have a bauxite treating capacity of 250 kmt/a, making it one of the largest in Africa. Additionally, the plant would be built in an area set aside as a free trade zone. Electrical power for the facility would necessitate the construction of a dam. The bauxite resource that would be exploited to feed the plant would presumably be at Minim-Martap. Bureau de Recherches Géologiques et Minières (BRGM) of France and Société des Bauxites du Cameroun (Sebacam) had previously surveyed the Minim-Martap deposits in the 1960's. Reserve estimates were 1 billion tons of ore grading 43% alumina and 3.4% silica.

### Mineral Fuels

Active petroleum producers in Cameroon are Pecten, Elf, and Kelt PLC of the United Kingdom. Within the offshore Rio del Rey basin are the producing oilfields of Itindi, Kole, Lipenja, and Mokoko-Abana. Rio del Rey is the most prolific petroleum producer in Cameroon. As of yearend 1992, Cameroon possessed 396 producing wells, with all of them located in the Rio del Rey basin. Of this total, 292 wells were operated by Elf, 92 wells were operated by Pecten, and the remaining 12 wells were maintained by Tepcam, a subsidiary of Total of France. Kelt recently won a bid to take over the operation of the 12 Tepcam wells, pending final approval by SNH.

During the 1960's and 1970's, oil exploration commenced in Cameroon. The first significant hydrocarbon discoveries occurred in the early 1970's in the offshore Rio del Rey basin. For almost a decade, foreign oil companies have been scarce in Cameroon's exploration arena, owing to unfavorable terms offered by SNH. The Government

hopes that the revised petroleum code changes the latter situation for the 1990's. Currently, the Douala basin is the main exploration target in Cameroon. As of 1992, significant quantities of natural gas have been discovered in the offshore Douala basin, but no commercial amounts of crude oil. The basin's geology indicates that commercial amounts of crude oil could exist in the basin. Additionally, Exxon Corp. of the United States was awarded one block for exploration in the Douala basin, but is under no obligation to drill wells on the concession.

Total throughput refining capacity in Cameroon was 42 kbb/d from a single refinery operated by Sonara, which is currently operating at 50% to 60% of capacity. The refinery produces gasoline, butane, kerosene, jet fuel, gas oil, and heavy fuel. Additionally, imported Nigerian crude oil is refined at the Sonara facility and distributed by Mobil and Texaco of the United States, the Netherland's Royal Dutch Shell, and Elf and Total. Illegal imports of Nigerian crude oil have become a major competition problem for fuel distributors. Illegal fuel is sold at a price that undercuts legal distributors. The Government has taken steps to correct the problem.

Natural gas exploration has never been undertaken in Cameroon. All natural gas discoveries have occurred during petroleum exploration. Natural gas deposits have been found in both the Rio del Rey and Douala basins, with a smaller deposit near the coastline off Douala. Studies regarding the possible construction of a liquefying plant or otherwise exploiting these reserves have been conducted but have not yet shown that such a project would be profitable.

### Reserves

Hydrocarbon resources in Cameroon are almost entirely offshore. Petroleum reserves have been estimated at 400 Mbb. Cameroon's reserves of natural gas are considerable and have been estimated at 100 billion m<sup>3</sup>. Cameroon hosts a variety of mineral deposits, but few have

been commercially exploited. The development of a viable mineral industry in Cameroon is difficult owing to inadequate infrastructure, insufficient electrical power, and a lack of financial investment.

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## INFRASTRUCTURE

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Total installed electrical generation capacity is 801 MW. The electrical distribution network is 6,491 km. Cameroon has a high hydroelectric generation potential and a number of feasibility projects are in work. Railroads total 1,003 km, of which 858 km is 1-m-gauge track, with the remainder being 0.6-m-gauge track. Highways total approximately 65,000 km, 50% of which is unpaved. The major seaport is at Douala.

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## OUTLOOK

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Lowered oil prices and declining petroleum reserves have caused sagging profits for SNH. Barring a significant global rise in oil prices, coupled with needed petroleum discoveries, Cameroon could become a net energy importer early in the 21st century.

Depressed economies typify some Francophone countries of central Africa, and Cameroon is no exception. Since 1986 the Communauté Financière Africaine (CFA) franc has become overvalued when compared to some other African currencies. Cameroon utilizes the CFA franc along with several other neighboring countries. The CFA franc is monetarily supported by the French franc, and France guarantees conversion at a rate of 50 CFA francs to 1 French franc. With the drop in global oil prices accompanied by inflation, intermittent pressure to devalue the CFA franc was growing. Ongoing capital flight out of Cameroon and other central African nations might speed the inevitable devaluation of the CFA franc.

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<sup>1</sup>Where necessary, values have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF264.69=US\$1.00.

## OTHER SOURCES OF INFORMATION

Department of Mines and Geology  
B.P. 70  
Yaounde, Cameroon  
Director of Mineral Resources  
Ministry of Commerce and Development  
B.P. 1004  
Yaounde, Cameroon

TABLE 1  
CAMEROON: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

Commodity <sup>2</sup>		1988	1989	1990	1991	1992 <sup>*</sup>
Aluminum metal, primary	metric tons	86,513	91,716	93,284	<sup>3</sup> 82,516	82,000
Cement, hydraulic	do.	584,523	614,000	624,229	622,000	620,000
Gold, mine output, Au content	kilograms	8	<sup>3</sup> 15	<sup>3</sup> 10	10	10
Petroleum, crude <sup>*</sup>	thousand 42-gallon barrels	62,780	<sup>3</sup> 58,648	<sup>3</sup> 64,605	<sup>3</sup> 55,480	<sup>3</sup> 50,370
Pozzolana	metric tons	130,490	<sup>1</sup> 130,000	<sup>1</sup> 130,000	130,000	130,000
Stone:						
Limestone	do.	57,369	<sup>1</sup> 57,000	<sup>1</sup> 57,000	57,000	57,000
Marble	do.	<sup>2</sup> 200	200	200	200	200
Tin ore and concentrate:						
Gross weight	kilograms	4,894	4,800	4,300	4,300	4,300
Sn content <sup>*</sup>	do.	3,400	3,400	3,050	3,050	3,000

<sup>\*</sup>Estimated.

<sup>1</sup>Includes data available through Aug. 1993.

<sup>2</sup>In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (clays, sand and gravel, and other stone) presumably are produced, but output is not reported quantitatively and available information is inadequate to make reliable estimates of output levels.

<sup>3</sup>Reported figure.

TABLE 2  
CAMEROON: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity	
Aluminum	Compagnie Camerounaise de l'Aluminium (Pechiney, France, 58%; Government, 42%)	Edea, south of Douala	85.	
Cement	Société des Cimenteries du Cameroun (Government, 100%)	Bonaberi	900.	
Do.	do.	Figuil	100.	
Fertilizer	Société Camerounaise des Engrais (Government, 100%)	Bonaberi	58 ammonium, 36 sulfate, 66 sulfuric acid.	
Gold	Artisanal workings	Batouri	NA.	
Petroleum, crude	million barrels	Société Nationale des Hydrocarbures (Elf, France, 40%; Government, 35.5%; Pecten, United States, 24.5%)	Rio Del Rey Oilfields (offshore and North of Victoria)	49.
Petroleum, refined	million barrels	Société Nationale de Raffinage des Hydrocarbures (Government, 66%; Total-Cie., France, 10%; Elf, France, 8%; Mobil and Shell, United States, 8% each)	Limbe	15.
Tin	Artisanal workings	Mayo Darle	NA.	

NA Not available.

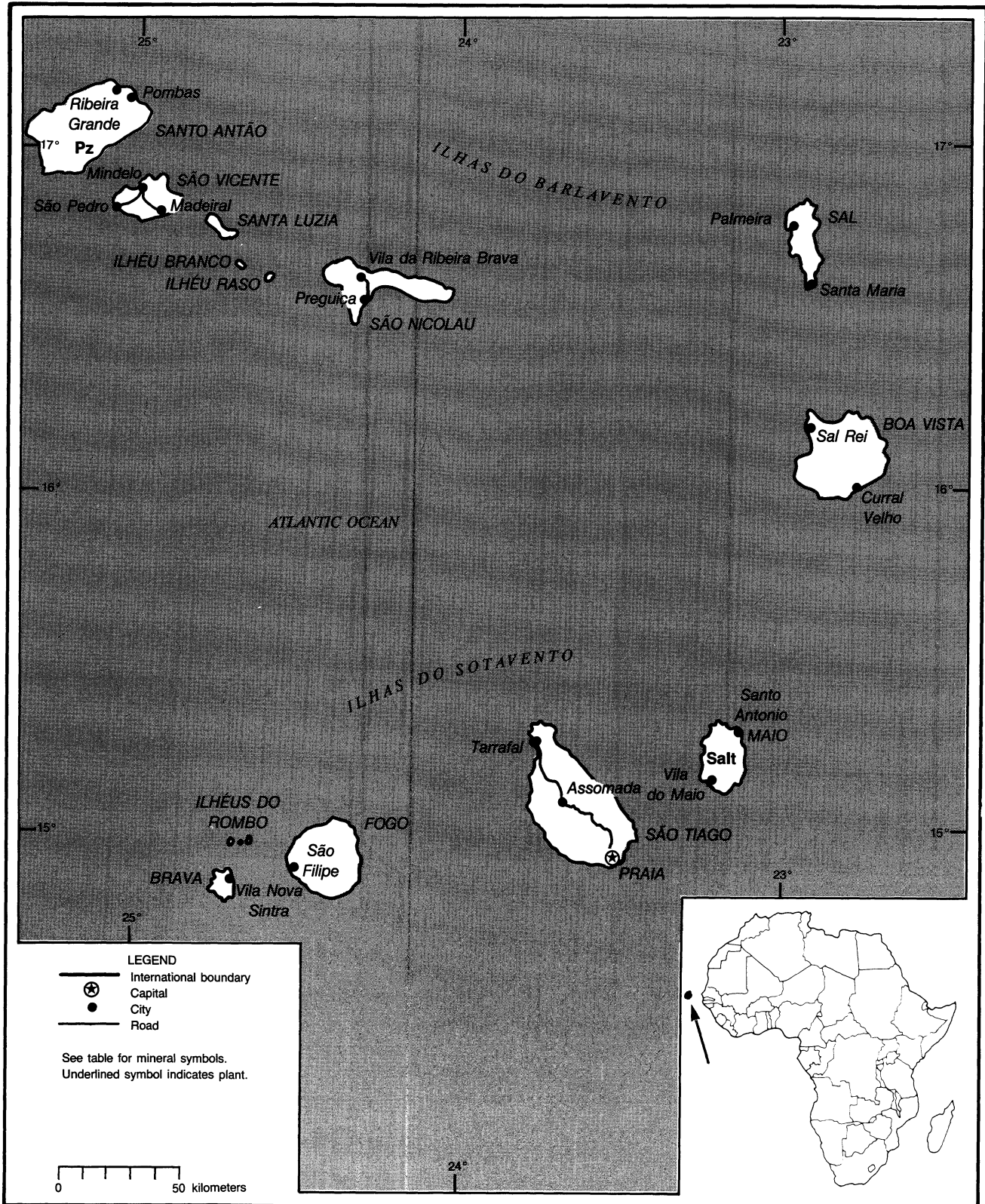




# CAPE VERDE

AREA 4,030 km<sup>2</sup>

POPULATION 386,000



# THE MINERAL INDUSTRY OF CAPE VERDE

By George A. Morgan

In 1992, mining's contribution to the economy of Cape Verde was insignificant. Production of mineral commodities was limited to salt, limestone, and pozzolana. The agricultural sector and services represented a major portion of Government revenue. Mineral resources found in the country included gypsum, kaolin, limestone, ornamental building stone, and pumice but were not in commercial quantities. However, building stone, limestone, and salt have been mined for local consumption. Cement was imported.

In 1989, the latest year for which such data were available, Cape Verde had \$107.8 million in imports and \$10.9 million in exports. In order of importance, Portugal, the Netherlands, Spain, France, Brazil, Germany, and Japan continued to supply Cape Verde with most of the necessities of life, including at least 50% of its food supply.

Four pozzolana mines on Santo Antao and two salt producers on Maio Island were all privately owned. In 1990, the latest date these data were available, the mining industry employed an estimated 170 people, of which 50 worked in the salt industry and 120 in the extraction of naturally occurring building materials.

The salt companies were Saline du Cap Vert (SCV), a private French company, and Companhia de Formento, which had recently shut down owing to operational difficulties. In the past, salt also was produced on Sal and Boa Vista Islands. Several price increases and a slight increase in production allowed SCV to increase its 1990 profits to about \$78,000 from \$31,000 in 1989. Though it directly accounted for less than 1% of Cape Verde's GDP, salt was considered important because one of its main uses

was to preserve Cape Verde's fish harvest. The fishing industry employed more than 6,000 persons and accounted for about 60% of the nation's export earnings in recent years. Salt consumption is expected to grow with the fishing industry, whose growth potential is high considering reports that Cape Verde harvested only an estimated 25% of its renewable catch limit. However, technical problems have limited the domestic salt industry and Cape Verde stopped exporting and became a net importer of salt.

The Empresa Publica de Electricidade e Agua (Electra) operated a number of thermal powerplants; a 2.8-MW plant on Praia, a 6.5-MW plant on Mindelo, and

a 1-MW plant on Sal. Local councils also operated 12 rural powerplants whose combined generating capacity was a little more than 2 MW. In 1989, the latest date these data were available, Cape Verde generated 34.5 GW•h. Electra foresaw meeting future demand through an interconnected system of combined wind-diesel powerplants. Ten 30-kW wind generators were in operation on Mindelo. The availability of water remains a major concern in a country that had suffered devastating droughts and famines every 20 to 30 years throughout its history.

<sup>1</sup>Where necessary, values have been converted from Cape Verdean escudos (CVEsc) to U.S. dollars at the rate of 77.4CVEsc=US\$1.00.

TABLE 1  
CAPE VERDE: ESTIMATED PRODUCTION OF MINERAL  
COMMODITIES<sup>1</sup>

(Metric tons)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992
Salt	<sup>3</sup> 3,000	3,000	3,500	4,000	4,000
Pozzolana	53,000	53,000	53,000	53,000	53,000

<sup>1</sup>Includes data available through Feb. 5, 1992.

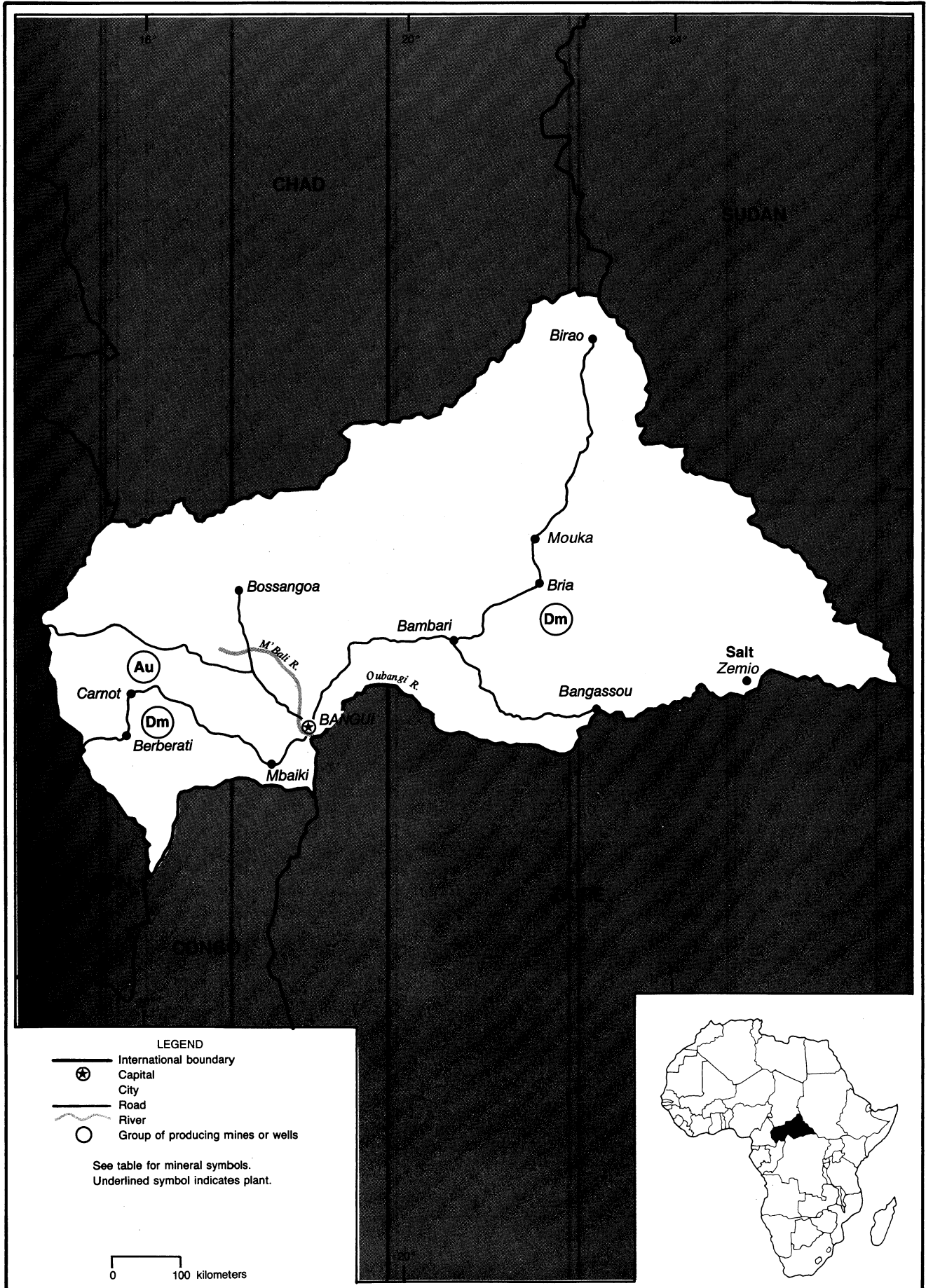
<sup>2</sup>In addition to commodities listed, small quantities of limestone, clays, gypsum, pumice, and ornamental building stone may have been produced, but output was not reported, and available information is inadequate to make reliable estimates of output levels.

<sup>3</sup>Reported figure.

# CENTRAL AFRICAN REPUBLIC

AREA 622,980 km<sup>2</sup>

POPULATION 3.0 million



# THE CENTRAL AFRICAN REPUBLIC

By Thomas P. Dolley

The Central African Republic's mining industry attracted foreign interest in the alluvial diamond sector during 1992. United Reef Petroleum Ltd. and Sikaman Gold Resources Ltd., both of Canada, have invested in diamond exploration at the Mouka Ouadda plateau, in the east central part of the country. However, by yearend 1992, activity had been minimal at these sites.

Diamonds are the most important commodity in the landlocked, undermonetized Central African Republic. About 75% of the diamond produced is of gem quality. The GDP for the Central African Republic was \$1.3 billion in 1990.<sup>1</sup> In 1992, the Central African Republic officially exported 414,000 carats of diamonds valued at \$62.5 million. Generally, a diamond's value will increase tenfold, to \$144 per carat, from the mine site to the eventual destination in Antwerp, Belgium. Alluvial gold also was mined in the Central African Republic in 1992, valued at \$1.3 million. Approximately 80% of the gold produced is exported.

Since 1925, when exploitation commenced, the mining sector has been dominated by the production and export of alluvial diamonds of gem quality. The highest recorded diamond production was in 1968 at 636,000 carats. Accurate production and export figures for both diamonds and gold are unavailable due to widespread smuggling. Additionally, Government statistics are underreported, reflecting perhaps only 50% of the total diamond exports and the avoidance of a 10% export tax. Diamond production supports an artisanal labor force of about 40,000 people, primarily in the riverbeds surrounding Carnot and Berberati, where the stones are more numerous but of lower quality. Additionally, diamonds are

mined at Bria. Diamond mining cooperatives also are present in the country. Officially, 9,052 miners were registered in 1992. The balance of the artisanal miners are subject to paying a license fee to the Government. No kimberlitic source for the diamond deposits has been found. Recent speculation indicates a possible extraterrestrial origin for the diamonds caused by the impact of a bolide.<sup>2</sup>

The Central African Republic gained independence from France on August 13, 1960. Mining legislation was based on the Mining Code, law No. 61/208, of April 11, 1961. This law was subsequently modified, beginning in 1979. In all, 12 additional amendments have been made to the law. These amendments provide guidelines for the ownership, exploitation, possession, and marketing of gold and raw diamonds. Permission of the Ministry of Mines is required before mining and purchasing precious stones and minerals. Hydrocarbon legislation was based on the Petroleum Code, Ordinance No. 73/016, of February 10, 1973.

The Central African Republic has no crude petroleum or natural gas production and no hydrocarbon refining capacity. All petroleum needs are imported via the parastatal Petroca. However, a large percentage of petroleum products are smuggled and sold illegally. Crude oil reserves have been indicated in the northern regions of the Central African Republic, but little is known of them. Prior seismic exploration activities were conducted between 1975 and 1985 by Petty Ray, Rogers, and Geosource of the United States. These seismic exploration companies were financed by a consortium of oil companies comprised of the Netherland's Royal Dutch/Shell and Exxon, Chevron, and Conoco of the

United States. A wildcat well that was drilled at Aoukale between 1985 and 1986, near the Chadian border, revealed no significant hydrocarbon deposit.

Denmark's Dansk Geo-servEx A/S, Ireland's Crowe Schaffalitzky & Associates Ltd., and Peter W. Harben Inc. of the United States evaluated a salt deposit at Zemio in 1992. To date, no exploitation has occurred. The small scale mining of quartz crystals for export has also been reported. Other minerals found in the Central African Republic include copper, iron ore, limestone, manganese, and uranium.

A lack of adequate transportation and industrial infrastructure, to include no railway system, continue to hinder the development of a viable mineral industry in the Central African Republic. (See table 1.)

<sup>1</sup>Where necessary, values have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF264.69=US\$1.00.

<sup>2</sup>R. W. Girdler, P. T. Taylor, and J. J. Frawley. A Possible Impact Origin for the Bangui Magnetic Anomaly (Central Africa). *Tectonophysics*, v. 212, Elsevier Scientific Publ., Amsterdam, 1992, pp. 45-58.

**TABLE I**  
**CENTRAL AFRICAN REPUBLIC: PRODUCTION OF MINERAL**  
**COMMODITIES<sup>1</sup>**

Commodity <sup>2</sup>	1988	1989	1990	1991	1992
<b>Diamond:</b>					
<b>Gem</b> carats	284,130	334,396	302,530	296,320	307,442
<b>Industrial</b> do.	59,278	80,806	78,496	82,323	106,522
<b>Total</b> do.	343,408	415,202	381,026	378,643	413,964
<b>Gold</b> kilograms	381	328	241	176	155

<sup>1</sup>Includes data available through May 1993.

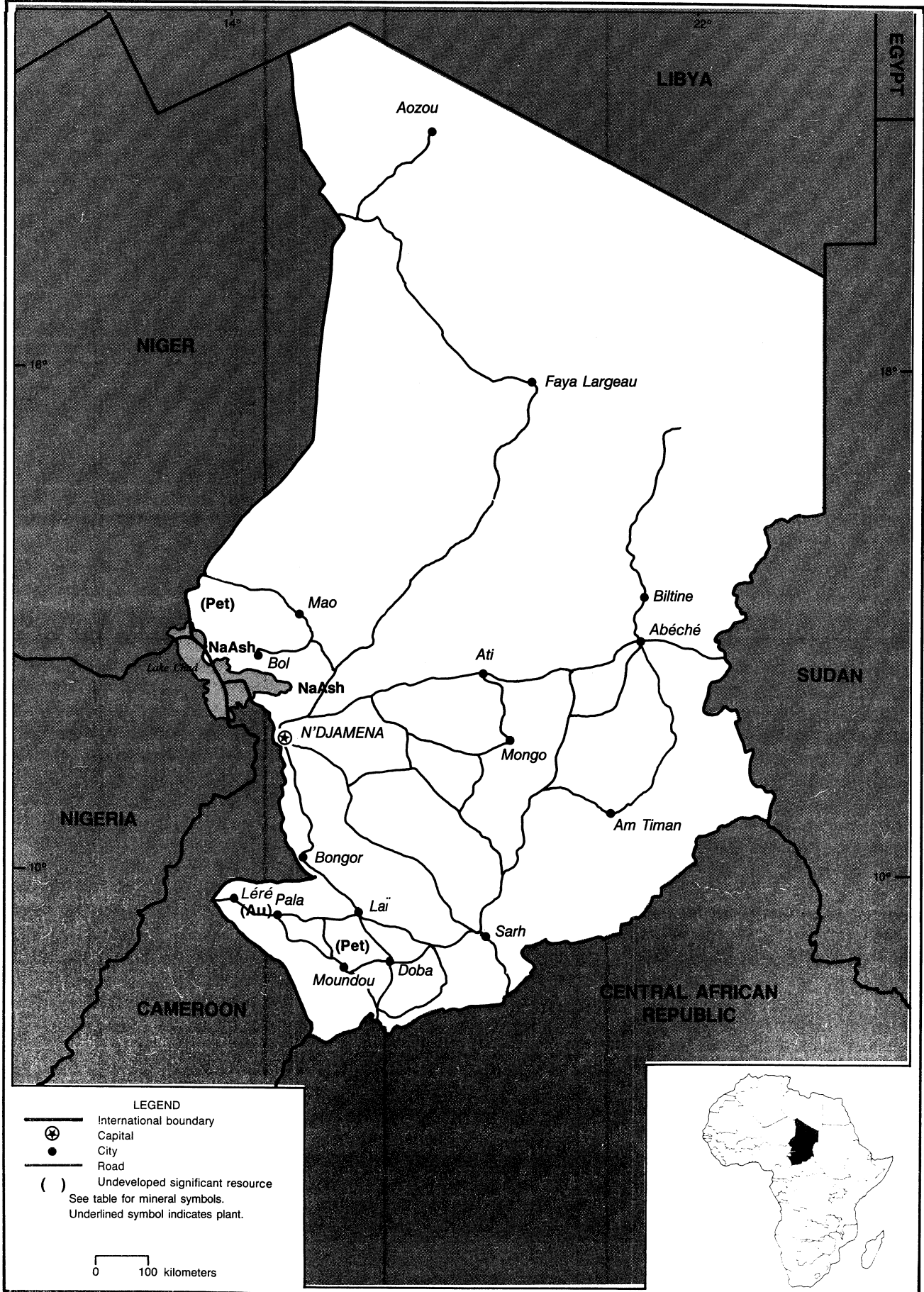
<sup>2</sup>In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (clays, gravel, sand, and stone) presumably are produced, but output is not reported quantitatively, and available information is inadequate to make reliable estimates of output levels.



# CHAD

AREA 1,284,000 km<sup>2</sup>

POPULATION 5.2 million



## THE MINERAL INDUSTRY OF

# CHAD

By Thomas P. Dolley

The landlocked Republic of Chad did not possess a viable mineral industry in 1992. Natron and salt remained the only mineral commodities produced, and only on a small scale. Chad's recent history is replete with drought, famine, war, and a lack of industrial infrastructure. All of these conditions have prohibited the development of a mineral industry.

Chad is the fifth largest country in Africa. However, with a 1991 per capita income of \$210, Chad is one of the poorest countries in the world.<sup>1</sup> Chad remained heavily dependent on foreign financial aid. In most years, the investment budget of Chad is 100% externally financed along with 70% of public-sector spending.

Cotton is the most significant export, accounting for more than 50% of Chad's GDP, which in 1991 was about \$1.2 billion. The latter, coupled with livestock exports, helped to underpin an otherwise troubled economy. The total value of U.S. exports to Chad in 1992 was \$5.3 million. The total value of U.S. imports from Chad in 1992 was about \$300,000.

Chad gained independence from France on August 11, 1960. Mining legislation in Chad was based on Mining Code No. 7/PC/TP/MH of January 18, 1962, and Petroleum Code No. 7/PC/TP/MH of February 3, 1962. The Government continued to support a mineral policy centered on the exploration and development of domestic hydrocarbons.

Chad has no significant domestic hydrocarbon production. Petroleum products consumed in Chad are exclusively imported from Nigeria and Cameroon. Lacking railway or pipeline facilities, importation of petroleum in Chad is by trucks, which are privately owned and operated. Distribution of the

majority of petroleum products is through Shell Oil Corp. and Mobil Oil Corp. of the United States and Total of France. However, smuggling of petroleum products into Chad from Nigeria and Cameroon is significant. The degree of illegal fuel importing is enough to undercut profits of the major petroleum importing companies in Chad, including the Government. Jet fuel is the only hydrocarbon commodity that is not extensively smuggled, owing to stricter international controls.

Crude oil was discovered in Chad in 1974 at Sedigi, north of Lake Chad, about 300 km from N'Djamena. In 1989, Esso Chad, a consortium of Shell, Chevron, and Exxon of the United States, confirmed the presence of crude oil with reserve estimates of 10.5 Mbbl. The proposed construction of an oil pipeline from the Sedigi Oilfields to a microrefinery in N'Djamena, including a pipeline extension to an export terminal in Cameroon, was being discussed by Esso Chad. However, as of yearend 1992 this proposed project was on indefinite hold. Additionally, the existence of petroleum has been postulated for the Erdis Basin in northeastern Chad. The Erdis Basin is an extension of the Kufra Basin in Libya, a major petroleum producer.

Though the geology of Chad has been incompletely examined, over the years some mineral resources have been identified. A quarry for road material, at Mani 93 km north of N'Djamena, is periodically utilized. An alluvial gold deposit exists in the Mayo N'Dala River about 14 km northwest of the city of Pala. Recently examined by a UN-sponsored project, the gold is found in the active channel of the river and the adjoining terraces, but the resource apparently totals only a few dozen

kilograms. The active channel cuts into Precambrian greenstone and Cretaceous sedimentary bedrock. The deposit is probably not economic beyond artisanal or semi-industrial development. Additionally, platinum has been found in a hornblendite pipe southwest of Léré.

Traditional fuels such as wood are still heavily utilized in Chad. Diesel generators utilizing imported fuel produce all electrical power. Total installed generating capacity amounted to 38 MW managed by Société Tchadienne d'Énergie Electrique. Only the major cities of N'Djamena, Moundou, and Abéché possess electric power and are not interconnected. The communications network infrastructure is embryonic. Chad possessed no railroad or river port facilities. Chad's predominantly landlocked commerce relies heavily on roadways, of which about 300 km are paved with asphalt for intracountry and intercountry trade.

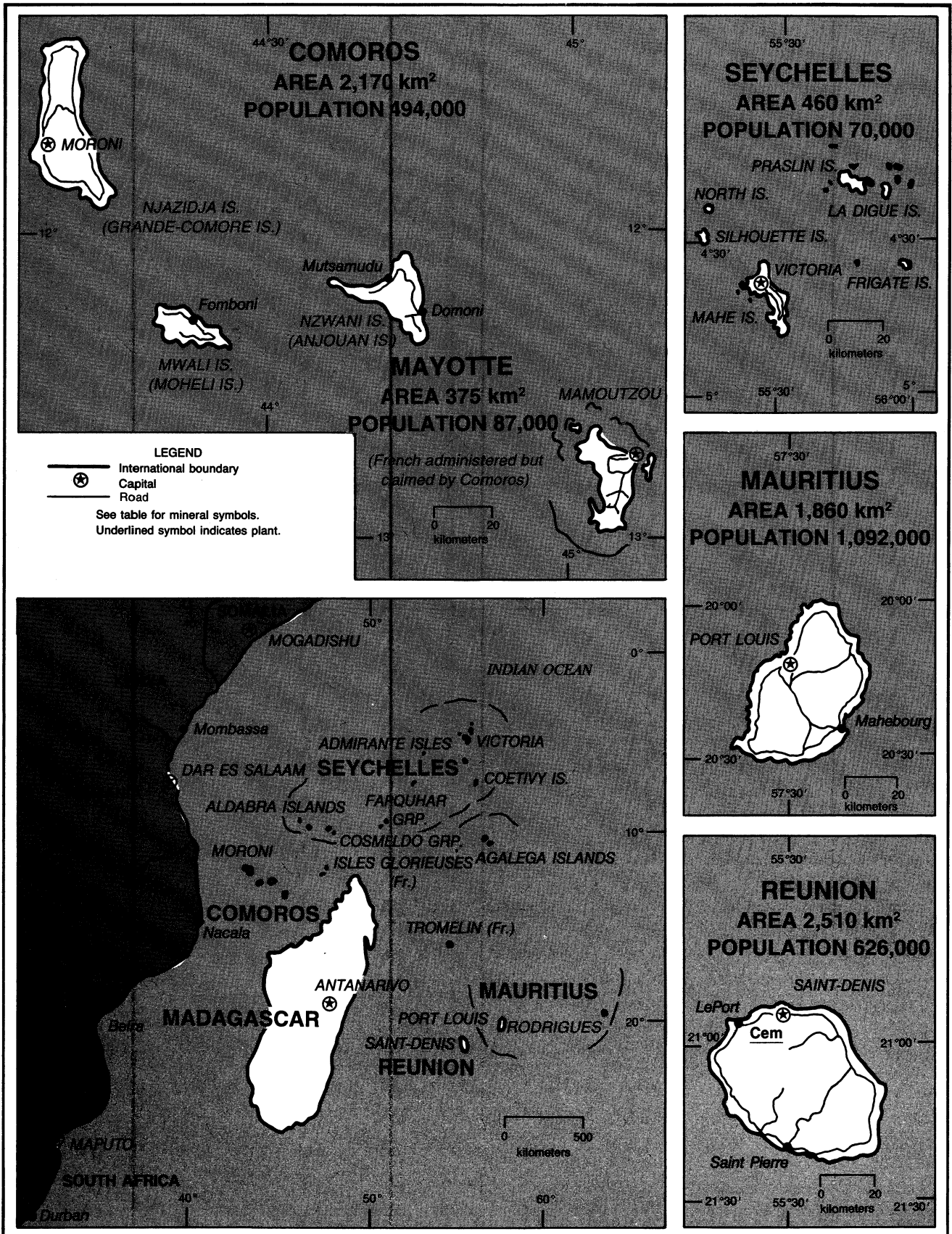
The continued depletion of water in Lake Chad has worsened environmental problems in the country. Representing an important resource for people in the area, Lake Chad provides fish and natron. Lake Chad has shrunk from its earlier extent of 25,000 km<sup>2</sup> to the current 500 km<sup>2</sup>.

Recurrent political instability in Chad will be detrimental to further foreign investment. A short-term strategy for mineral development in Chad should address commodities, such as crude oil, that can be initially utilized for domestic needs.

<sup>1</sup>Where necessary, values have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF264.69 = US\$1.00.



# ISLANDS OF COMOROS, MAURITIUS, REUNION, AND SEYCHELLES



# COMOROS, MAURITIUS, REUNION, AND SEYCHELLES

By Lloyd E. Antonides

## COMOROS

The mineral industry of Comoros remained limited to producing only common local building materials, such as clays, sand, gravel, and crushed stone, during 1992. Quantities were not available but were presumably very low because there were no significant construction projects noted in the press since the early 1980's. A construction method, suitable for unskilled labor, of using lava and volcanic ash was being promoted to reduce both imports of cement and mining of coral. Such reductions would help the trade deficit and cut degradation of the environment. Geothermal energy was considered a possibility for development.

The independent Islamic republic was a federation of three small main islands. Total land area was about two-thirds that of Rhode Island, of which Njazidja Island, formerly called Grand Comore, was 60%. The islands, volcanic mounts rising from 3,000-m depths, had hilly to mountainous terrain. One 2,500-m-high volcanic vent was still active on Njazidja. The climate was tropical. More than 40% of the land was cultivable, most in use, and almost 25%, meadow or woodland. Deforestation and erosion were severe in some areas.

Roads totaling 750 km, all improved with 210 km bituminous topped, gave somewhat limited access on the rugged islands. There were no railroads. Principal ports were Mutsamudu, the only one considered a deepwater port, and Moroni. An international airport was near Moroni, the capital, and each other island had smaller strips. All had permanent

surfaces. Utilities included 16 MW of installed electric power, all diesel except 1 MW hydroelectric. Telecommunications were tied to an earth satellite system in 1991.

The outlook for the economy and minerals output was for little change, at least in the near term.

Mayotte Island, the fourth major island in the Comoros archipelago, was claimed by Comoros. But Mayotte did not vote for independence in 1975 with the other islands and was designated a territorial collectivity of France in 1976. Its economy was similar to its neighbor. Roads totaled 42 km, one-half bituminous. There was a small port and a nearby airfield that was paved.

## MAURITIUS

The mineral industry of Mauritius was a negligible factor in the economy. Historically, the output consisted of basalt construction stone, coral sand, lime, and solar-evaporated sea salt. (See table 1.) Quantitative information was rarely available and then appeared to be inconsistent. Undoubtedly, the bulk of the coral sand was used for construction, but in 1991 about 20% was reported being used in industry. Presumably some was used to make lime. Coral mining was under pressure because of environmental effects on coastal lagoons. Sand from crushing basalt rock was proposed as a substitute for construction uses.

Polymetallic nodules occurred on the ocean floor at about a 4,000-m depth, from 400 km to 800 km north of the main island, northeast of Tromelin Island. The nodules averaged more than 15%

each of iron and manganese and more than 0.3% cobalt, with an abundance averaging 2 to 6 kg/m<sup>2</sup>.

Oil possibilities were inconclusively explored with geophysics and drilling by Texaco in the 1970's. The drilling was east of the polymetallic nodules area at shallower depths.

Steel reinforcing bars were made from imported ingot at three rolling mills. The Government continued searching for financing an oil refinery and a petrochemical plant based on imported crude.

The volcanic islands in the western Indian Ocean that made up the nation were dispersed over a large area. Geologically, they were associated with the submerged Mascarene Plateau and related ridges and outliers postulated to be a continental block split off Africa. Claims to some additional islands to the northeast and one to the west were disputed. Almost all of the land area and population was concentrated in the most southerly island after which the country was named. The main island was less than two-thirds the size of Rhode Island, consisting essentially of a large central plateau, probably an old caldera, edged by mountains and encircled by a narrower coastal plain fringed with coral reefs. The climate was subtropical. More than one-half of the land was cultivable with sugarcane grown on almost 90%. About 35% of the land was meadow or woodland.

In March 1992, the form of Government changed to an independent republic with a president, having been an independent parliamentary democracy whose head of state was the British

Monarch since 1968.

Roads totaling 1,800 km, more than 90% paved, radiated out from Port Louis and also encircled the island. There were no railroads. Port Louis was the principal port. The main airport was near Mahebourg with a paved runway suitable for heavier international traffic. Additional runways were available on other islands. Public electric power generating capacity was 233 MW in 1989, the latest year data were available. Two diesel and six hydroelectric plants were in the system. Private sugar operations owned another 15-MW capacity in thermal plants, from which the public utility bought about 10% of the power sold. Bagasse, sugarcane residue, was a commonly used fuel. The public system had an additional hydroelectric project under way and reportedly planned a bagasse-fired unit.

The outlook on mineral commodity-related matters was for little change other than a reduction in coral mining. The economy in general was expected to successfully adapt as conditions change.

## REUNION

Mineral commodities production was only a small part of the economy of Reunion in 1992 as in earlier years, even though little quantitative information was available. However, output of hydraulic cement, made by grinding imported clinker, presumably remained substantial, well above 300,000 mt/a. The plant, owned by Ciments de Bourbon S.A. at Le Port, had a capacity of 350,000 mt/a. Additionally, production of basic volcanic rock and sea coast coral undoubtedly continued to meet the needs of construction.

Reunion, an overseas department of France, consisted of a volcanic island slightly more than three-fourths the size of Rhode Island. It was the top of a large peak whose base was more than 4,000 m below sea level, off the southwestern end of the submerged Mascarene Plateau. The terrain was rugged and mountainous, up to 3,000 m, with a narrow coastal plain. One peak last erupted in 1990. The climate was tropical. Land use was

reported as slightly less than 25% cultivable, with sugarcane on 80% of that, and about 40% meadow or woodland.

Roadways totaled 2,200 km paved plus 600 km of stone or stabilized earth. A main route along the coast encircled the island and another crossed diagonally. Other roads gave only limited access into the interior owing to the rugged terrain. There were no railroads. The main shipping port was at Le Port and an international airport with paved runways was near St.-Denis. Installed electric generating capacity was 245 MW; at least some was hydroelectric, for which there remained a large potential.

Little change in the economy could be anticipated in the near future.

## SEYCHELLES

Mineral production for 1992 in the widespread island groups that comprised Seychelles continued to be mostly unspecified quantities of construction materials—clays, coral, rock, and sand. Output of guano, an organic phosphate fertilizer from bird droppings, ceased in the mid-1980's, but a 5,000-mt/a capacity remained with some occasional small production unofficially reported. There was also some potential for producing granite dimension stone from the bedrock of Mahe and nearby islands, which was done on a trial basis by an Italian firm in the early 1980's. More recently production of lime and cement from the abundant coral was under consideration, and offshore petroleum remained a possibility in several areas. In addition, polymetallic nodules were known to occur on the ocean bottom near the Admirante Islands, about 300 km southwest of Victoria. Limited sampling was done in the mid-1980's, but funds for the further work that was planned apparently were not forthcoming.

Petroleum tar balls from underground seeps were known for many years to occur on beaches of Coetivy Island, about 300 km south of Victoria, as well as on Mahe and some nearby islands. Oil exploration began in Seychelles in 1969 and continued throughout the 1970's and

early 1980's. It included drilling as well as geophysical work. A seminar on regional oil exploration, held in Victoria in December 1990, was expected to develop interest but no new activity was reported through mid-1993. In *Oil & Gas Journal*, August 31, 1992, a geophysical consultant to the parastatal Seychelles National Oil Co. reported that studies on the tar balls continued to give promise of a significant oil potential.

The Republic of Seychelles consisted of 100 to 120 islands clustered in several groups over a 400,000-km<sup>2</sup> area. Of the total land area, about 2.5 times that of the District of Columbia, about one-third was in one lagoon of an island in the southeast group, all coral atolls. Another one-third was on Mahe, the largest of about 40 steeply hilly, rocky granite islands with narrow coastal strips that made up the northeast group. On Mahe, elevations were up to 900 m. The group was considered to represent peaks rising from a relatively shallow submerged plateau of a continental block split off from Africa, similar to the basement rock of Madagascar. The 60 to 80 other outer islands were low and flat, formed from coral reefs around submerged remnant peaks, presumably mostly volcanic. The climate was tropical. Only slightly more than 20% of the land was cultivable but almost 20% was rather lush forest and woodland. Conservation of fresh water was important because even brief droughts resulted in shortages.

Roads included 160 km bituminous and 100 km crushed stone or earth, apparently all on Mahe. The principal port was at Victoria and an international class airport was about 20 km south. Electric generating capacity of the Public Utilities Corp. was 24 MW from three diesel plants. Two were on Mahe and one on Praslin, which also supplied La Digue by undersea cable. Privately owned generators were fairly common, especially on other islands.

In the future, the economy was not expected to incur major changes.

## OTHER SOURCES OF INFORMATION

### Agencies

Ministry of Economy

Government Building Moroni  
Grand-Comore Island, Comoros

Ministry of Agriculture and Natural  
Resources

Government House  
Port Louis, Mauritius

Bureau de Recherches Géologiques et  
Minières

46 Bis Rue de Nice, P.B. 1206  
Saint-Denis, La Reunion

Ministry for National Development  
Independence House, P.O. Box 199  
Victoria, Mahe, Seychelles

TABLE 1  
MAURITIUS: ESTIMATED PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992
Lime	7,000	7,000	7,000	7,000	7,000
Salt	6,000	6,000	6,000	6,000	6,000
Sand, coral	300,000	300,000	300,000	300,000	300,000
Stone: Basalt, not further described	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000

<sup>1</sup>Includes data available through June 1, 1993.

<sup>2</sup>In addition to the commodities listed, the following are presumably produced, but available information is inadequate to reliably estimate output: coral for lime manufacture (1.5 to 2 tons of coral per ton of lime) and minor quantities of locally used crude construction materials (clays, sand, stone, etc.).

TABLE 2  
REUNION: EXPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1991	Principal destinations
<b>METALS</b>		
Aluminum: Metal including alloys:		
Scrap	152	Madagascar 118; France 24.
Semimanufactures	1	All to Mauritius.
Copper: Metal including alloys:		
Scrap	278	All to France.
Semimanufactures	3	Mainly to Mauritius.
Gold: Metal including alloys, unwrought and partly wrought kilograms	1	All to Mauritius.
Iron and steel: Metal:		
Scrap	231	All to France.
Semimanufactures:		
Flat-rolled products:		
Of iron or nonalloy steel:		
Not clad, plated, coated	266	Comoros 263; Mauritius 2.
Clad, plated, coated	1,023	Comoros 829; Madagascar 113.
Of alloy steel	1	All to Madagascar.
Bars, rods, angles, shapes, sections	241	Comoros 170; Mauritius 70.
Wire	10	Comoros 8; Mauritius 1.
Tubes, pipes, fittings	40	Comoros 38; France 2.
Lead: Metal including alloys, scrap	5	All to France.
<b>INDUSTRIAL MINERALS</b>		
Cement	921	All to Mauritius.
Fertilizer materials: Manufactured:		
Potassic	220	All to Madagascar.
Unspecified and mixed	3	Do.
Salt and brine	14	Mainly to Djibouti.
Stone, sand and gravel: Dimension stone, worked	3	All to France.
<b>MINERAL FUELS AND RELATED MATERIALS</b>		
Petroleum refinery products: Liquefied petroleum gas 42-gallon barrels	2,285	All to Comoros.

<sup>1</sup>Comparable data are not available for 1990. No mineral export commodities to the United States were reported for 1991. Table prepared by Virginia A. Woodson.

TABLE 3  
REUNION: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1991	Principal destinations
<b>METALS</b>		
<b>Aluminum: Metal including alloys:</b>		
Unwrought	25	All from France.
Semimanufactures	418	France 396; Belgium-Luxembourg 14.
<b>Bismuth: Metal including alloys, all forms value, thousands</b>	<b>\$1</b>	<b>All from France.</b>
<b>Copper: Metal including alloys:</b>		
Scrap	4	All from Madagascar.
Semimanufactures	354	France 346; Italy 7.
<b>Gold: Metal including alloys, unwrought and partly wrought kilograms</b>	<b>20</b>	<b>All from France.</b>
<b>Iron and steel: Metal:</b>		
Scrap	12	All from Madagascar.
Pig iron, cast iron, related materials	6	All from France.
Steel, primary forms	1	Do.
<b>Semimanufactures:</b>		
<b>Flat-rolled products:</b>		
<b>Of iron or nonalloy steel:</b>		
Not clad, plated, coated	2,776	Belgium-Luxembourg 2,450; France 278.
Clad, plated, coated	15,639	France 11,931; Belgium-Luxembourg 3,387.
<b>Of alloy steel</b>		
Bars, rods, angles, shapes, sections	37,796	France 15,960; Belgium-Luxembourg 13,107; Spain 8,065.
Rails and accessories	401	France 388; Belgium-Luxembourg 13.
Wire	1,420	Belgium-Luxembourg 731; Republic of South Africa 450; France 107.
Tubes, pipes, fittings	9,205	France 5,414; Spain 765; Belgium-Luxembourg 311.
<b>Lead:</b>		
Oxides	5	All from France.
Metal including alloys, semimanufactures	16	Do.
<b>Mercury value, thousands</b>	<b>\$2</b>	<b>Do.</b>
<b>Nickel: Metal including alloys, semimanufactures do.</b>	<b>\$7</b>	<b>Do.</b>
<b>Silver: Metal including alloys, unwrought and partly wrought do.</b>	<b>\$8</b>	<b>Do.</b>
<b>Tin: Metal including alloys:</b>		
Unwrought do.	\$4	Do.
Semimanufactures do.	\$1	Do.
<b>Titanium: Oxides</b>	<b>14</b>	<b>Do.</b>
<b>Zinc:</b>		
Oxides	15	Do.
Metal including alloys, semimanufactures	46	Do.
<b>INDUSTRIAL MINERALS</b>		
<b>Abrasives, n.e.s.:</b>		
Natural: Corundum, emery, pumice, etc.	1	Do.
Grinding and polishing wheels and stones	65	France 62; Switzerland 2.
Barite and witherite	74	France 54; Germany 20.
Cement	339,496	Kenya 125,157; France 124,583; Greece 63,095.
Chalk	2,206	France 1,563; Republic of South Africa 349.
<b>Clays, crude:</b>		
Bentonite	102	All from France.

See footnotes at end of table.

TABLE 3—Continued  
**REUNION: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

Commodity	1991	Principal destinations
<b>INDUSTRIAL MINERALS—Continued</b>		
Clays, crude—Continued:		
Kaolin	14	All from France.
Unspecified	10	France 9; Madagascar 1.
Diamond, natural: Industrial stones value, thousands	\$4	All from Thailand.
Diatomite and other infusorial earth	66	France 50; Belgium-Luxembourg 16.
Fertilizer materials:		
Crude, n.e.s.	45	France 27; Republic of South Africa 18.
Manufactured:		
Ammonia	5	All from France.
Nitrogenous	3,782	Italy 1,106; Belgium-Luxembourg 1,011; Netherlands 1,000.
Phosphatic	619	Republic of South Africa 599; France 20.
Potassic	1,629	Jordan 1,500; Belgium-Luxembourg 20.
Unspecified and mixed	17,284	France 11,945; Mauritius 5,021.
Gypsum and plaster	13,376	All from France.
Lime	2,327	France 1,729; Belgium-Luxembourg 410.
Magnesite, crude value, thousands	\$1	All from France.
Mica: Crude including splittings and waste	27	Do.
Pigments, mineral: Iron oxides and hydroxides, processed	108	France 88; Germany 20.
Precious and semiprecious stones other than diamond:		
Natural value, thousands	\$45	Italy \$15; Madagascar \$12; France \$10.
Salt and brine	2,805	Germany 1,422; France 651; Madagascar 608.
Sodium compounds, n.e.s.: Sulfate, manufactured value, thousands	\$3	All from France.
Stone, sand and gravel:		
Dimension stone: Worked	749	France 579; Italy 90; China 34.
Dolomite, chiefly refractory-grade	290	France 280; unspecified 9.
Gravel and crushed rock	108	France 83; Republic of South Africa 25.
Quartz and quartzite	3	Mainly from France.
Sand other than metal-bearing	163	France 122; Republic of South Africa 41.
Sulfur:		
Elemental:		
Crude including native and byproduct	1	All from France.
Colloidal, precipitated, sublimed	2	Do.
Sulfuric acid	186	France 127; Belgium-Luxembourg 39; Netherlands 21.
Talc, steatite, soapstone, pyrophyllite	38	All from France.
Other:		
Crude	635	Germany 291; France 217; Republic of South Africa 91.
Slag and dross, not metal-bearing	1	All from France.
<b>MINERAL FUELS AND RELATED MATERIALS</b>		
Asphalt and bitumen, natural	561	Republic of South Africa 538; France 22.
Carbon black	2	France 1; Germany 1.
Peat including briquets and litter	542	Germany 399; France 84; Belgium-Luxembourg 59.
Petroleum refinery products:		
Liquefied petroleum gas 42-gallon barrels	253,332	Bahrain 202,037; Australia 26,204; Saudi Arabia 18,757.
Mineral jelly and wax value, thousands	\$3	All from France.
Bitumen and other residues 42-gallon barrels	91,239	All from South Africa.
Bituminous mixtures do.	2,383	Republic of South Africa 1,849; France 424; Germany 55.

<sup>1</sup>Comparable data are not available for 1990. No mineral import commodities to the United States were reported for 1991. Table prepared by Virginia A. Woodson.

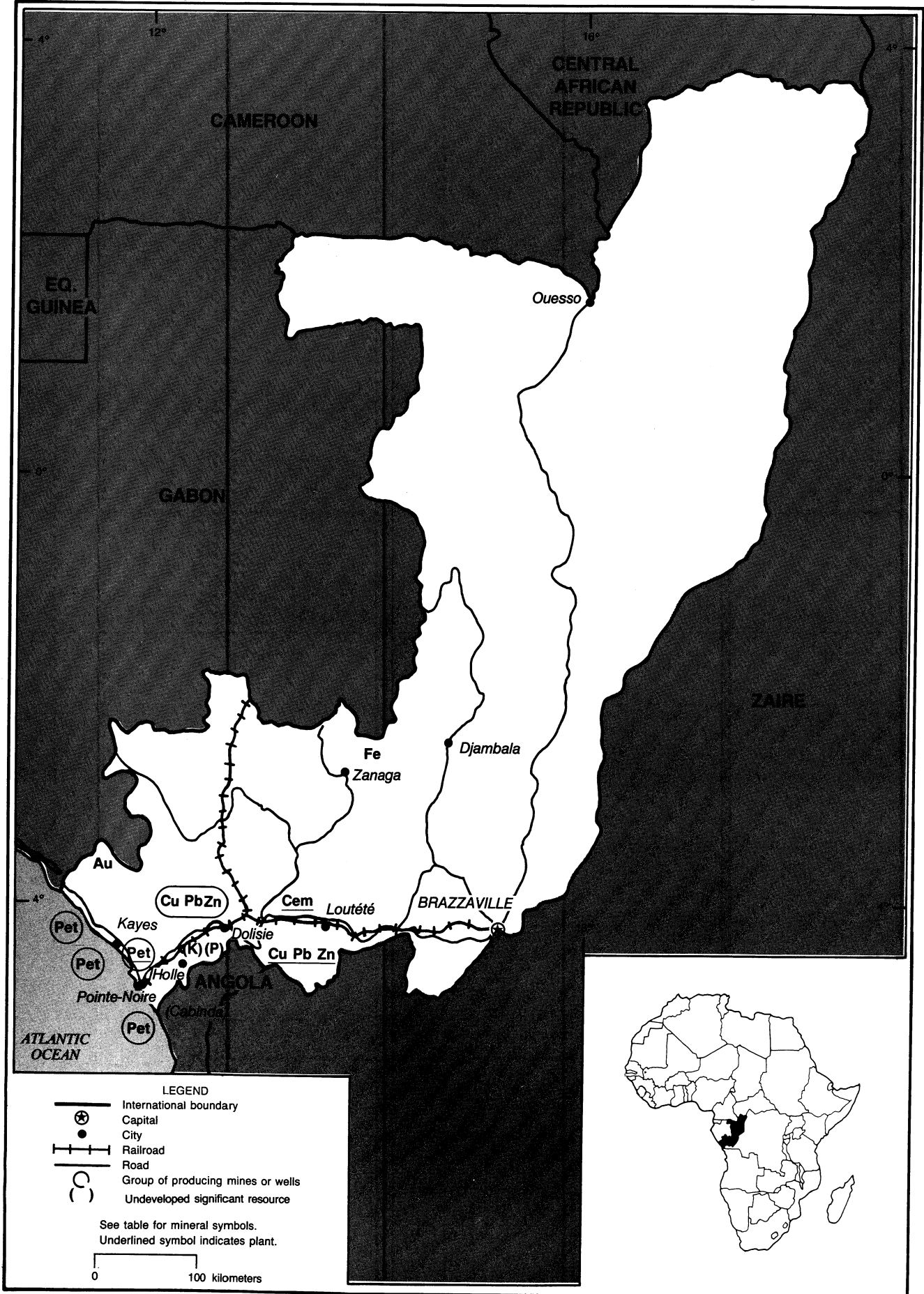




# CONGO

AREA 342,000 km<sup>2</sup>

POPULATION 2.3 million



## THE MINERAL INDUSTRY OF

# CONGO

By Thomas P. Dolley

The Republic of Congo, led by a new Government, continued to be a major producer of crude petroleum in central Africa in 1992. Traditionally, crude oil and natural gas account for more than 90% of export earnings. Congo's foreign debt totaled about \$4.7 billion in 1991.<sup>1</sup> In recent years, despite significant borrowing against future crude oil discoveries, the Government has benefited from important hydrocarbon finds during 1992. The GDP for 1991 was \$2.6 billion.

The production of other minerals, specifically copper, gold, lead, and zinc, has declined or been terminated for an indefinite period. Small private firms involved in gold mining have been closing, which is one reason for the mining downturn. Officially reported gold production generated slightly more than \$48,000 in 1992.

Congo achieved independence from France on August 15, 1960. In 1965, all mines were nationalized and continue to remain the property of the Government. Mining legislation in Congo is based on law 29-62 of June 1962. The law has been amended several times, most recently with Decree No. 86/814 of June 11, 1986. In general, mining is carried out by the state or through joint-venture agreements. Created in 1979, the parastatal Société Congolaise de Recherche et d'Exploitation Minière is involved with the exploitation of all nonfuel ores and minerals. Created in the early 1970's, Hydro-Congo is the state-owned petroleum company.

Société de Cimenterie du Congo is the parastatal that produces and sells cement from a factory in Loutété, which lies along the railway between Brazzaville and Pointe-Noire. Cement production in Congo is heavily subsidized by the

Government, which establishes nationwide fixed prices for cement. Problematically, the Government must pay transportation subsidies to offer the cement at the same fixed prices at remote locations in Congo. In times of cement shortages and thus higher cement prices, it remains difficult for the Government to enforce the fixed prices. The total value of finished cement produced in 1992 was more than \$23 million. Lime is produced by only one operator in Congo, Chauco of Brazzaville. Official statistics report that the total value of lime produced in Congo for 1992 was valued at slightly more than \$97,000.

The United States is a major importer of Congolese crude petroleum. Congo exported 15.7 Mbbl of crude oil to the United States in 1992. Congo is heavily dependent on foreign imports. Congo's imports from the United States were valued at \$59.7 million in 1992. Additionally, rapprochement between the Government and Israel in late 1991 led to an agreement on cooperation among both countries in the oil and mining sectors. Israel will train Congolese staff in these subject areas.

Foreign companies and expertise continue to play a primary role in the development of the hydrocarbons sector. However, Congo is not a member of OPEC and not subject to imposed production quotas. France's Société Nationale Elf Aquitaine (Elf), operating through its subsidiary Elf-Congo, was the primary petroleum producer with 80% of Congo's total crude oil output. By yearend 1991, Elf initiated production from its offshore Tchendo oilfield, with 26 wells in operation there. Output at the field is expected to rise to 20 kbb/d in 1993. Crude oil from the field is transported via pipeline to a terminus at

Djeno. Elf-Congo's crude oil production throughout the country is about 130 kbb/d. Accounting for much of the remaining 20% of Congo's oil production, at 45 kbb/d, is Italy's Azienda Generali Italiana Petroli S.p.A. (Agip-Congo). Agip-Congo is a subsidiary of Italy's parastatal Ente Nazionale Idocarburi. Equity participation at the Tchendo oilfield is Elf-Congo at 65% and Agip-Congo at 35%. Additionally, Elf-Congo was continuing to bring on-line the 16 planned wells of the offshore Nkossa oilfield, purported to be the largest offshore field in Congo. Initial production will be about 14 Mbbl/a, rising to 29 Mbbl/a by 1999.

By yearend 1992, a group led by Agip-Congo reported a significant hydrocarbon find in the offshore Marine VII area. Along with Agip-Congo at equity participation of 35.75%, Chevron Corp. of the United States at 29.25% is a partner in the group and reported drilling a well flowing at a rate of 13,500 bbl/d. Scant information exists on this offshore area; however, Agip-Congo reported that the well produced a high-quality, less dense oil than the typical crude oil produced in Congo. Hydro-Congo is also an equity investor in the crude oil find at 35%.

Another petroleum producer in Congo included the Amoco Corp. of the United States, averaging 15 kbb/d. By yearend 1992, the United Kingdom's British Petroleum and Conoco of the United States both relinquished their onshore petroleum exploration tracts after unsuccessful results.

According to the leadership of Hydro-Congo, the planned privatization of the parastatal was reinforced by restructuring moves that saved the Government \$42 million in 1992. Cuts in staff at Hydro-

Congo reduced the personnel from 1,300 people to 700 people. The company also plans to cut the salary bill, and privatization is considered a priority by the new Government.

Estimated petroleum reserves in Congo totaled 340 Mbbl. Reserves of natural gas have been estimated at 77 billion m<sup>3</sup>, representing about 0.05% of the world's total reserves. The Congo's nonfuel mineral resource potential has yet to be fully exploited. Copper, lead, and zinc mineralization exists in Congo along with occurrences of iron ore. Industrial mineral resource potential includes phosphate and potash in southeastern Congo and bentonite, granite, gypsum, kaolin, marble, and talc elsewhere.

Environmentally, the Congo has experienced some offshore oil spills and

a decline in forest ecosystems in recent years. Unregulated logging has destroyed some forest animal habitats. Currently, Congo is second only to Zaire in the range of its tropical forests, accounting for 62% of the country's territory. During 1992, the World Bank approved a \$22.5 million loan to help finance a project to save Congo's forests.

Congo's petroleum production base has been eroding at the rate of 10% per year. The recent significant hydrocarbon discoveries, coupled with the concomitant foreign investment, should help to bolster the nation's embryonic democracy. Successful nonfuel mineral resource development in Congo is dependent on the development of ready global markets and an adequate transportation infrastructure. (See table 1.)

<sup>1</sup>Where necessary, values have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF264.69=US\$1.00.

#### OTHER SOURCES OF INFORMATION

Société Congolaise de Recherche et d'Exploitation Minière (SOCOREM)  
BP 1485

Brazzaville, Republic of Congo  
Telephone: 83 39 12

Central African Mineral Resources Development Centre  
Centre de Mise en Valeur des Ressources Minérales de l'Afrique  
BP 579

Brazzaville, Republic of Congo  
Société des Potasses du Congo  
BP 1098  
Brazzaville, Republic of Congo

TABLE 1  
CONGO: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

Commodity <sup>2</sup>		1988	1989	1990	1991	1992 <sup>3</sup>
Cement, hydraulic	metric tons	77,000	121,690	90,326	102,571	<sup>3</sup> 114,854
Gas, natural: <sup>*</sup>						
Gross	million cubic meters	368	368	368	368	360
Marketed	do.	350	350	350	350	350
Gold, mine output, Au content <sup>*</sup>	kilograms	4	<sup>3</sup> 6	<sup>3</sup> 7	<sup>3</sup> 12	<sup>3</sup> 5
Lime <sup>*</sup>	metric tons	300	<sup>3</sup> 398	<sup>3</sup> 298	<sup>3</sup> 300	<sup>3</sup> 240
Petroleum, crude	thousand 42-gallon barrels	49,275	55,000	58,765	56,575	<sup>3</sup> 58,035

<sup>\*</sup>Estimated.

<sup>1</sup>Includes data available through Oct. 1993.

<sup>2</sup>In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (clays, gravel, sand, and stone) presumably are produced, but output is not reported quantitatively, and available information is inadequate to make reliable estimates of output levels.

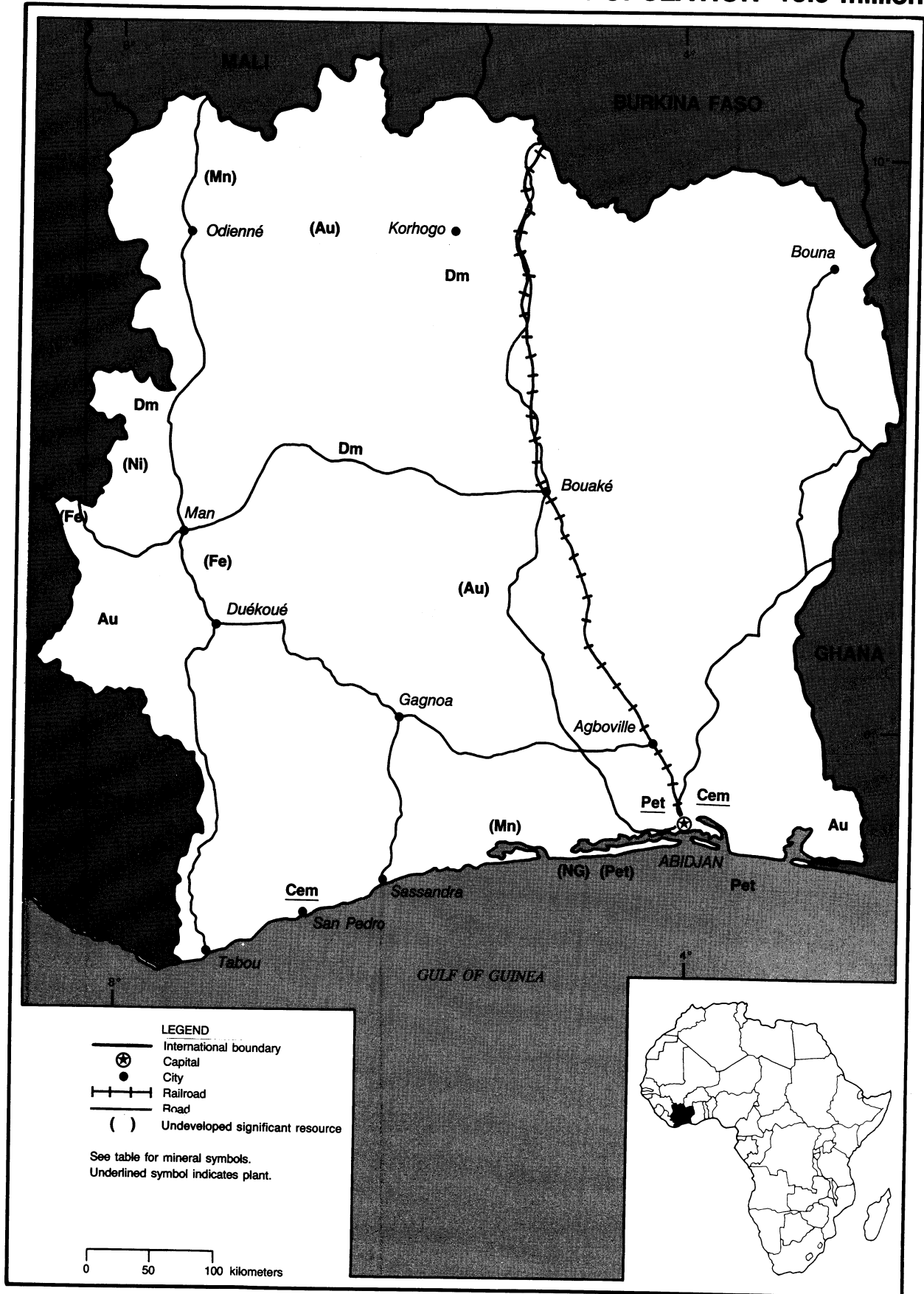
<sup>3</sup>Reported figure.



# CÔTE D'IVOIRE

AREA 324,460 km<sup>2</sup>

POPULATION 13.5 million



# THE MINERAL INDUSTRY OF CÔTE D'IVOIRE

By Hendrik G. van Oss

Domestic mineral production in Côte d'Ivoire is estimated to have been worth about \$525 million in 1992. By comparison, the country's GDP in 1992 was \$10.17 billion. The mineral industry was dominated by the production of mineral fuels, cement, diamonds, and gold (see table 1). About 85% of the value of mineral commodities produced was accounted for by mineral fuels, of which refined petroleum products accounted for about 99%.

Mineral commodity exports are estimated to have amounted to about \$385 million or about 14% of the country's total exports. About 84% of mineral commodity exports were accounted for by refined petroleum products. Cement exports are estimated to have been worth about \$25 million, and official gold and diamond exports are estimated to have been worth about \$17 million each. About 95% of the diamond exports was believed to represent material smuggled into Côte d'Ivoire. Data were unavailable on the value of gold and diamonds smuggled out of the country.

Mineral commodities accounted for about 25% of Côte d'Ivoire's official imports in 1992 of \$2.27 billion. Mineral fuel imports were reported to have been worth \$511 million (86% crude oil), although about 30% of this material was destined for reexport to neighboring countries. Clinker imports were worth \$30 million and fertilizer imports are estimated at about \$20 million.

Mineral exploration interest in Côte d'Ivoire has been keen in recent years. One gold mine was put into production early in 1991 and a second gold mine had its first commercial gold pour at the end of February 1992. A number of other gold properties were being explored. Significant nickel resources exist northwest of Man. Plans were well

advanced for bringing new oil and natural gas fields into production.

Société des Mines d'Ity produced about 1,000 kg of gold from the Ity Mine southwest of Man. The open pit, heap-leach mine had commenced gold production in January 1991. An agglomeration method was developed during the year that would allow the leaching of auriferous, but clay-rich, material underlying the laterite ore being exploited.

Société Minière d'Afema had its first gold pour from its Afema mine east of Abidjan at the end of February 1992. By yearend 1992, mining had increased to a rate of about 800 mt/d, all oxide ore from the Aniuri deposit, one of several known on the concession. Significant additional reserves were delineated during 1992 and were being evaluated at yearend. The

company was negotiating to expand its concession.

After several years of declining output, the oil reserves at the offshore Bélier Field were exhausted during the year and the field, Côte d'Ivoire's only oil producer, was shut down. An agreement was signed between the Government and a consortium of French and American companies to develop the Foxtrot natural gas field, west-southwest of Abidjan. Gas from the field was to fire a thermal power station, part new and part converted from fuel oil, the plant to be constructed by the same consortium. In June, the Government signed an agreement with United Meridian Corp. of the United States to further explore for oil, natural gas, and gas condensate from Block CI-11, immediately west of the Foxtrot permit.

TABLE 1  
CÔTE D'IVOIRE: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

Commodity <sup>2</sup>	1988	1989	1990*	1991*	1992*
Cement <sup>3</sup> thousand metric tons	700	*500	500	500	510
Diamond <sup>4</sup> carats	*11,157	*11,689	12,000	15,000	15,000
Gold <sup>4</sup> kilograms	6	3	20	1,100	1,500
<b>Petroleum:</b>					
Crude thousand 42-gallon barrels	<u>4,721</u>	<u>*771</u>	<u>*770</u>	<u>*730</u>	<u>*300</u>
<b>Refinery products:<sup>5</sup></b>					
Motor gasoline do.	2,644	1,794	1,800	1,800	1,800
Kerosene and jet fuel do.	1,970	1,538	1,600	1,600	1,600
Distillate fuel oil do.	3,670	3,618	3,700	3,700	3,700
Residual fuel oil do.	3,976	2,644	2,800	2,800	2,800
Liquefied petroleum gas do.	151	174	175	175	175
Other do.	182	196	200	200	200
<b>Total do.</b>	<u>12,593</u>	<u>9,964</u>	<u>10,275</u>	<u>10,275</u>	<u>10,275</u>

\*Estimated. Revised.

<sup>1</sup>Includes data available through June 7, 1993.

<sup>2</sup>In addition to the commodities listed, Côte d'Ivoire produces clay, stone, sand and gravel, and crushed granite for local construction purposes. Information is inadequate to make reliable estimates of output levels.

<sup>3</sup>Output based entirely on imported clinker.

<sup>4</sup>Does not include artisanal production smuggled out of the country.

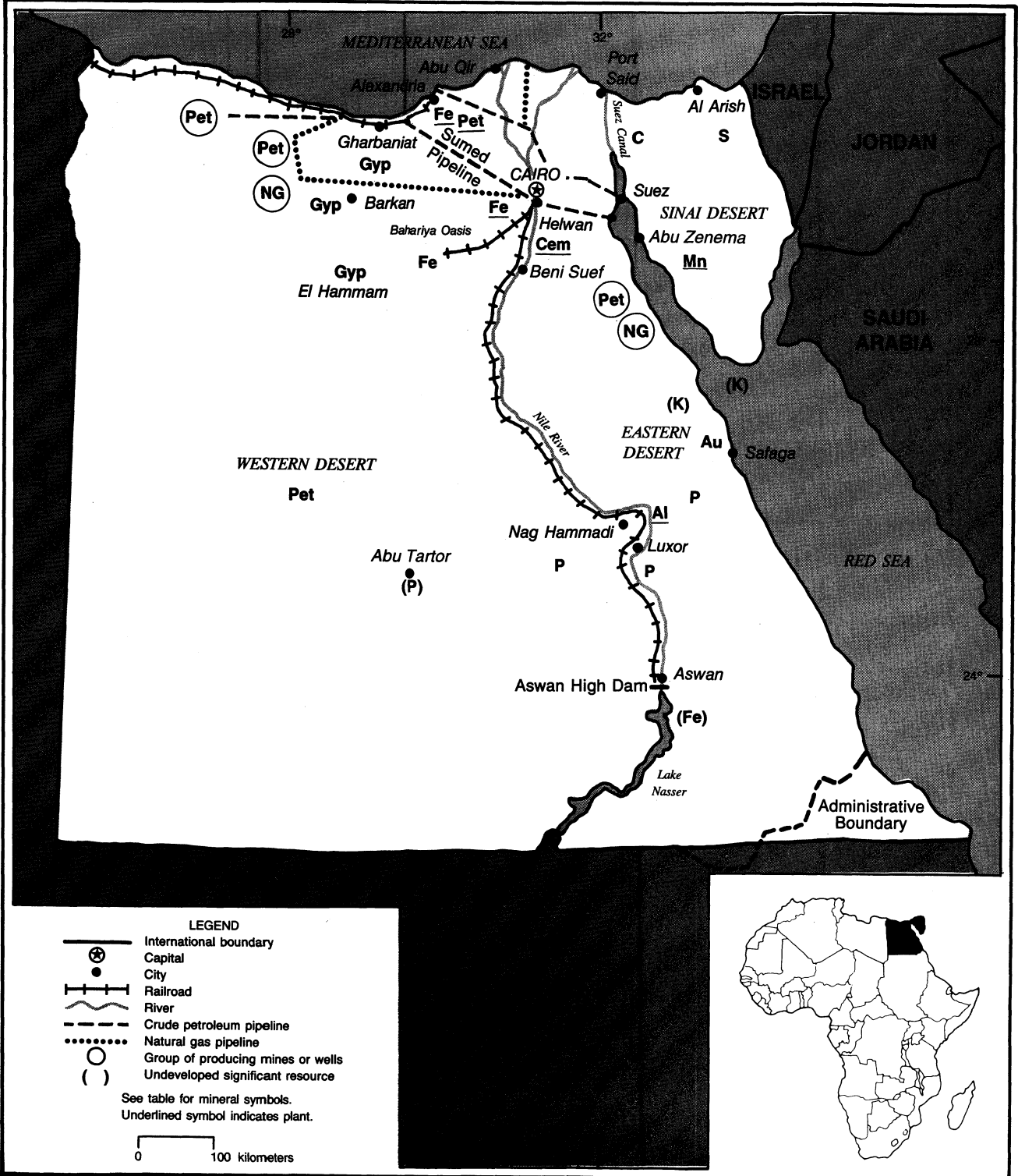
<sup>5</sup>Reported figure.

<sup>6</sup>Production from the Bélier Field only. Espoir Field shut down Oct. 26, 1988. Bélier shut down in 1992.

# EGYPT

AREA 1,001,450 km<sup>2</sup>

POPULATION 56.4 million



## THE MINERAL INDUSTRY OF

# EGYPT

By Thomas P. Dolley

In the past several years, the production and export of crude petroleum has been the second largest foreign exchange earner in Egypt. Despite a politically tumultuous year, Egypt planned to enhance its mineral sector in 1992. However, no major mineral deposits were discovered or developed during the year. As of yearend 1991, Egyptian oil production was ranked the 16th largest global producer, the 4th largest in Africa, and the 7th largest in the Arab world.

The GDP for Egypt in 1992 was \$32.8 billion.<sup>1</sup> Owing to terrorist attacks on foreign tourists and the resultant loss of tourist trade, Egypt suffered a \$700 million shortfall in 1992. Generally, the Egyptian tourism industry accounted for about 30% of foreign currency receipts and 10% of the GDP.

Environmental research has indicated that certain mining and related industrial activities, specifically steelmaking, cement manufacturing, and seismic vibration from explosives use at rock quarries, are damaging Egyptian antiquities. The activities at nearby Giza and Helwan are promoting the disintegration of the Pyramids and the Sphinx.<sup>2</sup> Total dust emission from the three cement plants in Helwan has been estimated at 1,650 mt/d. In addition to the sulfur dioxide emissions damage to the antiquities, there is serious damage to human health. The Government is being petitioned on a broad front to legislate and enforce environmental protection. During the year, the Egyptian Environmental Affairs Agency drafted a new environmental protection law, which was defeated by the People's Assembly. Revised and resubmitted legislation to the People's Assembly is awaiting disposition. To eliminate dust emissions from

cement operations alone could cost \$250 million; however, international donors are contributing.

A careful balance will have to be achieved between the value of the antiquities and the tourism revenue generated by them and the obvious need for new technology and efficient management in mining and industrialization.

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### GOVERNMENT POLICIES AND PROGRAMS

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Mining legislation dated back to the Mining Code Law No. 86 of 1956, the evaporite salt Mining Law No. 151 of 1956, and the Mining and Petroleum Code Law No. 66 of 1953. These laws provide the legal template for mineral exploration and exploitation. Additionally, laws No. 43 of 1979 and 50 of 1981 provide the governorates and local councils the power of administration for quarries in their particular districts. The Ministerial Decree No. 8 of 1990 was designed to assist the private sector in obtaining the required permits for mining. The Egyptian General Petroleum Corp. (EGPC) was created under law No. 20 of 1976. Recent petroleum policy called for all oil exploration permits to be awarded as production-sharing agreements and conversion of all joint ventures into production-sharing agreements. Privatization of some mining companies was also being planned for the future.

By mid-1993, the Minister of Petroleum and Mineral Wealth is to submit to the Cabinet a draft unified mining law to cover quarries, mines, and saltworks. In addition to providing the private sector with new incentives for mining, highlights of the proposed law are as follows: (1) increasing state

revenues by adjusting the fees for mineral exploitation rights concomitant with market value, (2) prohibiting companies from controlling unexploitable quarries under their concessions, (3) clearly defining the role of the Egyptian Geological and Mining Authority (EGSMA) and local districts in mining exploitation, and (4) adopting improved mine safety standards.

Egypt was not a member of OPEC. Thus, a Government commission sets the price per barrel of crude oil exports on the 1st and 15th of each month. Egyptian pricing policies for crude oil had been criticized in the past because prices were consistently higher than the world market price. The new pricing formula for crude oil, developed by the Government in 1991, was amended in 1992. Egypt's benchmark crude oil, Gulf of Suez 33° API, is priced at 60% of the prevailing price of North Sea benchmark crude oil, plus 20% of Iranian heavy crude oil, coupled with 20% of the international assessed value of the Gulf of Suez crude oil.

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### PRODUCTION

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The mining industry has been an integral part of the Egyptian economy and culture since antiquity. Some of the earliest reported mining development in Egypt dates back to 2920 B.C. when Pharaoh Snefru directed the exploitation of copper on the Sinai peninsula.

Egypt produces approximately 25 different minerals from more than 600 mines, quarries, and salt deposits. However, most of the minerals found in Egypt are in areas too remote to merit exploitation or are found in insufficient quantities. As of 1992, a thorough geological survey of these various mineral



deposits was incomplete.

Dominant nonfuel mineral production and concomitant downstream products in 1992 were cement, gypsum, iron ore, kaolin, phosphates, sand for glass, handmade porcelain, and finished glass products. Damage and ongoing reconstruction caused by the earthquake of October 12, 1992, principally in the Cairo area, helped to stimulate the production of construction materials. (See table 1.)

## TRADE

Nations of the EC are by far the largest trading partners with Egypt. Mineral trade operating via the Suez Canal is critical to the Egyptian economy. The Suez Canal Authority administers the Suez Canal and collects the tolls, which were increased in early 1992. Remittances from these tolls rose from \$1.6 billion in 1991 to \$1.86 billion in 1992. However, the number of ship transits through the Suez Canal dropped from 18,221 in 1991 to 17,473 in 1992. Additionally, the tonnage shipped dropped from 419 Mmt in 1991 to 408 Mmt in 1992. Currently, about 300,000 bbl/d of crude oil is shipped through the Suez Canal, with increases to 900,000 bbl/d expected by the turn of the century. The principal competitor for the Suez Canal in petroleum trade is the Sumed pipeline, with an installed capacity of about 1.6 Mbb/d of crude oil.

The United States imported about 12.5 Mbb/d of crude oil from Egypt in 1992. Israel is the largest importer of Egyptian crude at more than 13 Mbb/d in 1991. The total value of crude oil exports for 1991, the latest year available, was \$2.5 billion. In 1992, the United States Agency for International Development approved two 3-year contracts with Egypt's El Nasr Coke and Chemicals Co. for the importation of more than 500,000 tons of coal. The primary suppliers of the coal will be the Pittston Coal Co. and Mapco Coal Co. of the United States. Phosphate rock exports totaled 146,000 tons in 1992.

## STRUCTURE OF THE MINERAL INDUSTRY

Virtually all mining and mineral processing in Egypt was carried out by Government-owned mining companies. Egypt's Mining and Refractories Corp. (Maric) was the parastatal under the Ministry of Industry that controlled the mining and refractories industries. Foreign investors in the mining industry coordinate exploration activities through EGSMA, which is subordinate to the Ministry of Petroleum and Mineral Wealth. If a foreign mining investor enters the production stage of development, a joint-venture company is formed with EGSMA. Additionally, EGSMA is actively involved in mineral exploration, particularly in the Egyptian deserts. EGSMA's expenditures for mineral exploration are valued at \$900,000 per year.

Maric controls five major parastatals that dominate the Egyptian mining industry. These companies are the El Nasr Phosphate Co., Red Sea Phosphate Co., Misr Phosphate Co., the Sinai Manganese Co., and the El Nasr Saline Co. (See table 2.)

## COMMODITY REVIEW

### Metals

**Aluminum.**—Egypt's aluminum industry is dependent on the importation of bauxite. Though some deposits of clays and alkalic rocks within Egypt are aluminum-bearing, they are not considered feasible for development. Aluminum production in Egypt averages 180,000 mt/a with an estimated value of \$227 million.

**Ferroalloys.**—In 1992, the Sinai Manganese Co. commenced ferromanganese alloys production at Abu Zenema in the southern Sinai peninsula. Production capacity at the plant has been variously estimated between 20,000 to 40,000 mt/a at the plant. Development costs totaled about \$45.5 million, with the alloys to be exported to Germany and Japan.

**Iron Ore.**—To keep pace with the rising demand of the steel industry, iron ore production in Egypt has doubled from 1975 to 1992. Iron ore is mined in the El Gedida area of the Bahariya Oasis in the Western Desert. Primarily the high-grade iron ore, at 55% Fe, is mined in favor of the lower grade ore also found in the vicinity of Bahariya. The Government projects that the higher grade iron ore will be depleted in 12 years. In the future, advanced steelmaking technology planned for the Helwan steel facility will utilize the lower grade ores.

### Industrial Minerals

**Cement.**—Egypt plans to increase production capacity in its already large cement industry by the construction of a 1-Mmt/a plant at Beni Suef. The nation's installed cement production capacity is approximately 20 Mmt/a. However, the growing cement industry is plagued by environmental problems. The Egyptian cement sector is under increasing pressure to address these environmental problems. Additionally, privatization looms for Suez Cement Co., where a 37% share of the company has been offered for sale. Suez Cement Co. had profits of \$15 million on sales of \$71 million in 1991.

**Potash.**—The U.S. subsidiary of Australia's Broken Hill Pty. Ltd. Co., BHP Utah Minerals International, and EGSMA unveiled the existence of an 80-m-thick potassium chloride salt bed at the Gulf of Suez concession. The average depth of the resource is 2,000 m. Geophysical exploration and drilling will continue until 1994.

**Phosphate Rock.**—The Government continued moving forward with the development of the Abu Tartor phosphate project, the largest industrial mineral project in Egypt. Located about 50 km west of the Kharga Oasis in the Western Desert, the Abu Tartor project will cost an estimated \$900 million. The expected starting date for production at the phosphate operations is July 1995.

Phosphate production capacity is to be 2.2 Mmt/a, with the construction of 650-km railway to transport the phosphate from Abu Tartor to Safaga on the Red Sea coast and housing for 5,000 families at the mine site. To power operations at Abu Tartor, a 278-km-long high-tension electrical transmission line has been constructed from the Qena power station in the Nile Valley.

By yearend 1992, 25% of the construction at the mine site had been completed and 50% of the railroad had been constructed. Eventually, about 50% of the phosphate produced at Abu Tartor will be utilized domestically, with the remainder exported from the Port of Safaga. Execution of the project is under the jurisdiction of the General Authority for the Establishment of Industrial and Mining Complexes, which is subordinate to the Ministry of Industry.

**Sulfur.**—Freeport Egyptian Sulfur Co., a wholly owned subsidiary of Freeport-McMoRan Inc. of the United States, has indefinitely shelved its exploitation plans for its North Sinai sulfur concession. Citing recent declines in the world market price for sulfur and the lack of a nearby power source for extraction, the Freeport Egyptian Sulfur Co. has no near-term plans for developing the resource. However, Freeport Egyptian Sulfur Co. will retain its exploitation rights for the concession.

### Mineral Fuels

**Coal.**—Egypt's Sinai Coal Co. appeared near completion on development of the Maghara coal mine in the northern Sinai peninsula. Gullick Dobson of the United Kingdom was awarded the materials handling contract for the mine, which includes two longwall mining installations. The longwall mining equipment will be shipped to the mine in 1992 and 1993. Eventual production levels at the mine should reach 10,000 mt/d of coal to be utilized at the Ain Musa power station. The total coal resource at Maghara has been estimated at 52 Mmt, of which 27 Mmt is

recoverable.

**Natural Gas and Petroleum.**—Egypt is self-sufficient in crude oil production and utilizes the remainder, averaging about 42 Mbbl/a, for export. Petroleum exploration is accelerating in the Gulf of Suez, Mediterranean, Nile Delta, the Red Sea, and the Western Desert. Industry analysts speculate that an additional 1.5 to 3 billion bbl of crude oil could be discovered through this continuing exploration. The Gulf of Suez oilfields are by far the most prolific in Egypt, representing 90% of total production.

Egypt was converting as many of its domestic powerplants as possible from fuel oil to natural gas. This conversion would help to free more crude oil for export. Recent natural gas discoveries have helped to fuel the conversion. Approximately 60% of Egypt's natural gas output is utilized in power generation, with output slated to rise in the future. By yearend 1992, the Netherlands' Royal Dutch Shell was exploring for natural gas in the Western Desert.

### Reserves

Egypt's crude petroleum reserve estimates vary between 3.5 and 6.3 billion bbl. Natural gas reserves are estimated at 325 billion m<sup>3</sup>. Phosphate rock reserves are estimated at 1.27 billion tons. Estimated iron ore reserves total 450 Mmt, with varying grades.

### INFRASTRUCTURE

Railways within Egypt total 5,110 km. Roadways total more than 51,000 km, with crude oil pipelines at 1,171 km. During the year, the Egyptian Atomic Energy Authority awarded a contract to build its first nuclear reactor in 30 years to Argentina's Investigaciones Aplicadas (INVAP). INVAP won the contract to build the 22-MW research plant over competitors as varied as General Atomics of the United States, Atomic Energy of Canada, and a French-German consortium of Siemens and Framatom. The 5-year project will cost an estimated \$44.5 million, with work commencing in 1993.

The Inshas nuclear plant, 55 km northeast of Cairo, is to be dismantled. The Inshas reactor was built in 1961 by the former U.S.S.R.

### OUTLOOK

In an atmosphere of worsening political unrest, Egypt must continue to develop its mineral resources to generate needed revenue. Additionally, new technology is needed to make mine production more efficient and reduce damage to the environment.

<sup>1</sup>Where necessary, values have been converted from Egyptian pounds (£E) to U.S. dollars at a rate of £E3.33=US\$1.00.

<sup>2</sup>Farouk El-Baz. *Saving The Sphinx.*, Geotimes, May 1993, pp. 12-17.

### OTHER SOURCES OF INFORMATION

#### AGENCIES

Egyptian Geological Survey and Mining Authority  
Salah Salem Road  
Abbassiya, Cairo  
Egypt  
Egyptian General Petroleum Corp.  
Osman Abdul Hadiz St.  
Box 2130  
Nasr City, Cairo  
Egypt

#### Publication

Wali, A. M. A., and B. C. Schreiber. *Industrial Minerals of Egypt*. Presented at SME Annual Meeting, Salt Lake City, UT, Feb. 26 to Mar. 1, 1990. Society for Mining, Metallurgy, and Exploration, Inc., Preprint 90-77, 1990.

TABLE 1  
EGYPT: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1988	1989	1990	1991	1992*	
<b>METALS</b>						
Aluminum metal	173,460	179,500	179,167	<sup>2</sup> 177,707	177,000	
Chromite	<sup>8</sup> 800	<sup>2</sup> 2,448	<sup>3</sup> 399	<sup>2</sup> 649	600	
Copper, refined, secondary*	4,000	3,600	3,600	3,600	3,600	
<b>Iron and steel:</b>						
Iron ore and concentrate	thousand tons	2,000	2,562	2,405	<sup>2</sup> 2,144	<sup>2</sup> 2,400
<b>Metal:</b>						
Pig iron	do.	1,112	1,105	1,100	1,250	1,200
Ferrous alloys: Ferrosilicon		7,806	7,800	7,922	7,900	7,900
Steel, crude	thousand tons	2,025	2,114	2,235	<sup>2</sup> 2,541	2,500
Manganese		—	—	—	—	<sup>2</sup> 9,000
<b>INDUSTRIAL MINERALS</b>						
Asbestos	166	312	369	<sup>2</sup> 450	450	
Barite	5,651	7,295	6,197	<sup>2</sup> 5,943	5,900	
Cement: Hydraulic	thousand tons	9,787	12,480	14,111	<sup>2</sup> 16,427	<sup>2</sup> 17,000
<b>Clays:</b>						
Bentonite	3,166	3,512	4,904	4,900	4,900	
Fire clay	150,000	250,000	128,130	<sup>2</sup> 475,359	475,000	
Kaolin	124,122	121,515	49,032	<sup>2</sup> 192,870	190,000	
Feldspar, crude	6,131	27,731	9,894	<sup>2</sup> 32,636	32,000	
Fluorspar	1,849	1,721	1,249	<sup>2</sup> 1,790	1,700	
Gypsum and anhydrite, crude	1,100,000	1,309,426	1,279,000	<sup>2</sup> 1,238,519	1,200,000	
Lime*	95,000	95,000	67,650	<sup>2</sup> 749,421	749,000	
Nitrogen: Ammonia, N content	thousand tons	788	728	735	<sup>2</sup> 863	860
Phosphate: Phosphate rock	do.	1,146	1,347	1,143	<sup>2</sup> 1,652	<sup>2</sup> 2,000
P <sub>2</sub> O <sub>5</sub> content	do.	<sup>2</sup> 293	<sup>3</sup> 337	<sup>2</sup> 286	<sup>4</sup> 413	<sup>5</sup> 500
Salt, marine	do.	922	1,162	989	<sup>2</sup> 891	890
<b>Sodium compounds:</b>						
Soda ash	47,711	47,000	52,180	<sup>2</sup> 51,817	51,000	
Sodium sulfate	<sup>4</sup> 2,000	45,677	41,418	<sup>2</sup> 41,110	41,000	
<b>Stone, sand and gravel:</b>						
Basalt	thousand cubic meters	1,050	873	870	<sup>2</sup> 1,016	1,000
Dolomite*	thousand tons	500	500	500	<sup>2</sup> 910	900
Granite, dimension	cubic meters	<sup>1</sup> 2,000	21,487	21,000	<sup>2</sup> 10,496	10,000
Gravel	thousand cubic meters	<sup>1</sup> 1,000	11,527	11,000	11,000	11,000
Limestone and other calcareous n.e.s.	do.	<sup>1</sup> 5,000	16,347	286	280	<sup>2</sup> 18,000
Marble blocks (including alabaster)	cubic meters	13,000	27,857	743	<sup>2</sup> 57,960	57,000
<b>Sand:</b>						
Industrial sand (glass sand)	thousand tons	35	41	507	500	500
Construction sand	do.	20	18	26,004	26,000	26,000
Sandstone	thousand cubic meters	<sup>4</sup> 00	316	<sup>3</sup> 00	<sup>2</sup> 182	180
<b>Sulfur:</b>						
Elemental, byproduct*		7,600	7,600	7,600	7,600	7,600
Sulfuric acid		31,274	31,000	65,268	<sup>2</sup> 101,000	100,000
Talc, steatite, soapstone, pyrophyllite		7,268	7,146	6,340	<sup>2</sup> 9,091	9,000
Vermiculite		236	272	28	<sup>2</sup> 519	500

See footnotes at end of table.

TABLE 1—Continued  
EGYPT: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1988	1989	1990	1991	1992 <sup>2</sup>	
<b>MINERAL FUELS AND RELATED MATERIALS</b>						
Coke: Oven and beehive	thousand tons	936	930	1,077	<sup>2</sup> 1,210	1,000
Gas, natural:						
Gross production	million cubic meters	8,608	9,542	9,620	<sup>2</sup> 9,620	9,600
Marketed <sup>2</sup>	do.	7,843	8,749	8,800	8,800	8,000
Dry	do.	6,900	7,730	7,900	7,900	8,000
Petroleum and refinery products:						
Crude	thousand 42-gallon barrels	<u>309,520</u>	<u>310,980</u>	<u>319,375</u>	<u><sup>2</sup>320,470</u>	<u><sup>2</sup>317,805</u>
Refinery products: <sup>2</sup>						
Gasoline and naphtha	do.	27,000	27,000	<sup>2</sup> 18,615	18,000	18,000
Kerosene and jet fuel	do.	20,000	20,000	<sup>2</sup> 21,170	21,000	21,000
Distillate fuel oil	do.	30,000	30,000	<sup>2</sup> 29,565	29,000	29,000
Residual fuel oil	do.	60,000	60,000	<sup>2</sup> 78,110	78,000	78,000
Lubricants	do.	1,000	1,000	<sup>2</sup> 1,460	1,000	1,000
Liquefied petroleum gas	do.	5,000	5,000	<sup>2</sup> 4,015	4,000	4,000
Asphalt	do.	2,000	2,000	6,000	6,000	6,000
Unspecified	do.	4,500	4,500	18,000	18,000	18,000
Refinery fuel and losses	do.	6,500	6,500	<sup>2</sup> 8,760	8,000	8,000
Total <sup>2</sup>	do.	<u>156,000</u>	<u>156,000</u>	<u>185,695</u>	<u>183,000</u>	<u>183,000</u>

<sup>2</sup>Estimated.

<sup>1</sup>Table includes data available through December 1992.

<sup>2</sup>Reported figure.

TABLE 2  
EGYPT: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

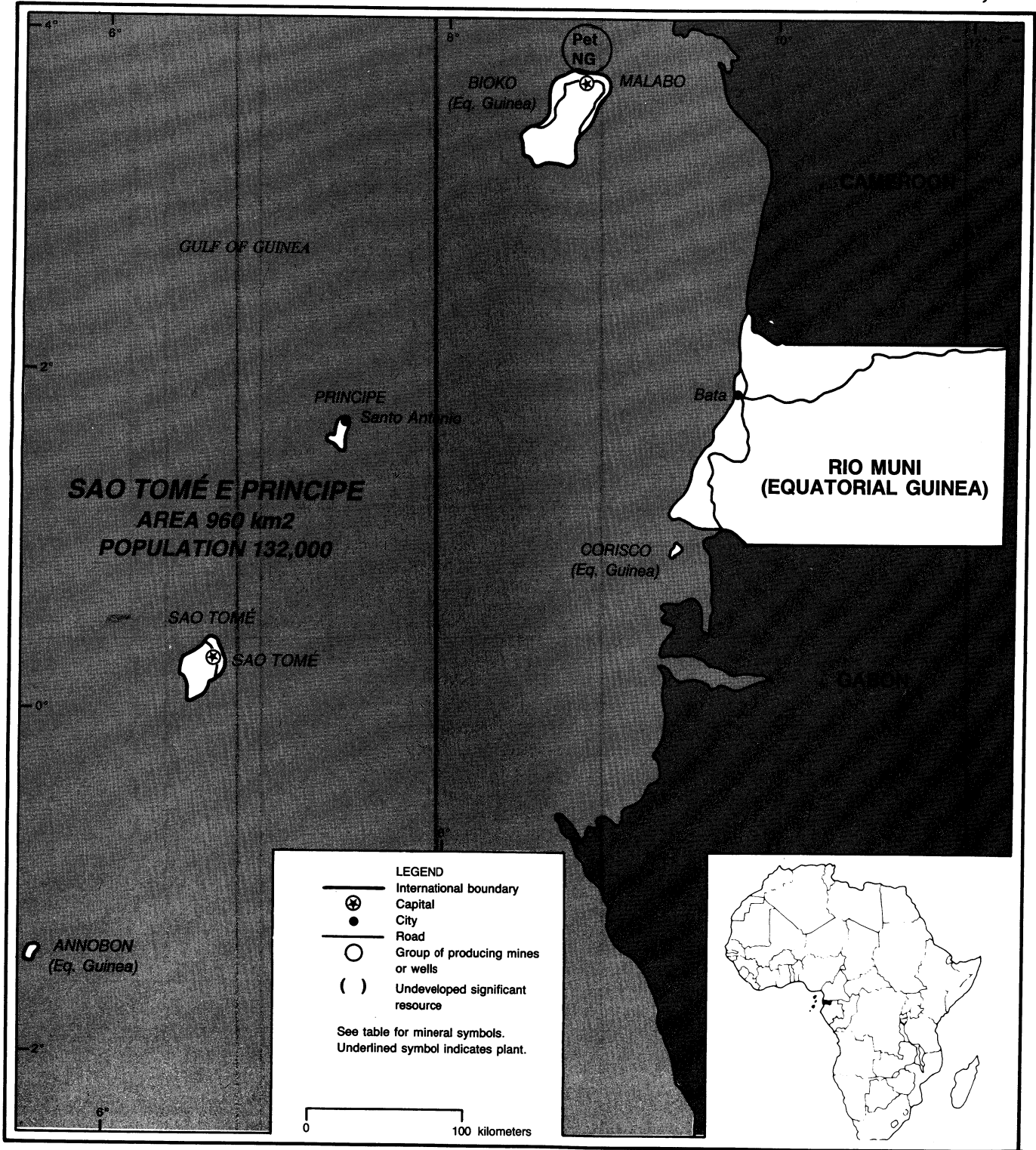
(Thousand metric tons unless otherwise specified)

Major commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity	
Aluminum	Aluminum Co. of Egypt (Government, 100%)	Nag Hammadi	170.	
Cement	Helwan Portland Cement Co. (Government, 100%)	Helwan	1,400.	
Do.	Tourah Portland Cement Co. Government, 100%)	Tourah	1,400.	
Fertilizers	Societe d'Engrais & d'Industries Chimiques (Government, 100%)	Talkha	1,370 (nitrogen).	
Do.	do.	Abu Qir	900 (nitrogen).	
Iron	Egyptian Iron and Steel Co. (Government, 100%)	Helwan steel plant	1,500.	
Petroleum, crude	million 42-gallon barrels	Egyptian General Petroleum Corp., (Government, 100%) and Amoco Egypt Oil Co.	El Morgan, Suez Gulf	42.
Do.	do.	July, Suez Gulf	51.	
Do.	do.	Ramadan, Suez Gulf	37.	
Petroleum, refined	million 42-gallon barrels	Suez Oil Processing Co. (Government, 100%)	Mostorod	28.5.
Do.	Alexandria Petroleum Co. (Government, 100%)	Alexandria	23.4.	

# EQUATORIAL GUINEA AND SAO TOMÉ E PRINCIPE

AREA 28,050 km<sup>2</sup>

POPULATION 389,000



# EQUATORIAL GUINEA AND SAO TOME E PRINCIPE

By Thomas P. Dolley

## EQUATORIAL GUINEA

Economic prospects for the Republic of Equatorial Guinea improved in 1992 with the continued production and development of the offshore Alba gas-condensate field, managed by Walter International of the United States. Discovered in the Gulf of Guinea, the 300-km<sup>2</sup> tract of the field is 36 km north of the island of Bioko. Walter International is the lead contractor of a group of smaller American independent oil companies that are exploiting the deposit. Samedan of North Africa, a subsidiary of Noble Affiliates Inc. of Ardmore, Oklahoma, in the United States, has a 40% equity interest in the project. Initially, only the condensates in the Alba Field will be exploited. The estimated oil production from the field for 1992 was 365 kbbl. Walter International plans to increase production to 4,000 to 5,000 bbl/d by the mid-1990's. Production should be maintainable through the first decade of the 21st century. Walter International also planned for further drilling of a wildcat well in the Gulf of Guinea in early 1993. Located north of the island of Bioko and south of the Cameroon maritime border, deeper hydrocarbon structures are the targets of this exploration. Additionally, United Meridian International Corp. (UM) of the United States signed a 6-year petroleum exploration lease with the Government on June 30, 1992. The area is a 160,000-ha offshore concession northwest of the island of Bioko. The lease extends to the Nigerian maritime frontier and lies to the west of the Walter International concession. UM's contract

with the Government is probably similar to the Walter International contract, allowing for exploration over a 6-year term with additional time for exploitation if it is found to be economic.

The Republic of Equatorial Guinea is a small, tropical west-central African nation that has a total land area of 28,050 km<sup>2</sup> and is slightly larger than the State of Maryland. The Republic consists of two main provinces: the volcanic island of Bioko in the Gulf of Guinea and Rio Muni on the African mainland. Equatorial Guinea also included the smaller volcanic islands of Pagalu, Corisco, and the Elobeies that are within the national territory. Malabo, the capital of the country, is on Bioko.

The GNP for Equatorial Guinea in 1990, the latest year for which data were available, was \$145 million<sup>1</sup> with an external debt valued at \$206 million. Debt cancellation agreements with Spain in 1989 and 1991 and France in 1989 have marginally helped the economy, but the high external debt remains problematic. Timber is the major export earner.

Equatorial Guinea gained independence after 124 years of Spanish control on October 12, 1968. However, as of 1990, Spain remained the largest financial aid donor to Equatorial Guinea. Petroleum exploration in Equatorial Guinea was controlled by the Hydrocarbons Law (Model of Agreement), section II, paragraph 2.8 (E). The law stipulates the method of cancellation of an agreement when a specific contractor does not start production of the hydrocarbon field within the specified time.

According to the Government's

Ministry of Mines and Hydrocarbons, several mineral and geological surveys have been conducted by various foreign organizations, commencing with a air photo survey in 1962. From 1981 to 1985, France's Bureau de Recherches Géologiques et Minières (BRGM) identified several types of minerals in Rio Muni. These minerals included bauxite, alluvial gold, ilmenite beach sands, phosphates, and stratiform Cu, Pb, and Zn. However, the Government indicated that further exploration was needed to determine the economic viability of these resources.

## SAO TOMÉ E PRINCIPE

Sao Tomé e Príncipe possessed no significant mineral industry in 1992. A former Portuguese colony where sugarcane was first planted in 1490, the dual island nation gained independence on July 12, 1975. The external debt was estimated at \$147 million in 1990.<sup>2</sup> The population in 1992 was approximately 132,000 people. The production and export of cocoa is the primary economic endeavor, although the crop has been declining in recent years. Tropical, volcanic, and mountainous, Sao Tomé e Príncipe is now promoting tourism to assist the ailing economy.

Recently transitioning to a multiparty democracy, the legal system of Sao Tomé was based on the Portuguese legal system and customary law. Decree Law 30-80 of July 1980 does not relate to mining investment specifically, but does stipulate the conditions of foreign investment. Some small clay and stone open pit operations are worked to assist local

construction needs.

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<sup>1</sup>Where necessary, values have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF262.14=US\$1.00.

<sup>2</sup>Where necessary, values have been converted from Sao Toméan dobras (STD) to U.S. dollars at the rate of STD240.05=US\$1.00.

## OTHER SOURCES OF INFORMATION

### Agencies

U.S. Embassy  
Calle de Los Ministros  
P.O. Box 597, Malabo  
Equatorial Guinea

U.S. Embassy  
Boulevard de la Mer  
B.P. 4000, Libreville  
Gabon (Administers for Sao Tomé e  
Príncipe)

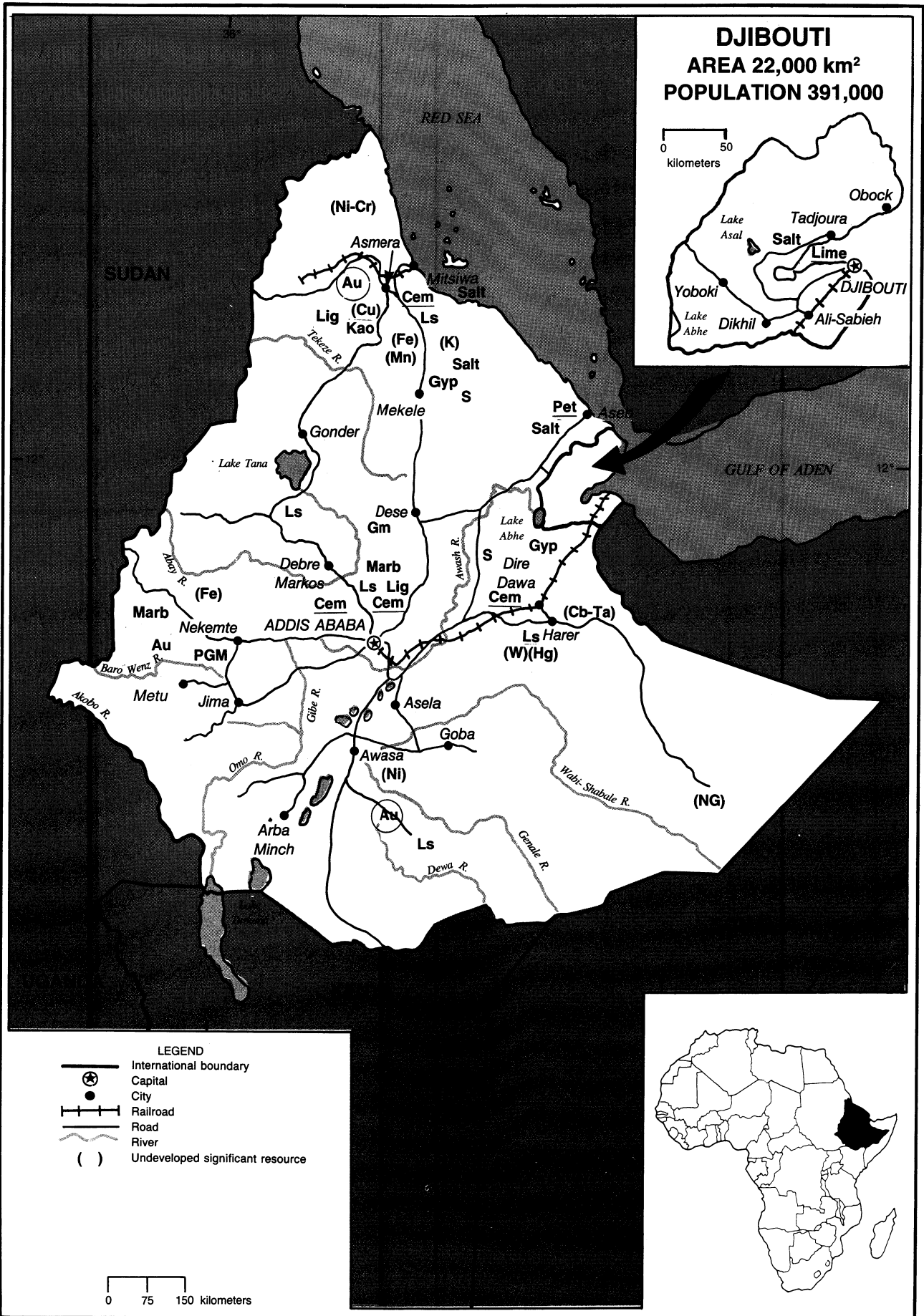




# ETHIOPIA AND DJIBOUTI

AREA 1,221,900 km<sup>2</sup>

POPULATION 54.3 million



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THE MINERAL INDUSTRIES OF

# ETHIOPIA AND DJIBOUTI

By Lloyd E. Antonides

## ETHIOPIA

Minerals-related activities began to increase in tempo during 1992 although they remained a small part of Ethiopia's GDP, which was heavily dependent on agriculture. The transitional Government, established after the military regime was overthrown in 1991, was market oriented and attempted to attract foreign investment with new laws and regulations. New officials were installed in the Government mineral organizations, and a U.S. consultant began a UN-sponsored review of the mineral investment potential that will culminate in a publication for international distribution.

The Government mining unit, Ethiopian Mineral Resources Development Corp. (EMRDC), advertised for additional staff, especially those with gold production background. For its idled lateritic residual platinum operation, EMRDC was searching for a method to improve recovery from gravity process slimes. For tantalum ores, a processing plant was being considered.

The African Development Bank funded a feasibility study of an apatite phosphate project. Gas reserves in the Ogaden region in the southeast were being considered for development, and the World Bank completed an environmental assessment of the project in March 1993. The mineral-rich Province of Eritrea achieved its independence in May 1993.

## DJIBOUTI

The mineral industry in Djibouti remained dormant. Political turmoil in the north was preventing much economic activity of any sort. Limestone, salt, and

construction materials, including marble and granite dimension stone, as well as sand, gravel, and crushed stone, were exploited resources. Geothermal fluids, gold, and petroleum continued to have incompletely tested potential.

## OTHER SOURCES OF INFORMATION

### Ethiopia

Ministry of Mines and Energy  
P.O. Box 486  
Addis Ababa, Ethiopia  
Telephone: 251-151-8250  
Fax: 251-151-5054

### Djibouti

Ministry of Industry &  
Industrial Development  
P.O. Box 175  
Djibouti, Djibouti  
Telephone: 253-350-340

TABLE 1  
ETHIOPIA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992 <sup>*</sup>
Cement, hydraulic	405,504	<sup>*</sup> 370,000	340,000	290,000	320,000
Clays: <sup>3</sup>					
Brick	23,000	8,000	17,000	14,000	15,000
Kaolin (China clay)	750	390	670	370	420
Diatomite <sup>4</sup>	<sup>2</sup> 20	10	<sup>3</sup>	<sup>1</sup>	5
Gold: Mine output, Au content kilograms	728	745	848	<sup>3</sup> 0,038	<sup>2</sup> 2,224
Gypsum and anhydrite, crude <sup>5 3 3</sup>	1,900	2,100	2,250	<sup>1</sup> 1,750	2,650
Lime	<sup>3</sup> 9,67	145	70	45	100
Petroleum refinery products: <sup>6</sup>					
Liquid petroleum gas thousand 42-gallon barrels	56	74	65	<sup>4</sup> 0	30
Gasoline do.	865	1,060	904	<sup>6</sup> 00	370
Jet fuel do.	382	503	400	<sup>2</sup> 50	210
Kerosene do.	95	82	40	<sup>6</sup> 0	—
Distillate fuel oil do.	1,294	1,534	1,409	<sup>8</sup> 50	680
Residual fuel oil do.	2,056	2,412	2,271	<sup>1</sup> 3,300	980
Other do.	340	50	468	<sup>2</sup> 00	260
Total do.	5,088	5,715	5,556	<sup>3</sup> 3,300	2,530
Platinum: Mine output, Pt content <sup>*</sup> grams	<sup>1</sup> 1,485	1,500	1,500	<sup>1</sup> 1,000	500
Pumice <sup>3</sup>	43,000	23,000	23,000	37,000	49,000
Salt: <sup>*</sup>					
Marine	<sup>1</sup> 166,582	100,000	100,000	85,000	100,000
Rock	<sup>8</sup> 1,166	10,000	10,000	8,000	10,000
Scoria <sup>4</sup>	<sup>3</sup> 12,000	10,000	10,000	8,500	8,000
Stone, sand and gravel: <sup>5</sup>					
Construction stone, crushed <sup>3</sup> thousand tons	1,230	4,630	1,560	2,640	860
Dimension stone	600	600	<sup>3</sup> 3,300	2,800	2,000
Limestone <sup>5</sup> thousand tons	<sup>3</sup> 145	150	100	<sup>9</sup> 0	100
Sand <sup>3</sup> do.	990	<sup>7</sup> 80	1,250	<sup>1</sup> 1,000	700

<sup>\*</sup>Estimated. <sup>\*</sup>Revised.

<sup>1</sup>Data are for year ending July 7 of the year listed. Includes data available through May 1, 1993.

<sup>2</sup>In addition to the commodities listed, production of soda ash (1,408 metric tons in 1990 and 18,465 metric tons in 1991) and tantalite (6 metric tons in 1990 and 10 metric tons in 1991) was reported. Also, some lignite and semiprecious gemstones reportedly were produced and some additional crude construction materials (clays, sand, gravel, stone, etc.) were presumably produced locally on a small scale, but information is inadequate to reliably estimate output levels.

<sup>3</sup>Reported as volume or pieces; conversions to metric tons are estimated.

<sup>4</sup>Reported figure.

<sup>5</sup>Apparently does not include production for cement manufacture. Normally the manufacture of cement requires 30 to 50 kilograms of gypsum and 1.5 to 1.8 metric tons of limestone per metric ton of finished cement.

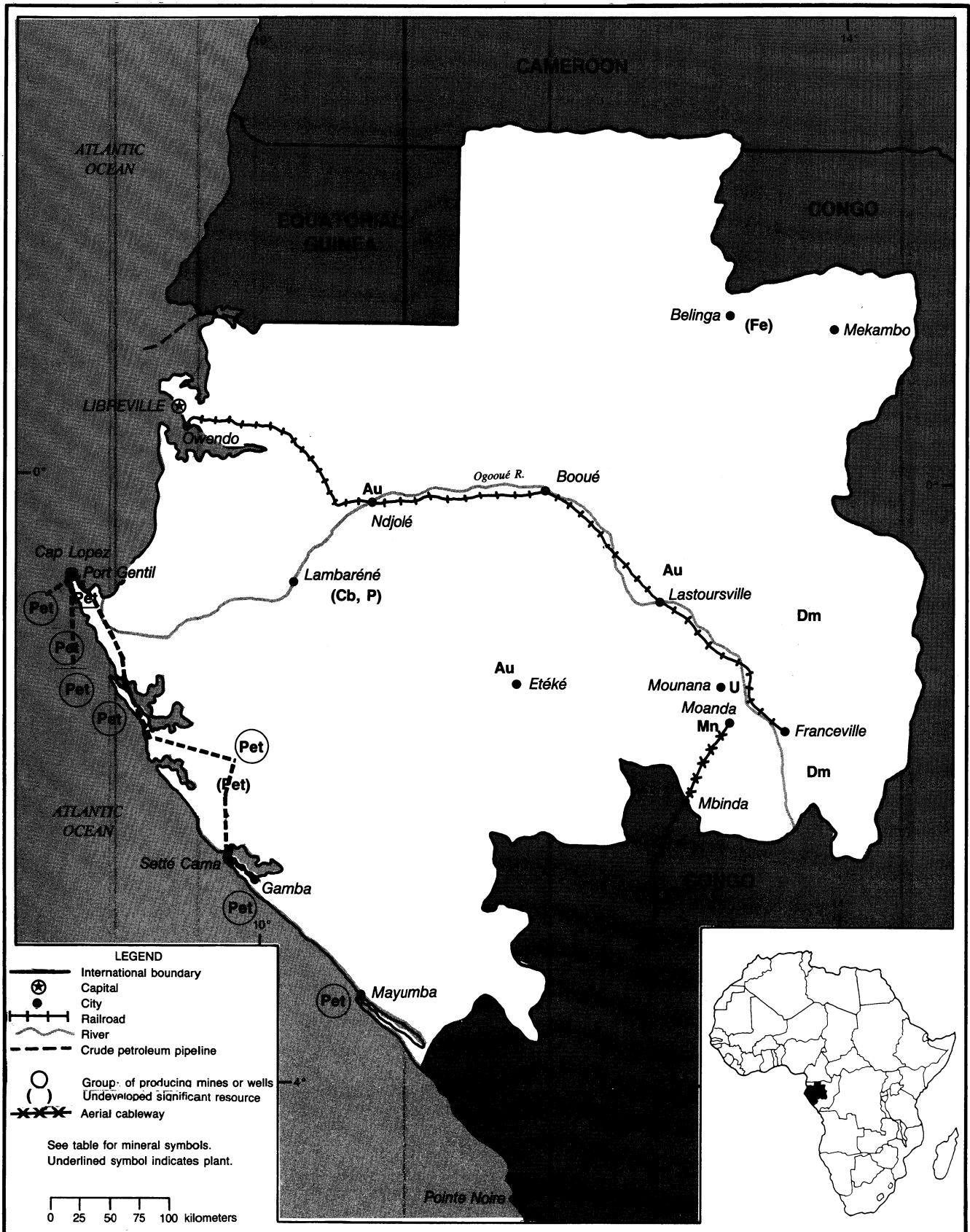
<sup>6</sup>Reported in metric tons. Refinery fuel and losses were distributed among individual products in 1988, 1989, and 1991 but were included in "Other" in 1990 (394,000 barrels) and 1992 (247,000 barrels). Data may not add to totals shown due to independent rounding.



# GABON

AREA 267,670 km<sup>2</sup>

POPULATION 1.09 million



## THE MINERAL INDUSTRY OF

# GABON

By George A. Morgan

In 1992, Gabon's mineral industry, and its economy, were most influenced by the petroleum sector, followed by production of manganese ore and uranium concentrate. The recession in the energy and steel sectors of the industrialized countries caused below capacity operations for manganese and uranium.

In 1990, the latest year that data were available, Gabon's GDP grew by an estimated 13% to about \$4.0 billion. Gabon's mineral industry accounted for about 61% of the nation's GDP and 92% of total exports. The production of crude oil and refined petroleum products accounted for about 54% of the GDP and 82% of total exports. Manganese and uranium mining accounted for about 7% of the GDP and about 10% of total exports.

Gabon's population of about 1 million and its developed, though small, primary mineral industries have resulted in a relatively high standard of living. The discovery and development of crude petroleum have been key milestones in its economic advancement. The construction of important elements of its infrastructure, particularly the Trans-Gabon railroad and the Port of Owendo, should provide for further diversification and growth.

### GOVERNMENT POLICIES AND PROGRAMS

The Government shifted from an emphasis on taxation to spending commitments by private companies. Crude petroleum production-sharing agreements normally provide for a royalty of 20%. However, an additional requirement is that a share of the company's profits be invested in local enterprises. Competition from the offering of other promising

oilfields in Angola, Namibia, and Nigeria has led to a relaxation of contract terms. Labor disputes early in the year caused disruptions at Elf Gabon's facilities, and general strikes have been threatened owing to dissatisfaction with the Government.

The basic mining law of Gabon was the 1962 Mining and Petroleum Code-law 15/62, as modified in 1968 by law 16/68, and in 1970 by decree No. 981. The mining fiscal regime is now governed by ordinance No. 38/79/PR. Petroleum exploration and exploitation was further regulated in 1974 by law 14/74 and reregulated in 1982 by law 14/82.

### PRODUCTION

Mineral output in virtually every sector has been quite stable for several years. However, crude petroleum production continued to increase owing to very high success rates for discovery and relatively low cost capitalization and infrastructure requirements for coastal reservoir development. Reduced demand in domestic and foreign markets for primary raw materials also accounted for stable production. (See table 1.)

### TRADE

In 1990, the latest year data were available, the value of Gabon's total exports increased by 60% to \$2.6 billion. This followed a 40% increase in exports during 1989. Petroleum was about 82% of Gabon's 1990 exports. Other major export commodities included manganese, wood, and uranium. The United States took 27% of Gabon's exports, 97% of which was petroleum. France took 31% of total exports and the United Kingdom

19%. In 1991, crude oil exports to the United States increased by 31% to 30.6 Mbbl.

Imports decreased by 29% in 1990 to about \$650 million, despite a modest growth in the GDP. Almost one-half of Gabon's imports was machinery, equipment, and manufactured goods in support of the petroleum and mining sectors. France furnished about 47% of total imports, while the United States accounted for about 9%. Other major suppliers, in order of importance, were Italy, Japan, Germany, the United Kingdom, the Netherlands, and Belgium.

### STRUCTURE OF THE MINERAL INDUSTRY

A number of private companies were active in Gabon's mineral industry. Most of them were subsidiaries of French companies, although several in the fuels area were American. The Government claimed participation in nearly every mineral company, having 15% to more than 90% of control. The structure of the industry continued to be shaped by Government's active oversight of petroleum operations and nonmineral sector development. (See table 2.)

### COMMODITY REVIEW

#### Metals

**Gold.**—All production of gold was by artisanal miners. Exploration was completed in the Eteke district in the south-central part of the country by Le Syndicat Or Eteke (SOE). SOE was a joint venture of the Government, 45%, Compagnie des Mines d'Uranium de Franceville (Comuf), and Bureau de Recherches Geologique et Miniere of

France. Geologic resources were found in four main deposits.

**Manganese.**—Production was significantly below capacity owing to lack of demand by the steel industry. Open pit mining operations of the Mangombe Plateau at Moanda consisted of stripping 6 m of overburden using draglines and scrapers. Actual ore lies in a horizontal, 6-m-thick seam. Back hoes and loaders load the ore onto trucks for haulage to the primary crusher. Ore is drawn from a number of ore bodies to provide the correct specifications for consumers. All marketable product is shipped to the Port of Owendo via the Trans-Gabon Railroad.

**Uranium.**—Output was an estimated 700 tons of  $U_3O_8$  out of a capacity of 1,770 tons of  $U_3O_8$  owing to a very depressed world uranium market. The Compagnie Minière de L'Ogooue (Comilog) was the sole producer from the only underground mine in the country. A French company had a majority ownership in the producer and set production levels to correspond with domestic demand for uranium.

Two mines were operational, the Oklo and Okelobondo Mines. Emphasis has recently been placed on the Okelobondo Mine, which is actually an extension of the Oklo Mine at 400 m depth, owing to its higher grade ores. Mechanized operations have increased at Okelobondo to improve competitiveness. Single-boom jumbos have replaced hand drilling, and a new roof bolter has been purchased. Mining methods include top slicing and room and pillar. Although exploration has been deemphasized owing to low prices, a recent reevaluation of the Okelo North deposit is under way. The potential for locating a richer, more extensive portion of the deposit is expected to lead to about 15,000 m of drilling in 1993. All reserves currently known would be mined by underground methods, excluding the Mberse deposit, which contains 250 tons of contained U.

### Mineral Fuels

Further oilfield development was extremely promising in Gabon, as seven

onshore and six offshore exploration blocks were opened for licensing. Closure date for application was June 1993. Several of the southern blocks had complex geology, as evidenced by early seismic work. Oil finds with reserves of 15 to 37 Mmbl have been made in the northern blocks and were available for development. The Government's oil minister indicated that all aspects of a contract impacting company profits were open to negotiation. The normal minimum 25% Government participation may also be reconsidered. The relaxation in terms was partly due to increase competition for exploration and development action by other nearby countries. Additionally, a separate offering to Elf Gabon outside the normal licensing process led to concern by American operators. A number of blocks have been relinquished, and American Oil Co. and Conoco Co. have withdrawn from Gabon. Production at the Rabi-Kounga onshore oilfield was 150,000 bbl/d. It was Gabon's largest oilfield with reserves of 600 Mmbl, and was expected to produce 170,000 bbl/d in 1993. Output is sent to a separation and metering station, then via 2 pipelines for export. Shell Gabon Oil Co.'s portion is shipped 135 km south to Gamba, and the remainder is shipped 230 km north to Cap Lopez for Elf Corp. and Amerada Hess. With further work on existing discoveries, output could reach 350,000 bbl/d.

### Reserves

Marketable manganese ore reserves were reported by the Mining Journal to be 250 Mmt, compared with 200 Mmt reported in 1991. About 45 Mmt remained at the Bangombe Plateau, the site of current mining. Five other deposits stretching to the northeast make up the remainder of the reserve.

Comilog estimated uranium reserves at 28,000 tons as uranium metal in ores averaging 0.3% U. The Government had previously estimated about 33,000 tons of uranium metal in ores.

Geologic gold resources were estimated to total 19 to 24 tons of gold to a depth of 200 m, found in four

mineralized areas. The Dango area had 14 tons in four structural units, grading 2.4 to 9.8 g/mt. Gold in the Dondo-Mobi area was about 15 g/mt to a depth of 150 m over a strike length of 400 m. The Ovala area has 2 tons in ore grading 11 g/mt in subvertical lenses, while the Western Ikoy and Migoto placer deposits grade 1.2 g/m<sup>3</sup> and contain about 700 kg of gold.

Iron ore resources at Belinga were 566 Mmt grading 64.24% Fe, 2.18% silica, and 0.122% phosphorus, according to the Government. Of this amount, approximately 345 Mmt was low phosphorus (less than 0.07% phosphorus) material.

## INFRASTRUCTURE

The 669-km-long 1.437-m-gauge Trans-Gabon railroad is the most important infrastructure unit in Gabon, linking the Atlantic coast Port of Owendo with Franceville near the country's southeastern frontier. It provides for the shipment of both manganese and uranium, as well as wood products, fuel, and equipment. It is expected to facilitate further mineral development, such as diamond, iron ore, and gold. Gabon's petroleum infrastructure was particularly well developed.

## OUTLOOK

Further development and expansion of the mineral sector remains dependent upon world markets for crude petroleum, manganese, and uranium owing to the export nature of Gabon's output. The possibility of the establishment of a formal gold mining sector is good. Further industrial activity along the route of the Trans-Gabon railroad may be expected.

<sup>1</sup>Where necessary, values have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate CFAF260=US\$1.00.

**TABLE 1**  
**GABON: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	<sup>a</sup> 1991	1992 <sup>b</sup>
Cement, hydraulic <sup>3</sup>	132,038	115,442	115,000	117,000	115,000
Clinker	104,000	113,000	113,000	125,677	125,000
Diamond, gem and industrial <sup>4</sup> carats	500	500	500	500	500
Gas, natural: <sup>4</sup>					
Gross million cubic meters	1,904	2,100	1,965	2,000	2,000
Dry gas <sup>5</sup> do.	127	—	—	—	—
Gold, mine output, Au content <sup>5</sup> kilograms	138	81	80	50	50
Manganese:					
Metallurgical-grade ore, gross weight (50% to 53% Mn)	2,186,158	2,500,800	<sup>c</sup> 2,360,390	<sup>e</sup> 1,565,348	2,000,000
Pellets, battery- and chemical-grade, gross weight (82% to 85% MnO <sub>2</sub> )	67,977	91,607	<sup>c</sup> 62,578	<sup>e</sup> 55,040	60,000
Total	2,254,135	2,592,407	<sup>c</sup> 2,422,968	<sup>e</sup> 1,620,388	2,060,000
Petroleum:					
Crude thousand 42-gallon barrels	57,895	75,819	100,000	<sup>e</sup> 109,500	115,000
Refinery products:					
Gasoline do.	459	<sup>c</sup> 730	<sup>c</sup> 800	800	800
Jet fuel and kerosene do.	499	<sup>c</sup> 730	<sup>c</sup> 800	800	800
Distillate fuel oil do.	1,153	<sup>c</sup> 1,825	<sup>c</sup> 1,800	1,800	1,800
Residual fuel oil do.	1,080	<sup>c</sup> 1,825	<sup>c</sup> 1,800	1,800	1,800
Other <sup>6</sup> do.	100	100	100	100	100
Refinery fuel and losses <sup>6</sup> do.	150	<sup>c</sup> 365	<sup>c</sup> 365	365	365
Total <sup>6</sup> do.	3,441	<sup>c</sup> 5,575	<sup>c</sup> 5,665	5,665	5,665
Uranium oxide (U <sub>3</sub> O <sub>8</sub> ), content of concentrate	1,094	1,047	828	700	700

<sup>a</sup>Estimated. <sup>b</sup>Revised.

<sup>1</sup>Table includes data available through May 14, 1992.

<sup>2</sup>In addition to the commodities listed, a variety of crude construction materials (clays, sand and gravel, and stone) is also produced, but output is not reported, and available information is inadequate to make reliable estimates of output levels.

<sup>3</sup>Includes cement produced from imported clinker.

<sup>4</sup>Reinjected for repressuring.

<sup>5</sup>Gold production figures likely do not include production smuggled out of the country, for which there are no reliable data.

<sup>6</sup>Reported figure.



TABLE 2  
GABON: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
<b>Cement</b>	Société des Ciments du Gabon (Government, 90.54%; ELF-Gabon, 9.44%; other, 0.01%)	Clinker plant at N'Toum, 40 kilometers east of Libreville	350 clinker.
Do.	do.	Clinker-grinding plant at Owendo	270 cement.
Do.	do.	Clinker-grinding plant at Franceville	130 cement.
<b>Manganese</b>	Compagnie Minière de l'Ogooué (Government, 29.23%; Compagnie Française de Mines, 17.60%; USX Corp., 15.10%; others, 38.7%)	Open pit mine at Moanda	2,700.
<b>Petroleum, crude</b> thousand barrels	ELF-Gabon (Société Nationale ELF Aquitaine of France, 75%; Government, 25%)	Mandji onshore and offshore field near Port Gentil	40,000.
Do.	Shell Gabon (Royal Dutch-Shell, 75%; Government, 15%; Amerada Hess 10%)	Lucina Marine offshore field, 15 kilometers south of Mayumba	4,000.
Do.	do.	Gamba-Ivinga Field, onshore at Gamba	4,000.
Do.	do.	Rabi Kounga Field, 100 kilometers north of Gamba	55,000.
Do.	AMOCO	Oguendjo offshore field, 85 kilometers southeast of Port Gentil	6,000.
Do.	British Gas Corp.	Obando, Octopus, and Pelican offshore fields, 60 kilometers southwest of Port Gentil	5,000.
<b>Petroleum products</b> thousand barrels	Compagnie Gabon-ELF de Raffinage (ELF-Gabon, 70%, Government, 30%)	Refinery at Port Gentil	8,760.
<b>Uranium</b> tons	Compagnie des Mines d'Uranium de Franceville (Compagnie des Mokta of France, 38.98%; Government, 24.75%; Compagnie des Matières Nucléaires of France, 18.81%; Uranium Pechiney, 10.62%; others, 6.84%)	Two mines near Mounana	1,770 uranium oxide.

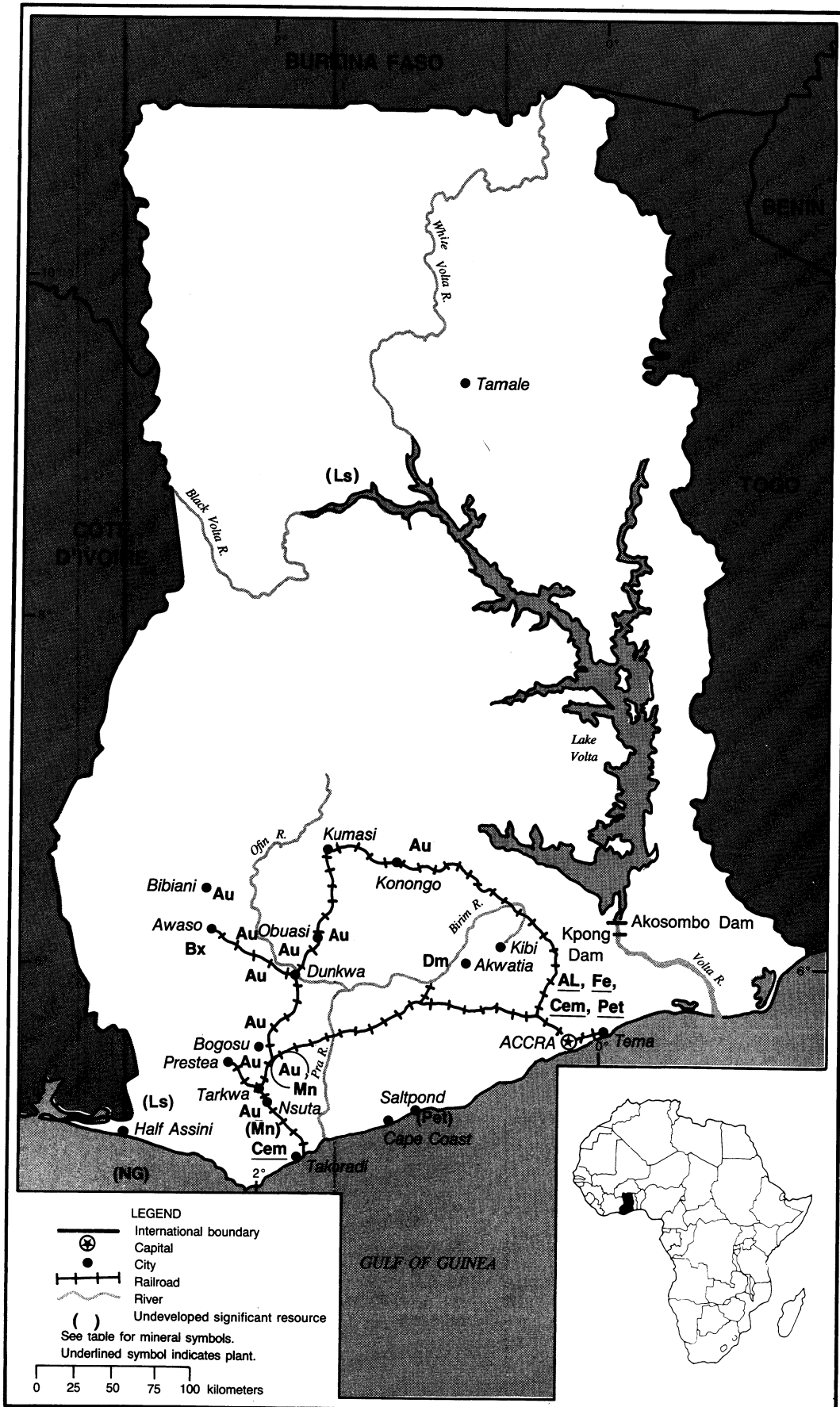
<sup>1</sup>The other equity shareholders in COMILOG are: Maaldrift B.V. of the Société Auxiliare du Manganèse de Franceville (SAMAF) of France, 10.01%; Elkem AS. of Norway, 5.70%; and Société de Ferromanganèse de Paris-Ou Gabonese nationals, 0.62%.



# GHANA

AREA 238,540 km<sup>2</sup>

POPULATION 16.2 million



## THE MINERAL INDUSTRY OF

# GHANA

By Hendrik G. van Oss

Mining has long been a major component of the Ghanaian economy, particularly in terms of exports. Although total revenues and employment levels in agriculture exceed those in mining, agricultural output has been adversely impacted in recent years by stagnant or declining world prices and by drought. In contrast, mine output and revenues have generally increased, particularly since the mid-1980's. In 1992, mining's stature in Ghana was given a further boost as gold, for the first time in many years, became the country's single most valuable export. Ghana was the largest gold producer in Africa after the Republic of South Africa. Ghana is also a significant producer of bauxite, diamonds, and manganese. The country began producing arsenic as a byproduct from one gold mine in 1991 and from a second gold mine in 1992. Ghana has significant secondary mineral production, most notably aluminum, which is toll refined in Ghana and the output of which was the largest in Africa in 1992. Cement, refined petroleum products, and steel also are produced, but in modest quantities.

Except for construction materials, virtually all of Ghana's primary mineral production was exported. Primary mineral exports in 1992 were equivalent to almost 6% of the country's GDP of \$6.88 billion<sup>1</sup> and about 40% of total exports. Official exports of gold, by far the largest mineral export, were worth about \$344 million, a 12% increase in value from that in 1991. This reflected a large increase in gold output, which more than offset a 5% lower gold price. Exports of aluminum, toll refined from imported alumina, were worth about \$230 million; the Ghanaian value-added component of this amounted to about \$80

million. By comparison, revenues from cocoa, the most important agricultural export, amounted to about \$305 million. Exports of timber were worth an estimated \$130 million in 1992. The most significant mineral commodities sold on the domestic market were petroleum products, worth an estimated \$250 million, and cement, worth an estimated \$100 million. Imports of mineral commodities were dominated by crude oil, refined petroleum products including petroleum coke, alumina, and clinker for cement. These totaled an estimated \$315 million, or about 22% of total imports.

Ghana is one of the most heavily mineralized countries in Africa. Economically, the most important part of Ghana's geology is a series of steeply dipping, isoclinally folded, northeast-trending lower Proterozoic greenstone belts made up of volcanic and sedimentary rocks of the Birimian Series. Some of the greenstone belts have associated major northeast-trending shear zones, and these commonly host quartz veins. Most of Ghana's gold deposits have developed in these veins or in areas of strong sulfide (pyrite and arsenopyrite) mineralization in the shear zones.

The Birimian belts can have the gross form of synclinoria, some of which are cored by clastic rocks of the Tarkwaian Series. Near Tarkwa, these clastics include gold-bearing conglomerates very similar to the banket conglomerates of the Witwatersrand gold field in the Republic of South Africa. By yearend 1992, three mines were exploiting Tarkwaian conglomerate gold ore. Alluvial diamonds eroded from the Birimian Series, and gold from both the Birimian and Tarkwaian Series, form widespread placer deposits that are exploited formally

and on an artisanal basis. The Nsuta Mine exploits manganese ore developed in Birimian Series rocks, and deep weathering of aluminous Birimian rocks has produced a number of bauxite deposits, including that exploited by the Awaso Mine.

Proterozoic granites intrude much of the Birimian, especially in the south-central and northwest parts of the country. Near the Birimian gold belts, some of these granites themselves are gold-bearing. The southeast corner of the country, along the coast and Togo border, is dominantly made up of lower Precambrian Dahomeyan gneisses and schists. These were long thought to represent basement to the Birimian, but are now regarded by some as migmatites derived from Birimian protoliths. The central and eastern one-third of the country is covered by horizontally bedded clastic sedimentary rocks of the upper Proterozoic to lower Paleozoic Voltaian System. These non-Birimian rocks are locally important as sources of industrial and construction rocks and minerals.

### GOVERNMENT POLICIES AND PROGRAMS

For decades, Government economic policies have favored agriculture, a reflection of the fact that about one-half of the work force and the GDP involved that sector. But agriculture has been hurt in recent years by low world prices for the country's principal cash crops and by periodic droughts. Increasing awareness of the loss of tropical rainforest in Ghana and throughout west Africa has led to severe cutbacks of the Ghanaian lumber industry. It is generally recognized that the growth potential of the agricultural

sector is limited, especially in terms of foreign exchange earnings. In contrast, the mining industry, after declining through the early 1980's, has grown fairly steadily since. Total mineral exports now rival agricultural exports; indeed, gold in 1992 was Ghana's single most valuable export. Mining is recognized as being a key component of Ghana's future economic growth.

The growth of the mining sector since the mid-1980's has been largely the outcome of a shift in Government legal and financial policies toward one of actively promoting growth of the sector. A major impetus to the new emphasis was a late 1980 report by a committee appointed to review the decline in the Ghanaian mining industry. The committee identified as major factors in mining's decline the overly tight restrictions on the availability of foreign exchange, unrealistic investment laws, and the many years of inefficient management of the state-owned mining companies. These factors had led to a major deterioration of the country's mine and transport infrastructure and an unfavorable climate for foreign mining investment. It also was noted that a large number of skilled Ghanaians had emigrated because of low wages and the country's general economic decline. Of particular detriment to the mining industry was the quagmire of more than 70 mining-related laws enacted since 1900. The committee recommended enacting new investment and mining legislation to supersede the old laws. The Minerals and Mining Law, 1986 (PNDCL 153), which now governs mining and mineral exploration in Ghana, and which has been favorably received by the international mining community, was a direct outcome of this recommendation. Another important recommendation was the rehabilitation of the existing mines.

Restoration of the mining industry has been a keystone of the ongoing general Economic Recovery Program, launched in 1983. Apart from new mining legislation, the Economic Recovery Program has sought to reverse the deterioration throughout the economy through a combination of improved investment laws, a relaxation of foreign

exchange restrictions, and the privatization of the large state-owned industrial sector.

In 1984, rehabilitation work began at the Ashanti Mine, the country's largest gold producer. In 1985, a similar program started for mines owned by the State Gold Mining Corp. (SGMC). The goal of these programs was to increase the production of the mines through a combination of mine expansion and rehabilitation, improving mine safety, rehabilitating the mills, and improving mine management and cost accounting. Loans for the rehabilitation programs were secured, by and large, through international lending agencies such as the International Finance Corp. and the World Bank. The relaxation of the country's foreign exchange laws has allowed the mines to purchase much needed new equipment and supplies. The improvement in output from the Ashanti Mine attributable to the rehabilitation and expansion programs has been dramatic. Improvement among the SGMC subsidiaries Dunkwa Goldfields Ltd., Prestea Goldfields Ltd., and Tarkwa Goldfields Ltd. has been minor by comparison and has largely been in the safety field rather than in output. Privatization of the SGMC mines is now seen as the only hope for their eventual return to profitability. The parastatal Ghana Consolidated Diamonds Ltd. (GCD) also was destined for privatization (and rehabilitation). More recently, it was decided to privatize Ghana National Manganese Corp. (GNMC), although this decision has met with resistance owing to GNMC's reportedly being one of the nation's few profitable parastatals. A subject of much speculation in recent years has been the privatization of the Government's shares in the Ashanti Mine. Several international mining companies, including at least two mining houses from the Republic of South Africa, have, in recent years, held talks with the Government on this subject. The mine's profitability has long been cited as a reason why privatization was unlikely. But, in 1992, the Government announced that it was considering a partial divestment of its shares. It remained

undecided at yearend what percentage of the Government's shares would be sold, whether they would be sold directly to a private company or offered on one or more stock exchanges, and when the divestiture would occur.

The Minerals and Mining Law, 1986, is based on the state's ownership of all minerals in Ghana. Under the law, the Government is entitled to 10% equity participation in all mining ventures and has the option to purchase an additional 20%. The law applies equally to foreign and Ghanaian nationals, with the exception that certain small-scale mining activities, and the mining of certain commodities, such as sand and gravel, are reserved to Ghanaians. Licenses are required for all exploration and mining, and the law sets forth the conditions under which such licenses are issued, renewed, or canceled. The taxation regime, including provisions for tax holidays and depreciation, is specified in the law, with reference to existing laws where retained. The law specifies that Ghanaian nationals are to be trained to replace expatriates wherever possible and that preference is to be given to Ghanaian sources for supplies. Furthermore, the law recognizes the importance of protecting the environment.

Other related and applicable laws include the Additional Profits Tax Law, 1985 (PNDCL 122); the Minerals Commission Law, 1986 (PNDCL 154); and the Minerals (Royalties) Regulations, 1987 (LI 1349). The basic investment codes of Ghana are those of 1981 (Act 437) and 1985 (PNDCL 116). The Petroleum (Exploration and Production) Law, 1984 (PNDCL 84), controls petroleum-related activities. The importation, transportation, and transfer of mercury is governed by the Mercury Law, 1989 (PNDCL 217). Regulation of artisanal gold mining was set forth in the Small-Scale Gold Mining Law, 1989 (PNDCL 218). The Precious Minerals Marketing Corporation Law, 1989 (PNDCL 219), set up the Precious Minerals Marketing Corp. (PMMC) to promote the development of small-scale gold and diamond mining in Ghana and to purchase, directly and through licensed

buyers, the output of such mining. The PMMC's right to market diamonds from GCD was transferred in late 1991 to a private company, although the PMMC still markets a large number of diamonds (and gold) produced by artisanal miners.

The Ministry of Lands and Natural Resources has authority over all aspects of the Ghanaian mineral economy and is the entity that grants mineral exploration and mining leases. Within the Ministry, the Minerals Commission has overall responsibility for recommending mineral policy, promoting mineral development, advising the Government on mineral matters, and serving as a liaison between industry and the Government.

Geologic studies of Ghana are conducted by the Geological Survey Department; the Lands Commission maintains records of exploration licenses and mining leases; and the Mines Department has authority in mine safety matters. All mine accidents and other safety problems also must be reported to the Ghana Chamber of Mines. The Chamber also provides information on Ghana's mining laws to the public and negotiates with the mine labor unions on behalf of its member companies. All of the mining companies operating in 1992 were members of the Chamber of Mines. The Ministry of Fuel and Power formulates Ghanaian energy policy and issues licenses for petroleum and natural gas exploration in and offshore Ghana. The Government controls petroleum products selling prices in-country and has generally charged only slightly higher prices than those needed to recover costs. However, from time to time this policy has been questioned, as it has led to smuggling of petroleum products into neighboring countries, particularly Côte d'Ivoire, for resale at much higher prices.

## PRODUCTION

With the major exception of manganese ore, output of mineral commodities increased in 1992 (*see table 1*). Ghana's official gold production in 1992 was the highest to date, exceeding the hitherto record production of 28,470 kg reached in fiscal year 1958-59. The

new record performance was attributable to major improvements in output at the country's three largest gold mines and to the startup of a large new mine. But some of the smaller mines performed poorly during the year, and at least one former significant producer was closed. Included in the 1992 production number is 338 kg of gold mostly produced by artisanal miners and sold to the PMMC. The true artisanal gold output likely exceeded this amount by a considerable but unknown margin, with the excess being smuggled out of the country.

Ghana's official diamond output increased slightly in 1992 to 694,029 carats, the result of increased artisanal output. Production by GCD, the sole formal mine, actually fell significantly. Artisanal diamond purchases by the PMMC fell, but this was an artifact of new, non-PMMC marketing of artisanal diamonds from the GCD concession. Because of greatly improved purchase prices for artisanal diamonds, the level of smuggling was believed to have fallen significantly. The overall production level for the year shown in table 1 reflects this belief. The gem to industrial diamond ratio shown in table 1 for all years has been adjusted to reflect the fact that many of the hitherto "industrial" diamonds were in fact very small gem and near-gem stones that could be cut on the Indian market.

Ghana's bauxite production evidently increased significantly, although this is based on the assumption that the reported production level in fact represented the level of sales, as has been commonly the case in past years. Manganese ore output fell, probably owing to a decrease in production of oxide as opposed to carbonate ore. Both manganese and bauxite production were still somewhat constrained by inadequate rail infrastructure. Output of aluminum was essentially at capacity level in 1992, despite a soft world market for the metal. Cement production increased dramatically, reflecting both a strong domestic construction market and strong demand, for heap-leach agglomeration, in the gold industry. Some of Ghana's gold is contained in arseniferous ores, and the

contained arsenic has traditionally been vented as waste during roasting. Although production data have yet to become available, in 1991, one mine began recovering this pollutant and was joined in 1992 by a second, larger mine. The arsenic was exported.

## TRADE

Total exports in 1992 were \$986 million, down slightly from the total value in 1991; the decline was due to disappointing agricultural revenues. Official exports of primary minerals are estimated to have been worth about \$395 million. Gold accounted for about \$344 million of this. The true value of legal diamond exports was not available, but was estimated to have been about \$22 million. Bauxite exports were worth about \$9.5 million, and manganese ore exports were worth \$16.2 million. Although data were not available, it is estimated that arsenic trioxide exports in 1992 were worth about \$2 million.

The true value of smuggled diamonds and gold was not known. Owing to improved prices offered in country for artisanal diamonds, it is likely that the amount of diamonds smuggled out of Ghana declined. Accordingly, for the smuggled component estimate used in table 1, the value would have been only about \$1 million or less. Of interest is the fact that Ghana appears to be an entrepôt for diamonds produced elsewhere in Africa. In 1991, U.S. Customs showed diamond imports from Ghana of about 933,000 carats, worth approximately \$63 million; data for 1992 were unavailable. Gold smuggled from Ghana, largely through Côte d'Ivoire and Togo, was estimated to have been worth \$20 million in 1990, equivalent to about 1,600 to 1,650 kg. It is likely that smuggling in 1992 was at a similar level.

Export revenues from value-added mineral commodities were minor by comparison with primary minerals, with the notable exception of refined aluminum. Aluminum is toll-smelted in Ghana from imported alumina, petroleum coke, and certain other inputs. Aluminum exports were worth about \$230 million

and the value-added component of this, exclusive of taxes, was about \$80 million. About \$50 million of this was for electricity, for which the aluminum smelter was Ghana's largest customer. Ghana's exports of electricity were worth about \$40 million.

Ghana's imports in 1992 totaled about \$1.457 billion. Crude petroleum and refined petroleum products accounted for an estimated \$200 million of this. Clinker imports, on which the Ghanaian cement industry was totally dependent, were worth an estimated \$40 million. Alumina and petroleum coke imports for the country's aluminum refinery were worth about \$60 million and \$15 million, respectively. Data on the total value of imports of mining machinery, mill reagents such as sodium cyanide, and explosives, were unavailable but probably exceeded \$75 million for the year.

Traditionally, the United States has purchased most of Ghana's aluminum output, but in recent years much of the output has been sold on the London Metal Exchange. Officially, most Ghanaian diamonds were sold to Belgium and to India. Most of Ghana's bauxite exports were to the United Kingdom. Ghana's manganese oxide exports were to various European customers; manganese carbonate and some oxide ore sales were to Japan. Ghanaian gold was toll refined in Europe before being sold on the world market.

As in previous years, Nigeria was the source of Ghana's imports of crude oil and much of its refined petroleum products. In recent years, Jamaica and the United States have been major sources of Ghana's imports of alumina, although, in 1992, U.S. alumina sales to Ghana amounted to only about 41,000 tons.

## STRUCTURE OF THE MINERAL INDUSTRY

The Ghanaian mineral industry is fairly diverse, although its output, in value, is dominated by gold and aluminum. The Government is a significant equity participant in much of the minerals

industry (see table 2).

Gold remained by far the most important primary mineral commodity produced in Ghana in 1992. There were nine formal gold mines operating during the year, six of which were lode mines and the rest placer operations. There was also minor byproduct gold production from a formal placer diamond mine and significant production by artisanal miners. Most other mineral commodities were produced by a single operation each.

Less than 1% of the Ghanaian work force was employed by the minerals industry. Including temporary laborers, the mineral sector employed about 20,000 workers; about 15,000 of these worked for the gold mines. These numbers included workers directly employed in the mining and ore milling operations, in exploration, and in company-owned shiploading facilities, farms, lumber mills, and other captive service industries. It is estimated that an additional 150,000 persons were directly dependent on the wages earned in the formal mining sector. The mining and related companies have been the source of most of the educational and health care facilities for the mining towns and surrounding areas. The livelihood of a significant proportion of the employees of Ghana Railway Corp. was tied to the raiing of bauxite and manganese ore and of mining equipment and supplies. About 2,000 persons were employed by the Government in agencies dealing with minerals. About 30,000 Ghanaians worked at least part time as "galamsey" or artisanal miners; this estimate may include workers from the formal mining sector who engaged in artisanal mining on weekends and holidays.

## COMMODITY REVIEW

### Metals

*Aluminum and Bauxite.*—The aluminum industry in Ghana dates to the mid-1960's with the construction, by Kaiser Engineers of the United States, of a dam and hydroelectric facility at Akosombo on the Volta River and the construction of the Volta Aluminum Co.

(VALCO) aluminum smelter at Tema. The first potlines became operational in 1967. VALCO is a tolling operation and relies on imported alumina, generally from the United States or Jamaica. In 1992, the smelter continued to operate on just 90% of the plant's five potlines; hot metal output was near capacity and was the highest since 1981. Net salable production was 178,953 tons. The performance in 1992 was impressive given the fact that there had been some labor problems during the year, including worker slowdowns, associated with contract negotiations. Negotiations were ongoing at yearend.

Bauxite in Ghana was discovered in 1914, and several deposits have been explored in detail. The only bauxite operation to date has been the Awaso Mine, which opened in 1940. In 1992, Ghana Bauxite Co. Ltd. (GBC), operator of the Awaso Mine, largely completed its project to upgrade and expand its loading infrastructure at the port of Takoradi. The goal of this project is to allow the company to increase its exports to 500,000 mt/a and, given adequate railing capacity, ultimately to 1 Mmt/a. Output increased significantly during the year, but was still constrained by the limited availability of rail stock, which is shared with the GNMC.

*Gold.*—Gold mining, on an artisanal basis, has been an important economic activity in Ghana for centuries. Formal mining by Europeans commenced in the 1620's on a small scale, but large-scale gold mining in Ghana did not occur until the 1880's. The subsequent 50 years saw a large number of gold mines developed, and gold output increased substantially. The number of active formal gold mines declined precipitously after World War II. The surviving mines, however, were large and yielded Ghana's highest gold output to that date in the fiscal year 1958-59. Declining grades and ruinous fiscal policies caused a fairly steady decline in gold output thereafter until 1983, at which time new, more favorable policies began to show results. Production since 1983 has increased dramatically; official output in 1992 was the highest on record

and missed the 1-million-troy-ounce (31,104-kg) mark by only a slight margin. Most of the gold output increase since 1983 can be attributed to the ongoing rehabilitation and expansion projects at the Ashanti Mine at Obuasi. But, gold mine development stemming from the 1986 mining law also has been important. The Southern Cross Mine, near Konongo, opened in 1988 and was followed in 1990 by the Bogosu and Teberebie Mines, by a couple of small placer operations in 1990 and 1991, and by the Iduapriem lode mine in 1992. Indeed, apart from the record gold output, 1992 was notable in that the substantial increase in production from the Ashanti Mine was exceeded by the total increases from the new mines. Thus, whereas the Ashanti Mine's output in 1991 was almost 75% of the country's total, it accounted for only about 66% of the total in 1992. However, not all the gold mines did well in 1992—the Southern Cross Mine, for example, was closed during the year, and some others showed production declines.

Apart from the formal mines, a significant amount of gold is produced by artisanal miners. The true level of this is unknown. The PMMC recorded purchases of 338 kg in 1992, but this includes a small output from GCD's placer diamond mine. It is generally believed that total artisanal gold production, including material stolen from the formal mines, greatly exceeds the PMMC purchases.

The Ashanti Mine at Obuasi is a world-class gold mine that, by yearend 1992, had recorded production of about 676,000 kg of gold since its opening in 1897. The mine is famous for its very high-grade ores, averaging about 20 g/mt gold for most of its history. In recent years, grades have fallen as the proportion of quartz underground ore, as opposed to sulfide ore, has decreased, and as large quantities of low-grade surface ores and tailings began to be exploited. For the 1991-92 fiscal year, for example, underground ore milled averaged about 11.2 g/mt gold, surface ores (excluding tailings) about 2.1 g/mt gold, and that for the mine overall about 3.3 g/mt gold. However, the decline in

grade has been more than offset by increased ore throughput. Ashanti increased its gold output by almost 15% in 1992 to 20,351 kg, the highest level yet.

Since 1984, the Ashanti Mine has been involved in a \$156 million rehabilitation and expansion program. This program has undergone several phases of evolution as new reserves were developed, new mining technologies and methodologies were adopted, and annual production targets were regularly exceeded. The latest phase is called the Ashanti Mines Expansion Project (AMEP), for which a feasibility study was completed early in the year and for which a \$140 million loan agreement, coordinated through the IFC, was signed in November. Overall, the goal of the various expansion programs is to bring the Ashanti Mine's gold output to 1 million troy ounces (31,103 kg) in the fiscal year 1995-96 (ending September 30, 1996). This target is to be achieved by mining both surface and underground ore bodies and by improving the gold recovery facilities to allow the processing of hitherto below-cutoff-grade material. Additionally, a large volume of old tailings is being reprocessed.

Underground, emphasis has been on developing relatively shallow quartz and sulfide ores toward the south end of the mine and a large sulfide ore body at moderate to deep levels in the central part of the mine. Work toward this end in 1992 included sinking and lining the Kwesi Mensah Shaft (KMS) to within 18 m of its design bottom, and constructing a second winder house for the shaft. The KMS is to be one of the main hoisting shafts for Ashanti's expanded output. At the service and ventilation George Cappendell Shaft (GCS), the ore discharge facilities for an offset subvertical shaft were completed and full sinking of the subvertical shaft commenced and reached to just above the 35 level by the end of the 1991-92 fiscal year. A number of stopes at Ashanti were consolidated to improve mining efficiency. Underground ore mined during the year fell slightly as a result, but this was offset by an almost 7%

increase in grade to 13.27 g/mt. In August, excavation work commenced on the portal for the North Ramp Mine. This spiral ramp decline, part of AMEP, will access high-grade ore in certain old safety pillars and backfill from the shallow portions of the northern workings. Mining will involve trackless equipment. Beyond the term of the present expansion program are plans to mine deep ores (below about 1,500 m) at the north end of the mine; this will, however, require the installation of refrigeration.

Both quartz and sulfide ore from the underground workings are processed at the Pompora Treatment Plant (PTP), which has both gravity and flotation-roasting-cyanidation circuits. The plant recovered 10,989 kg of gold in fiscal year 1991-92, a 6.5% increase. Much of the rehabilitation work at PTP had been completed by yearend 1991, but in 1992 a new flotation bank was installed and a new roaster was under construction. The latter was needed to handle part of the additional sulfide material to be mined under AMEP. The Ashanti sulfide ore is mainly arsenopyrite, and for years the PTP has had serious arsenic oxide emissions problems. Probably the most significant development at PTP in 1992, along with other environmental abatement and monitoring work throughout the mine-mill environs, was the July commissioning of a 20-mt/d arsenic trioxide scrubber. Data for 1992 were not available but output likely amounted to about 3,000 tons. The arsenic was exported.

Old mill tailings were being reprocessed at a separate treatment facility. Throughput in fiscal year 1991-92 increased 27% to 1.72 Mmt; gold recovery amounted to 2,403 kg.

Since 1989, the surface oxide extensions of the main Ashanti ore bodies have been mined in a series of open pits. The open pits are collectively referred to as the Sansu Project. Initially, the oxide ore was all heap leached, but a dedicated carbon-in-pulp (CIP) treatment plant for the oxide ore was completed in early 1991, and subsequently, the higher grade oxide material has been diverted to this plant. In the 1991-92 fiscal year, ore



processed by the oxide plant almost doubled to 2.5 Mmt; the ore graded 2.88 g/mt gold. The plant recovered 6,405 kg of gold. Ore sent to the heap leach, in contrast, amounted to only about 862,000 tons for the fiscal year, a 21% decline, and its gold grade averaged only 0.99 g/mt, a 35% decline. Reportedly, the heap leach's Merrill Crowe recovery plant was not used in 1992, it being cheaper to run the pregnant solution to the oxide plant. The heap leach was credited with a recovery of 556 kg for the fiscal year.

Under AMEP, the open pits are being expanded to access shallow sulfide ores. The planned expansion, however, appears to be less than earlier proposed, based on an examination of the company's resources listing for the end of the 1991-92 fiscal year. The total open pit sulfide ore resources show a decline from the previous year in excess of that explained by the small amount of sulfide ore mined (and processed at PTP) during the interim. It is likely that a portion of these earlier sulfide resources have been transferred to the underground categories and that shallow underground mining is to be expanded. From whichever source, AMEP calls for a large increase in sulfide ore mining and, even with the new roaster, PTP's capacity will be inadequate to handle the increased throughput.

Just as the Ashanti Mine adopted heap-leach technology to handle its hitherto below-cutoff-grade oxide ores, the company has decided to follow the lead of some smaller operations elsewhere in the world and adopt bacterial preoxidation technology to handle its low-grade sulfide ore. A significant part of the \$140 million AMEP loan mentioned earlier will be for the construction of the world's largest biooxidation plant, to be constructed near the southern open pit workings. Reportedly, the plant will have an ore throughput capacity of 220,000 mt/month and will recover about 10,000 kg/a of gold. The milling and cyanidation circuits for the plant were planned to be completed by September 1993 and would be used to process oxide ores until the bacterial preoxidation circuit is completed

in early 1994. The biooxidation plant will handle virtually all of the open pit sulfide ore, as well as low-grade underground sulfide ore. Some high-grade open pit sulfide ore will be processed at PTP. The biooxidation plant offers significant cost advantages over conventional roasting technology and has a major advantage of eliminating arsenic emissions. Arsenic will be precipitated as an iron arsenate instead and this material will be exported. Given satisfactory performance, it was possible that the biooxidation plant would be expanded in the future to replace altogether the roasting circuit at PTP.

The addition of limestone is required for the bacterial preoxidation process, and the company was considering exploiting the Nauli limestone deposit northeast of Half Assini for this feed.

Reserves at the Ashanti Mine were increased during the year as a result of ongoing surface and underground exploration and the inclusion of some hitherto below-cutoff material, safety pillars, and stope backfill in the northern part of the underground mine. As of September 30, 1992, proven underground reserves were given by the company as 8.45 Mmt grading 16.6 g/mt gold; this was a very slight increase in contained gold from the reserves given for the previous fiscal year. Total underground resources (including the proven reserves) were listed as 39.15 Mmt grading 10.2 g/mt and represented a 13% increase in contained gold. These resources, however, include 26.56 Mmt of sulfide material grading below the current stated pay limit of 10 g/mt. Presumably, this low-grade sulfide material is to be treated using bacterial preoxidation. Surface proven reserves (oxide plus sulfide ore) amounted to 22.48 Mmt grading 4.5 g/mt gold, a modest decline in contained gold from the previous fiscal year. Total surface resources were given as 28.11 Mmt grading 4.3 g/mt gold. This represented an almost 18% decrease in contained gold from the listing of the previous year, the decline being largely through significant drops in all categories of sulfide ore. Given the fact that only a small amount of open pit sulfide ore was mined during the (fiscal) year, it must be

assumed that the decline in surface sulfide resources was through accounting transfer of this material to the underground inventory. Total tailings resources were listed as 13.61 Mmt grading 2.9 g/mt, of which 7.8 Mmt, grading 3.2 g/mt, was considered proven reserves.

Surface exploration in the Ashanti Mine area identified several new areas of potential oxide mineralization. The company constructed a pilot plant on a nearby placer gold prospect, and trial mining and processing were under way during the 1991-92 fiscal year.

The Teberebie Mine near Tarkwa had its first year of operations at full capacity in 1992. Inaugurated in March 1992, the open pit mine had in fact reached full production levels late the previous year. Gold production in 1992 increased 63% to 4,000 kg and the mine easily retained its status as Ghana's second largest gold producer.

The Teberebie concession has, for neighbors, the Tarkwa and Iduapriem Mines. All three mines exploit Tarkwaian conglomerate ore having some similarities to that of the Witwatersrand in the Republic of South Africa, and in this regard all three operations are much simpler, geologically, than the Ashanti Mine. The Teberebie Mine processes ore in a conventional heap leach, as opposed to conventional milling plus gravity recovery at Tarkwa, and milling plus carbon-in-leach (CIL) processing at Iduapriem. During the third quarter of 1992, Teberebie completed a major exploration program that more than doubled reserves to 149,000 kg contained gold; an independent audit confirmed 143,000 kg of this. Given the new reserves and lower than expected production costs, the company was planning to greatly increase output. Mining, which was at a rate of 3.3 Mmt/a at yearend 1992, was to rise to 5 Mmt/a in 1994 for a targeted output of about 7,775 kg/a of gold. Production for 1993 was targeted at 5,130 kg. Toward this end, the company acquired an additional 17 km<sup>2</sup> for its concession, giving it a total of 42 km<sup>2</sup>. Most of the new ground will be used for a new plant site, for dumps, and for other uses.

Mining will occur on only about 2 km<sup>2</sup> of the new area. To date, the heap-leach gold recovery rate has been about 80%, but nevertheless, the company was considering switching to processing by conventional milling plus either CIL or CIP gold recovery to increase the recovery rate. Reserves for Teberebie at yearend 1992 were given as 143,000 kg contained gold, of which 94% was in ore and the remainder in dumps.

After starting development work in 1991, the Iduapriem Mine commenced mining in May 1992 and commissioned its CIP plant in July. The gold pour was in September, and the official inauguration was scheduled for early 1993. Output for 1992 was reported to be 1,178 kg of gold, the fourth largest in Ghana. At full production, the mine is expected to produce about 4,040 kg/a of gold. As initially planned, early mining was to include mill-grade ore grading 1 to 3 g/mt gold and lower grade material to be stockpiled for later treatment. But it became apparent early on that mill working capacity would exceed planned throughput of the mill-grade ore. Accordingly, toward yearend, some of the low-grade stockpile was being utilized as blend for the mill. At yearend, mining was at a rate of about 1.5 Mmt/a of ore.

The Iduapriem proven plus probable reserves at midyear 1992 were given by the company as 18.64 Mmt of ore grading 1.85 g/mt gold. The proven recoverable gold inventory in this amounted to 17,110 kg. The mine concession is adjacent to the Teberebie concession and has Tarkwaian conglomerates exposed for a strike length of 9 km. The reserves are along 5 km of this, and work is continuing to explore the additional ground. During 1992, the company also was drilling on the adjacent Ajopa concession and there identified additional resources, according to the company, of 4.7 Mmt grading 2.0 g/mt gold.

The Bogosu Mine had its second full year of operation in 1992. A number of technical problems that had plagued the milling operation, particularly the sulfide circuit, in 1991 appear to have been at least partly solved. Gold production for

1992 increased 27% to 2,428 kg. At full output, gold production is expected to be in the 3,100- to 3,500-kg/a range.

The Bogosu deposit had been previously exploited by Marlu Mining Areas Ltd., which ceased operations in 1955. Marlu had concentrated on mining oxide ores, whereas the norm for Ghana in those days was to mine the sulfide ores instead. Accordingly, the Bogosu operation has had only a small amount of oxide ore with which to generate its initial cash-flow and thus the initial problems in its sulfide roasting circuit have been especially unwelcome. The sulfide ore contains both arsenopyrite and pyrite, and the fluidized-bed roaster has an arsenic (trioxide) scrubbing unit to eliminate arsenic in the roaster fumes. Although production or full export data for arsenic were not available, the mine exported about 244 tons of arsenic trioxide to the United States in 1991 and almost 1,050 tons in 1992. Gold ore reserves (all classes) at the beginning of 1992 amounted to about 17 Mmt grading about 3.4 g/mt gold.

The parastatal State Gold Mining Corp. (SGMC) operated three gold mines: Dunkwa, Prestea, and Tarkwa, in 1992. All three mines have been especially hard hit by past poor management and fiscal policies. In recent years, SGMC has received loans from international lending institutions to rehabilitate and expand the mines, particularly Prestea and Tarkwa, with the goal of reaching a total output of 4,000 kg/a. Little work was scheduled for the Dunkwa dredging operation. Although significant improvements, especially in terms of safety, were made at the Prestea and Tarkwa underground mines, gold output has been disappointing. Combined gold output for SGMC was only 1,593 kg in 1990; 1,728 kg in 1991; and 1,496 kg in 1992. Whereas Prestea and Tarkwa had shown production increases in 1991, all three operations showed declines in 1992. Dunkwa's gold output fell 10% to 145 kg, Prestea's output fell 26% to 525 kg, and Tarkwa's output fell 4% to 826 kg. In the case of Dunkwa, the dredges and dredging methods seem unsuited to the conditions on site and it is not clear if

the company's reserves are adequate to justify new equipment. At Prestea, mine output has for several years suffered from declining ore grades, increasingly refractory ore, and poor performance of the antiquated roasting circuit. In 1992, the mine's problems were aggravated by labor unrest, which led to a 10-week closure of the operation. Tarkwa has metallurgically simple ore and relatively few mill problems; output is constrained by an inability to supply adequate mill feed.

The lack of improved gold output by the SGMC mines reportedly has led to the suspension of rehabilitation funding, and the Government has given renewed emphasis to the privatization of the mines. Little interest was reported in 1992 for Dunkwa. However, toward yearend, an agreement was reached with Gold Fields of South Africa (GFSA) giving GFSA the option to purchase Prestea and Tarkwa. Both mines were considered to have good exploration potential, particularly in terms of open pit mining. Neither mine has seen significant reserve delineation work in recent years. Although reserve data were not available for 1992, they have likely not increased significantly from those of the late 1980's. At that time, total gold ore reserves of the Prestea Mine were given by the company as 7.2 Mmt grading 7.88 g/mt, of which about 30% was proven. However, much of this inventory was in pillars or was otherwise not available for (underground) mining. Reserves available for mining amounted to only 680,000 tons grading 5.7 g/mt, and it is likely that about one-third of this material had been mined by yearend 1992. Total ore reserves of the Tarkwa Mine at yearend 1988 were given by the company as about 6.1 Mmt grading 6.8 g/mt. Of this inventory, only about 665,000 tons grading 8.1 g/mt was considered to be proven reserves, of which about 495,000 tons grading 8 g/mt was available for mining. Again, it is likely that, by yearend 1992, only about 50% of these reserves remained. Dunkwa's reserves, in contrast, appear to be large, exceeding 200 Mm<sup>3</sup> grading 0.15 g/m<sup>3</sup> gold, according to the company.

Bonte Gold Mining Ltd. had its first full year of production at its placer mine near Kumasi. The mine had poured its first gold in September 1991 after a year of processing plant problems related to the high clay content of the gravels. These problems were only partly overcome in 1992; gold output for the year was 151 kg, well below the 200 kg anticipated. The company claims proven reserves on its concession of 16 Mm<sup>3</sup> grading about 0.75 g/m<sup>3</sup>.

The Goldenrae placer gold mine, on the Kwabeng concession about 16 km north of Kibi, recorded an output of only 50 kg in 1992, well below the already disappointing 172 kg achieved the previous year. However, the poor performance was anticipated; the mine's washing plant had been found inadequate in 1991 and, in 1992, work was under way to replace it with a new facility. The new floating wash plant was installed about midyear, and commissioning tests were completed in October. The plant was formally commissioned in November 1992, and its subsequent performance was reported to be satisfactory. The plant is designed to process 0.84 to 1.00 Mm<sup>3</sup>/a of gravel to yield 470 to 560 kg/a of gold. The company was studying the possibility of adding one or two more floating wash plants, of smaller size, over an 18-month period. The goal of the additional plants would be to boost gold output to about 1,000 kg/a. The company claims gold reserves of about 7,800 kg (all classes) in gravel grading about 0.6 g/mt gold—adequate for 10 years of mining. Negotiations were ongoing with the Government for an additional concession area.

The Southern Cross Mine, which was on the verge of closure at yearend 1991, was put on standby in 1992 and recorded no gold output for the year. The mine, which came on-stream in 1988, had been Ghana's first heap-leach gold operation and was the inspiration for the heap-leach component of the Sansu project at the Ashanti Mine. Southern Cross had a very successful 1989, but began to experience problems in 1990. Some of the problems were related to dwindling oxide ore reserves, grade control, and an

unanticipated refractory character of some of the oxide ore. But the main problem appeared to be the fact that the mine was undercapitalized. Its Australian parent company was suffering from severe cash-flow problems at home and was placed into receivership in 1991. There was little money available for exploration; reconnaissances to find additional oxide mineralization was fairly successful but money was not forthcoming to delineate reserves on these prospects. There was also no money to construct facilities to process the mine's considerable sulfide resources. There was very little mining in 1991 and none recorded in 1992. The mine was put up for sale in late 1992.

The mining subsidiary of Ghana Libya Arab Holding Co., a joint venture of the Government of Libya, 60%, and the Government of Ghana, 40%, had a small gold recovery plant for the treatment of tailings at an inoperative gold mine near Bibiani. The plant was idle in 1992; gold recovered in 1991 was only 20 kg.

A number of companies were active in gold exploration in Ghana in 1992, although the number of exploration projects was not as high as in 1989 and 1990. The reasons for the apparent decline included lackluster gold prices in 1991-92, the fact that the "best" concessions were already taken, and the increased corporate capital requirements for obtaining a concession.

Probably the most significant undeveloped gold prospect in Ghana was the Ayanfuri deposit, about 15 km west of Dunkwa. The deposit is on the Bokitsi concession held by Cluff Resources Plc of the United Kingdom. Mineralization at Ayanfuri is somewhat unusual for Ghana in that the gold is found in weathered granitic rocks and the immediately adjacent Birimian metasediments. Mineralogically, the gold can occur free, associated with iron oxides, or associated with sulfides (pyrite and, to a lesser extent, arsenopyrite and chalcopyrite). Both sulfide and oxide gold resources have been delineated, but attention has been focused on the oxide ore. Reserve delineation drilling on the deposit was completed in 1991 and a feasibility study was completed in May 1992. Emphasis

has been on the oxide ore, which extends to a depth of 65 m and which can be open pit mined. Although the ore is amenable to heap leaching, the feasibility study instead favors the use of a convention CIL recovery circuit. Proven and probable oxide reserves, according to Cluff, amount to 6.06 Mmt having a gold grade of 1.68 g/mt. Sulfide resources amount to about 4.8 Mmt grading 1.9 g/mt gold; presumably there is a higher grade core within this inventory. Cluff spent much of 1992 negotiating development financing for the deposit.

Glencar Explorations Plc, an early partner on the Teberebie Mine project, was involved in exploration on the Kanyankaw/Asheba concession, about 40 km south of Tarkwa. The company has a 50% earn-in option on the property. A reverse circulation drilling program was carried out in 1992, which reportedly returned several gold intercepts both in the Birimian basement rocks and in the 85-m-thick saprolite overlying them. More work was planned in 1993 on the property. Glencar was less successful with its exploration work on the Antubia gold concession, about 65 km west of Awaso, and decided to relinquish the concession.

**Manganese.**—The Nsuta Mine has been the only significant producer of manganese ore in Ghana and has been worked since 1916. Production fell significantly in 1992, apparently because of the glut of manganese ore on the world market. The mine produces both oxide and carbonate ores, although data on the latter tend to include a mixture locally referred to as "carbox." The production decline in 1992 appears to have been in the carbonate (plus carbox) category; Japan has traditionally been the sole customer for this material. Although the Nsuta Mine has large reserves of carbonate ores remaining, the mine has for years been reported as having virtually exhausted its oxide ore reserves. However, an active exploration program for oxide ore has been able to support continued substantial production of oxide, largely through the discovery of several small pockets of this material.

Apart from unfavorable world manganese ore prices, the Nsuta Mine's total production has been constrained by limited raiiling capacity; the railroad is shared with the Awaso bauxite mine. The mine's \$18 million carbonate ore calcining plant completed in 1982 remained uncommissioned at yearend.

The Government is trying to sell the Nsuta Mine, despite the operation being profitable. At least one major international company, also a manganese producer, was reportedly negotiating to buy the property. The same company was reported to hold a large manganese exploration concession in the area around the Nsuta mining concession, stretching southeast toward the coast. A number of other manganese deposits are known in this area, but limited drill-testing of them by Soviet geologists in the early 1960's failed to demonstrate large reserves. Nevertheless, there is geophysical evidence suggesting better potential than has so far been shown. The Nsuta concession has significant gold potential in addition to manganese, but it was not clear if the gold rights would transfer with the concession upon purchase.

### Industrial Minerals

Alluvial diamond deposits were discovered in Ghana in 1919, and subsequent mining has been from several of these deposits. Only one formal mine was in operation in 1992. Production by formal mining operations peaked in excess of 2.5 million carats in the 1970's but has declined severely since. There has long been artisanal mining of diamonds as well, but estimates of the annual output of such vary widely. Over the years, most of the artisanal production has been smuggled out of the country. More recently, the Government has offered better prices for diamonds and it is believed that the level of smuggling has declined as a result.

The sole formal diamond operation in Ghana in 1992 was the Akwatia Mine. The mine opened in 1924 and was operated until 1982 by Consolidated African Selection Trust, at which time the Government assumed total ownership of

the property through a new operating company, GCD.

Production by GCD in 1992 was reported to have been 214,155 carats, almost 50% higher than in 1991, but the 1992 figure included production by artisanal "tribute" miners operating on the property. The GCD mine itself produced only 124,900 carats, a 14% decline and a level below that needed to break even financially. Virtually all of the Akwatia diamond output in 1992 was from Birim River gravel deposits about 12 km away from the old mine processing plants. These plants are situated on terrace gravels that had contained the high-grade placer diamond deposits upon which the mine was originally based. The terrace gravel reserves are severely depleted—only isolated pockets remain. In the early 1980's, extensive diamond reserves along the Birim River were delineated by the UN, and these gravels have been exploited since 1987. GCD believed, and has partly confirmed through subsequent drilling, that the true reserves were roughly twice as large as that determined by the UN. However, exploitation of the river gravels has been made uneconomic by the long haulage to the processing plant and by the fact that the mill is in a state of severe disrepair. The latter is a result of ruinous past Government foreign exchange policies that prevented the acquisition of spare parts, and the undervaluation of the mine's production. A 1989 feasibility study on the rehabilitation of Akwatia recommended abandoning the old mills in favor of several new semimobile plants to be located on the Birim gravels. These would process a total of 1 Mm<sup>3</sup>/a of gravel, and annual diamond production would amount to about 1.1 million carats. To attract financing for the new plants, the Government began seeking buyers for Akwatia in 1990. In late 1991, it was announced that the mine was to be sold to a joint venture between Inco Ltd. of Canada and Lazare Kaplan International of the United States, each to take 40% of GCD with the Government retaining 20%. The initial agreement was for Lazare Kaplan to market Akwatia's diamonds, and for Inco, as an interim

partner, to help secure financing for the rehabilitation and to do further feasibility studies. In late 1992, a \$5.5 million combination loan and grant was arranged through Caisse Centrale. Some rehabilitation work was done to the old mill with a view to efficiently process the remaining terrace gravel reserves and to boost annual total mine output for the interim to 500,000 carats. Production from the terrace gravels was to provide an interim cash-flow while several modular plants, designed for fast disassembly, movement, and reassembly, were constructed to handle the Birim River gravels. Throughout 1992, Inco was negotiating with the Government the terms of Inco's full participation in the operation. A significant point of discussion was the mine's level of staffing; the new mining plans called for a major work force reduction. Negotiations were near completion in early 1993 when a combination of falling nickel and diamond prices, the latter due to the world recession and the unrestricted outflow of diamonds from Angola and Russia, led Inco to withdraw from the venture.

Akwatia's diamonds, up until late 1991, were all sold through the PMMC, which had paid GCD an average of only \$12 to \$13 per carat on the basis that most of the diamonds were of industrial quality. This characterization was based solely on the exceptionally small size of the stones, not their clarity, color, or shape. However, it turned out that about 80% of the stones, notwithstanding their small size, were readily cuttable in India and thus the stones were actually of gem or near-gem quality. Part of the "sale" of GCD to Lazare Kaplan-Inco involved Lazare Kaplan's taking over the marketing of Akwatia's diamonds. This plan was opposed by the PMMC but went through notwithstanding. In early 1992, it was reported that Lazare Kaplan had offered in excess of \$40/carats for a parcel of Akwatia diamonds, more than twice the valuation placed on the stones by the PMMC. During 1992, the stones were valued at an average price of about \$35 per carat. The Government announced that it was launching an investigation into

the past marketing practices of the PMMC. The implications of past undervaluation of the Akwatia diamonds were significant. Higher past revenues to the mine would have allowed the purchase of much needed equipment and spare parts for the mill and mining machinery. The original rehabilitation feasibility study, based on undervalued future production, was now in need of revision.

Exploration interest in diamonds in Ghana was concentrated along the Birim River. Canadian companies Cornucopia Resources Ltd., Teryl Resources, and Nora Exploration all were involved with diamond concessions in this area. Work by all three companies in 1992 was at a preliminary level.

Notwithstanding the new marketing arrangement for Akwatia's production, the PMMC continued to purchase artisanal output, save that from tribute operations at Akwatia. PMMC purchases amounted to 479,874 carats in 1992, an artificial 11% decline; the purchases would have shown a net 5% increase had the Akwatia tribute diamonds been purchased.

### Mineral Fuels

Ghana became a crude oil producer again in 1992, although only on a small-scale and on a test basis. About midyear, GNPC completed west Africa's (and Ghana's) first horizontal drill hole. The hole was in the offshore South Tano Field 32 km south of Half Assini. Test production of oil was removed from the drill ship by tanker. Data for the total output for the year were unknown but production was reported to have reached 6,000 bbl/d by yearend. The GNPC plans a second horizontal hole for the same field. The GNPC had planned to develop the South and North Tano Fields for natural gas, but would welcome oil production if warranted. Natural gas is to be used to fire a powerplant at Half Assini; this would require a minimum flow of 1.4 Mm<sup>3</sup>/d. GNPC also was considering restarting oil production at the old offshore Saltpond Field.

### Reserves

GBC claims that it has about 30 years of bauxite reserves in the present ore body being exploited at the Awaso Mine, and reserves in other ore bodies nearby adequate to support a total mine life of 100 years. Mining plans call for an increase in output to 500,000 mt/a, to be doubled eventually. As reported in detail by the director of the Ghana Geological Survey Department,<sup>2</sup> Ghana has significant undeveloped bauxite resources, most notably the unmined portions of the Sefi-Bekwai deposits of the Awaso area, the Aya-Nyinahin deposits about 60 km west of Kumasi, and those in the Atewa Range near Kibi. These have been extensively drill sampled. GBC likely has access to most of the Sefi-Bekwai deposits. The Aya-Nyinahin drill-delineated bauxite inventory totals 278 Mmt grading 48.9% to 51% alumina and 2.8% to 4.4% silica. The Kibi area bauxite resource totals 120 Mmt grading 40.8% to 45.7% alumina and 1.8% to 3.9% silica.

Ghana has large gold reserves, although the summation of such from the existing mines and advanced projects is made difficult by differences in reserve reporting methods used by the different companies. A conservative estimate, excluding resources at the idle Southern Cross Mine, of proven plus probable reserves in Ghana would be about 610,000 kg. Of this, 44% is accounted for by the Ashanti Mine. However, the Ashanti Mine has additional gold resources totaling about 290,000 kg, a significant percentage of which will likely be upgraded to reserve status in the future. This inventory dwarfs the presently known resources of the other mines. Ghana's total gold resources are undoubtedly much larger than exist at the present mines, based on the known extent of host rocks, the widespread artisanal production of gold, and the encouraging results of a number of ongoing exploration programs. In addition, there remain a number of closed old mines, many of which shut down without having depleted their gold resources and which have not yet been evaluated under a current economic scenario.

Although several manganese deposits are known in Ghana, the only large established reserves are at the Nsuta Mine. Current ore reserves at the Nsuta Mine have not been published, although it is believed that the mine has reserves of oxide ore of approximately 1.0 to 1.5 Mmt, sufficient for about 10 more years of production at 1992 levels. Direct-shipping carbonate ore reserves calculated in 1964 by the Ghana Geological Survey Department were listed as about 17 Mmt grading 31% manganese. Remaining reserves of carbonate ore are likely adequate for 50 to 60 years of production at current levels.

Ghana's diamond resources are large, based on known reserves at the Akwatia Mine and the widespread artisanal production of diamonds. The low- and high-terrace gravel deposits that have accounted for almost all of the Akwatia Mine's historic output are now virtually exhausted. Future production from the mine will be from gravels along the Birim River. The proven reserves in these gravels were delineated by the UN during a drilling program from 1980 to 1983; according to GCD, the reserves amount to about 15 Mm<sup>3</sup> grading about 1.1 carats/m<sup>3</sup>. However, because of access difficulties in marshy areas, the UN drilling program was restricted to only about one-half of the area of interest. It is believed that the true reserves amount to about twice those determined by the UN.

Ghana's oil and gas resources are not well known, although ongoing drilling programs were testing resources in a couple of fields. As of yearend 1992, virtually all of Ghana's oil production had been from the offshore Saltpond Field, which produced approximately 3.8 Mbbl of oil during about a 7-year period ending in 1985. The field was shut down in 1985 because of low pressures and other production difficulties. The field's original reserves, as indicated by the Government, were approximately 8.9 Mbbl. Earlier tests of the South Tano Field indicate that oil resources there may total about 82 Mbbl, although recovery would be difficult. Test production was under way during the latter half of 1992, but results had not been announced by

yearend. Work was ongoing to better delineate the natural gas reserves of this field, although they are estimated at about 2.8 billion m<sup>3</sup>. The North Tano Field's recoverable gas resources have been estimated at about 1.7 billion m<sup>3</sup>.

## INFRASTRUCTURE

Ghana's road, railing, and electric power infrastructure is concentrated in the south and southwestern part of the country. This is largely an outcome of these regions having the bulk of the country's population and resources.

In 1992, Ghana's road network amounted to about 32,000 km, of which about 20% was paved. Many of Ghana's paved roads were in poor condition, although the Government was improving some of the more heavily used stretches. The major rivers and Lake Volta provide about 1,400 km of navigable waterways. Ghana has 953 km of 1.067-m-gauge railroad forming an A-shaped network linking the ports of Takoradi and Tema with Accra and Kumasi. There is an important branch line to the Awaso Mine. By the early 1980's, the entire railroad network had deteriorated severely. Rehabilitation work started in the late 1980's, with priority being given to the western line, which is the export route for the country's manganese ore and bauxite production and serves the major gold-producing area. As of yearend 1992, significant improvements had been made to the western line; however, the eastern and central lines remained in poor condition, and the entire system continued to suffer from a shortage of railing stock. All railing was by the Ghana Railway Corp., which transported an estimated 850,000 tons of freight in 1990, the largest tonnage railed in a decade. About 80% of this was ore and cement. Railing data for 1991 and 1992 were unavailable.

Ghana's major ports are Takoradi and Tema, each of which can handle ships up to about 30,000 dwt. All of the country's manganese ore and bauxite shipments are from Takoradi. Ore shiploading capacity at Takoradi was being renovated by GNMC and GBC and was estimated to be about 350,000 mt/a for manganese ore

and about 400,000 mt/a for bauxite. However, the bauxite loading facilities were being expanded to handle a near-term shipping goal of 500,000 mt/a and a long-term export goal of 1 Mmt/a. VALCO has its own berth at Tema for offloading alumina and other inputs to its reduction plant and for loading aluminum ingot. The facility can offload alumina at a rate of 500 mt/h and has storage facilities for 75,000 tons of alumina and 22,500 tons of petroleum coke.

In 1991, the latest year for which data were available, Ghana's electrical generating capacity was reported to be 1,185 MW, of which 1,072 MW was from hydropower, installed in the Akosombo Dam (912 MW) and the Kpong Dam. Ghana reportedly produced 4,140 GW·h in 1991. Production is expected to decline in the next few years owing to retrofitting the turbines at Akosombo. The scheduled reductions are not expected to hurt VALCO's output of aluminum; VALCO typically consumes about 60% of Ghana's total electrical output. Excess beyond domestic sales has traditionally been sold to Togo, Benin, and Côte d'Ivoire. These exports have typically totaled 500 to 800 GW·h/a. Electricity consumption by Ghana's mines has, in recent years, averaged about 400 GW·h/a. The major mines all are connected to the national grid, but most have backup oil- or wood-fired generators. Ghana's domestic grid is being rehabilitated and expanded. The grid was extended to the northern part of the country in 1989 and has been further extended in this region since. It was likely that the country's existing hydroelectric powerplants would be inadequate to meet the demand from the expanded grid and generating capacity was to be supplemented with new thermal plants, especially a natural gas-fired unit on the southwest coast. Despite the use of electricity, more than 70% of the country's cooking and heating energy needs were met through burning wood. In an effort to reduce wood consumption, and thus slow the cutting of the country's rainforests, the Government was encouraging the use of LPG for cooking purposes. The Tema Oil Refinery used to

flare gas, but started selling part of its gas output as LPG in 1989. In 1991, LPG consumption in Ghana was reported to have been 116 Mbbl, almost twice the level of that in 1990; data were unavailable for 1992.

## OUTLOOK

Gold is likely to remain Ghana's main primary mineral export and unless cash crop prices and production levels improve, should remain the country's single most important export for the near future. Gold production should increase significantly, with major contributions to the increased output coming from the Ashanti, Teberebie, Bogosu, and Iduapriem Mines. Based on current production forecasts for these mines and developments at other mines and advanced prospects, total formal gold output could approach 50,000 kg by 1996. Long-term production at or near this level will depend on the ability of the Ashanti Mine to sustain its targeted output levels beyond 1996, and will likely require the bringing on-stream of significant new production at other mines. The lackluster gold prices experienced since 1988 have begun to erode the available financing for new exploration projects in Ghana, which could limit future discoveries. Also of concern to Ghana is the dilution of interest in the country as international companies begin to expand their exploration interests to other geologically favorable countries in west Africa. A possible mitigating factor is the increasing interest in Ghana by mining companies from the Republic of South Africa.

Ghana's diamond output is expected to increase significantly in the near term, if the planned rehabilitation and expansion of the Akwatia Mine can be financed. Unless major new deposits are found, Ghana's manganese production is expected to stagnate or decline. Ghana has the potential to increase its exports of bauxite through the expansion of output from the Awaso Mine. The development of new deposits, however, is considered unlikely in the near future because of the modest grades of the known undeveloped

deposits and because of inadequate infrastructure.

There is good potential for Ghana to produce modest quantities of natural gas and crude petroleum for domestic use. However, there appears to be little potential to develop exportable quantities of these mineral fuels.

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<sup>1</sup>Where necessary, values have been converted from Ghanaian cedis (C) to U.S. dollars at a rate of C437=US\$1.00.

<sup>2</sup>Kesse, G. O. The Mineral and Rock Resources of Ghana; A.A. Balkema, Rotterdam, 1985, 610 pp.

#### **OTHER SOURCES OF INFORMATION**

Geological Survey Department

P.O. Box M.80

Accra, Ghana

Minerals Commission

P.O. Box M. 248

Accra, Ghana

The Ghana Chamber of Mines

P.O. Box 991

Accra, Ghana

Precious Minerals Marketing Corporation

P.O. Box M.108

Accra, Ghana

TABLE 1  
GHANA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

Commodity <sup>2</sup>	1988	1989	1990	1991 <sup>3</sup>	1992 <sup>3</sup>
<b>Aluminum:</b>					
<b>Bauxite:</b>					
Gross weight metric tons	284,500	347,065	381,273	380,000	450,000
Sales do.	299,939	374,646	368,659	<sup>3</sup> 324,313	<sup>3</sup> 399,155
Metal, smelter, primary do.	161,392	168,581	174,241	<sup>3</sup> 175,437	<sup>3</sup> 179,930
Arsenic, trioxide do.	—	—	—	500	4,500
Cement, hydraulic <sup>4</sup> thousand metric tons	<u>477</u>	<u>565</u>	<u>675</u>	<u><sup>3</sup>750</u>	<u><sup>3</sup>1,024</u>
<b>Diamond:</b>					
Gem <sup>5</sup> thousand carats	<sup>1</sup> 495	<sup>1</sup> 395	<sup>1</sup> 520	<sup>1</sup> 560	570
Industrial <sup>5</sup> do.	<sup>1</sup> 125	<sup>1</sup> 99	<sup>1</sup> 130	<sup>1</sup> 140	140
Total <sup>6</sup> do.	<u><sup>6</sup>620</u>	<u><sup>6</sup>494</u>	<u><sup>6</sup>650</u>	<u><sup>6</sup>700</u>	<u><sup>6</sup>710</u>
Gold <sup>7</sup> kilograms	11,601	13,358	16,840	<sup>3</sup> 26,311	<sup>3</sup> 31,032
<b>Manganese:</b>					
Ore and concentrate, <sup>8</sup> gross weight metric tons	259,614	279,210	246,869	<sup>3</sup> 319,727	<sup>3</sup> 276,019
Mn content <sup>8</sup> do.	<u>97,000</u>	<u>110,000</u>	<u>96,000</u>	<u><sup>1</sup>120,000</u>	<u>106,000</u>
<b>Petroleum, refinery products:</b>					
Gasoline thousand 42-gallon barrels	1,207	1,233	808	1,200	1,200
Jet fuel do.	200	200	200	200	200
Kerosene do.	826	1,108	736	1,000	1,000
Distillate fuel oil do.	2,163	1,716	1,567	1,700	1,700
Residual fuel oil do.	446	466	480	500	500
Other <sup>9</sup> do.	285	345	391	400	400
Refinery fuel and losses <sup>9</sup> do.	300	300	280	300	300
Total <sup>9</sup> do.	<u>5,427</u>	<u>5,368</u>	<u>4,462</u>	<u>5,300</u>	<u>5,300</u>
Salt <sup>9</sup> metric tons	50,000	50,000	50,000	50,000	50,000
Silver, Ag content of gold ore <sup>9</sup> kilograms	580	<sup>6</sup> 670	840	1,315	1,550
Steel, semimanufactures <sup>9</sup> metric tons	6,500	17,500	25,500	<sup>2</sup> 27,000	25,000

<sup>1</sup>Estimated. <sup>2</sup>Revised.

<sup>3</sup>Table includes data available through Sept. 30, 1993.

<sup>4</sup>In addition to the commodities listed, a variety of crude construction materials (clays, sand and gravel, and stone) are produced, but output is not reported. Crude oil production resumed on a test scale in 1992, but data on total production were unavailable.

<sup>5</sup>Reported figure.

<sup>6</sup>All from imported clinker.

<sup>7</sup>Gem versus industrial diamond breakdown has been revised to reflect the value of near-gem material, classified as industrial prior to 1991, but which was ultimately being sold for well above industrial prices.

<sup>8</sup>Production includes that of Akwatia Mine (1988—225,200 carats; 1989—134,030 carats; 1990—151,627 carats; 1991—145,887 carats; 1992—214,155 carats), PMMC purchases of artisanal production (1988—34,231 carats; 1989—151,606 carats; 1990—484,876 carats; 1991—541,849 carats), and estimates of smuggled artisanal production.

<sup>9</sup>Does not include estimate of smuggled production.

<sup>10</sup>Manganese ore production for 1988 is processed ore output reported by Nsuta Mine. Production for 1989 is the reported mine production minus carbox fines, which were unsalable.



TABLE 2  
GHANA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Aluminum		Volta Aluminum Co. Ltd. (VALCO) (Kaiser Aluminum & Chemical Corp., 90%; Reynolds Metals Corp., 10%)	Aluminum smelter at Tema	200. <sup>1</sup>
Bauxite		Ghana Bauxite Co. Ltd. (Government, 55%; British Alcan Chemicals Ltd., United Kingdom, 45%)	Bauxite mine at Awaso	500.
Cement		Ghana Cement Works Ltd. (Government, 75.5%; Scancem International ANS, Norway, 24.5%)	Clinker grinding plants at Takoradi and Tema	800.
Diamond	thousand carats	Ghana Consolidated Diamonds Ltd. (Government, 100%)	Placer mine at Akwatia	200.*
Gold	kilograms	Ashanti Goldfields Corp. (Ghana) Ltd. (Government, 55%; Lonrho Plc, United Kingdom, 45%)	Underground and surface mine at Obuasi	20,000.
Do.		Billiton Bogosu Gold Ltd. (Billiton International Metals B.V., Netherlands, 81%; IFC, 9%; Government, 10%)	Open pit mine at Bogosu	3,000.
Do.		Bonte Gold Mining Ltd. (Akrokeri-Ashanti Gold Mines, Inc., Canada, 90%; Government, 10%)	Placer mine at Esase, about 40 kilometers southwest of	175.*
Do.		Ghana Australian Goldfields Ltd. (Golden Shamrock Mines, Ltd., Australia, 68.95%; Government, 20%; IFC, 10%; private shareholders, 1.05%)	Iduapiem open pit mine near Tarkwa	4,050.
Do.		Goldenrae Mining Co. (Roan Selection Trust Overseas S.A., 85%; Government, 10%, Akyem Abuakwa Development Fund, Ghana, 5%)	Placer mine at Kwabeng, 16 kilometers north of Kibi	560.*
Do.		State Gold Mining Corp. (Government, 100%)	5 gold dredges near Dunkwa	200.
Do.		do.	Underground mine at Prestea	600.
Do.		do.	Underground mine at Tarkwa	900.
Do.		Teberebie Goldfields Ltd. (Pioneer Group Inc., United States, 90%; Government, 10%)	Open pit mine near Tarkwa	4,050.
Manganese ore		Ghana National Manganese Corp. (Government, 100%)	Open pit mine at Nsuta	300.*
Steel		Steelworks Co. subsidiary of Ghana Industrial Holdings Co. (Government, 100%)	Steel mill at Tema	2.5 (rebar).
Do.		Wahome Steel Ltd. (private Taiwanese investors, 95%; Ghanaian investor, 5%)	do.	30 (rod, rebar, and wire).
Petroleum products	thousand barrels	Tema Oil Refinery (Government, 100%)	Refinery at Tema	10,600 (crude input).

\*Estimated.

<sup>1</sup>Based on five potlines. Operational capacity in 1992 was 180,000 tons.

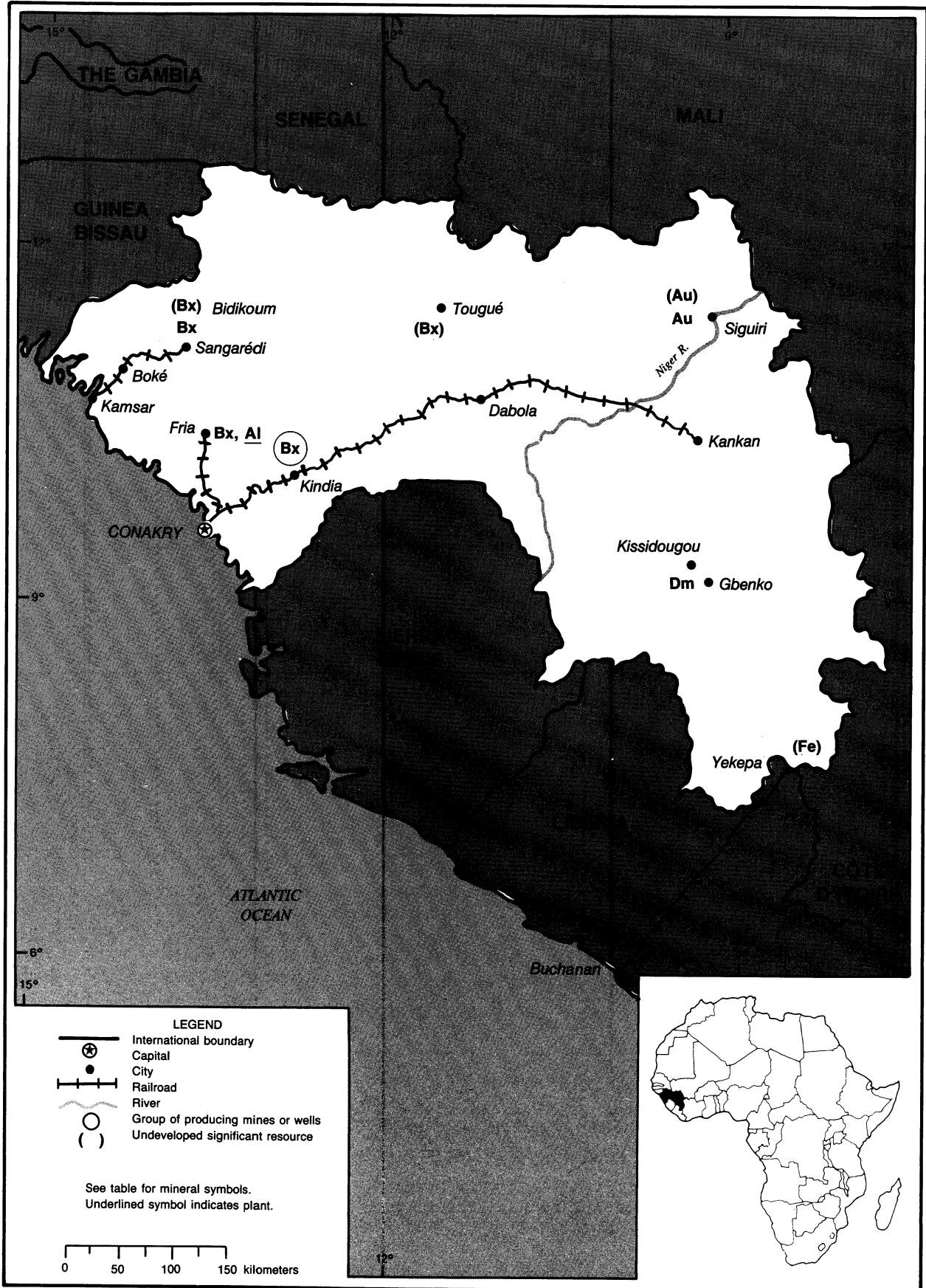


*George Cappendell Shaft Ashanti Mine, Ghana.*

# GUINEA

AREA 245,860 km<sup>2</sup>

POPULATION 7.5 million



## THE MINERAL INDUSTRY OF

# GUINEA

By David Izon

In 1992, Guinea was second only to Australia in production of bauxite and has the largest known bauxite deposits in the world. Sales of three main commodities—bauxite, diamond, and gold—account for more than 98% of all mineral sales in the country. The minerals sector accounted for about 25% of the GDP of about \$3 billion in 1992. The main foreign exchange earners, alumina and bauxite, accounted for more than 80% of all mineral exports, and mineral exports accounted for more than 90% of the country's total exports. Production of bauxite and diamonds declined sharply, and the only gold mine in the country was closed in August 1992. Production of bauxite declined in 1992 owing to a generally depressed aluminum market. Plans by the Government to coordinate artisanal production and trade in diamonds have not come to fruition. However, artisanal gold production continued and was partially accounted for because the Central Bank bought back gold at 50% of market price.

The future of the MIFERGUI-Nimba iron ore mining project was not certain owing to delays stemming from lack of financing and inadequate infrastructure. Another major factor affecting the project was the civil insurgencies in Liberia.

The review of the country's investment code was reported to be in its final stages of completion. There was no significant change in investment patterns during 1992. Negotiations between the Government of Guinea and Iran to establish a new joint venture to develop the Tougue region bauxite deposits were completed in July 1992. This included the Dian Dian deposits.

### GOVERNMENT POLICIES AND PROGRAMS

The European Investment Bank (EIB) approved a \$10 million loan to finance a water supply project in Conakry. The project involved the extension and modernization of existing facilities, including the construction of a second treatment plant and two reservoirs. The EIB also approved a \$15 million loan for the expansion of electricity generation capacity in late 1992. Power supply problems are expected to be reduced with this project.

The current mining code was code No. 076/PRG of March 1986, as amended by orders (Nos. 10236-10245) issued October 22, 1988. The current investment code was that as adopted in code No. 001/PRG/87 of January 1987.

Previously adopted policies under the Government's structural adjustment program continued to be implemented particularly for revitalizing the economy. Other fiscal policies being implemented for the 1992-93 fiscal year were intended to diversify the mineral industry, particularly the Government's dependence on revenue and export earnings from bauxite mining. Efforts were under way to organize and supervise artisanal mining of diamond and gold. The current policy on diversification makes it mandatory for manufacturers to identify local resources to substitute imported materials. This policy has the potential for increased development and expansion of the industrial minerals sector.

### PRODUCTION

Production of minerals dropped in general; particularly sharp drops were reported for bauxite due to production

and equipment problems at Fria and Kindia. Diamond and gold production also dropped sharply in 1992. Mineral production was mainly from six mines, excluding quarries; four bauxite mines at Bidikoum, Fria, Kindia, and Sangarédi; one diamond mine; and a gold mine. Development and production of one of Guinea's potentially important minerals, the high-grade iron ore deposits at the Nimba Mountains, have been hindered by lack of adequate infrastructure, cost, and regional stability. (See table 1.)

### TRADE

The total value of mineral exports for 1991, the latest year for which data were available, was about \$1.05 billion. Estimated mineral export earnings for 1992 was about \$962 million. Value of alumina exports was about \$550 million, bauxite about \$376 million, diamond about \$25 million, and gold about \$11 million. Earnings from bauxite and alumina account for about 90% of mineral exports and 80% of Government revenue.

The minerals sector dominated exports as nearly all major minerals produced were sold in overseas markets. Other export commodities included palm kernels and other agricultural produce.

Revenue from sale of diamonds and gold do not include the value of smuggled artisanal production. Mineral exports to the United States were mainly bauxite. Guinea imported industrial machines, vehicles, construction materials, fertilizers, petroleum products, and pharmaceuticals from the United States. Principal trading partners were Australia, Cameroon, Canada, former U.S.S.R., France, Germany, Nigeria, Norway, Portugal, the United Kingdom, and the

United States.

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## STRUCTURE OF THE MINERAL INDUSTRY

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The mineral industry remained dominated by the production of bauxite by three companies, one of which was entirely state-owned. There was widespread artisanal production of diamond and gold for which official estimates were not available.

Guinea's labor force is estimated to be about 2.6 million workers, an estimated 20% of whom are in industry. Guinea's formal mining industry employed about 7,000 workers in 1992. About 78% of these were in the bauxite and alumina sector. The diamond and gold industries accounted for about 1,400 workers. Government policy encourages the training of Guinean staff to replace expatriates. The latter account for about 6% of the mining labor force. (See table 2.)

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## COMMODITY REVIEW

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### Metals

**Bauxite and Aluminum.**—The 5-Mmt decline in bauxite output was primarily due to equipment deterioration, the depressed aluminum market, and shortage of spare parts. In 1992, Friguia's production of alumina dropped slightly. Renovation activities continued at the plant. Employment figures as reported by the Ministry of Mines remained at the same level of 1,485 people, of which 32 were expatriates.

In 1992, Compagnie des Bauxites de Guinea's (CBG) bauxite production from the Sangarédi Mine was 11.032 Mmt, wet basis, with an aluminum ( $Al_2O_3$ ) content of 57.74%. A second mine was opened in Bidikoum for blending with the production from Sangarédi to prolong the life of the high-grade ore found in Sangarédi. Total exports from CBG operations for the year amounted to about 10.619 Mmt, dry basis, 95,780 tons of which was calcined, valued at about \$306 million. The Government's scheduled

phase-in of the Bidikoum deposit commenced in 1992. Of 2,517 employed at CBG, 17 were expatriates. Bauxite operations at Office des Bauxites de Kindia employed 1,841 workers, including 67 expatriates.

**Gold.**—Union Miniere, the principal company responsible for the operation of Aurifère de Guinée's (AuG) Koron Mine, pulled out in August 1992. The reason for closure of the mine was excessive operating cost and high annual losses. However, production at the time of the closure reached 1,113 kilograms valued at about \$11 million. AuG's total work force was 450, including 27 expatriates. However, artisanal production continued after the closure. The Government was renegotiating to reopen the mine with Union Miniere and its partners.

### Industrial Minerals

There was significant decline in production at Aredor<sup>2</sup> diamond mine in Gbenko in 1992. The decline may be attributed to widespread disruptions caused by illicit miners beginning in November and December of 1991 near Banankoro, a few km from the main plant at Aredor. Also, some of the mobile machinery was seriously damaged or destroyed during the disturbances, and operations were in areas that were of lower grade. In April 1992, production had reached 60% of the level prior to the disturbances. According to Bridge Oil Services (Overseas) Pty. Ltd. of Australia, a London-based company that operates the Aredor Mine in Guinea, production through December 1992 was 75,065 carats. There were no official estimates of artisanal production of diamond, but reports indicated that most was smuggled out of the country. The total value of diamonds produced in 1992 was about \$25.2 million. Aredor's work force also declined to 954. A total of 30 expatriates worked for Aredor.

### Reserves

Guinea's official estimates of total bauxite resources vary but are on the

order of 20 billion tons, and proven reserves were about 18 billion tons, according to Direction Generale de Geologie, Guinea. Reserves remaining at Sangarédi were about 175 Mmt grading between 50% to 60% alumina and 0.5% to 2%  $SiO_2$ . Reserves at Bidikoum were about 20 Mmt grading about 55% alumina. There were large additional deposits of lower grade ore in the area. Reserves at the Debelé deposit were about 28 Mmt grading about 45% to 46% alumina. Friguia's reserves were reported to be in excess of 200 Mmt grading about 40% alumina. Official reserve estimates for diamond and gold were not available but believed to be significant.

Iron ore reserves at the Nimba Mountains were estimated to be about 350 Mmt grading 66.5% iron. A number of other lower grade iron ore resources occur elsewhere in Guinea, but these are of little or no commercial value.

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## INFRASTRUCTURE

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The mining railroads totaled 239 km of standard-gauge 1.435-m line and 806 km of 1-m line. A 135-km standard-gauge 1.435-m line linked the Sangarédi Mine with the Port of Kamsar, and a 104-km standard-gauge line linked the Kindia Mine with Conakry. A 145-km, 1-m line linked the Fria Mine with Conakry. In addition to the mine railroads, there was 661 km of 1-m-gauge line linking Conakry with Kankan that has been in very poor condition but which was undergoing rehabilitation with French assistance.

Guinea has two main ports: Kamsar and Conakry. Kamsar serves the Sangarédi Mine, handling only bauxite shipments. Conakry serves the Fria and Kindia Mines and is also the country's main general cargo port. The country has 1,280 km of navigable waterways, which provide an adequate source of hydroelectric power for future demand.

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## OUTLOOK

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Bauxite and alumina should continue to dominate the economy of Guinea. The addition of the Bidikoum Mine is

expected to prolong the life of the quality of bauxite ore produced in the country. Friguia's production capacity of alumina should increase as renovations and expansions are completed. Projects requiring major hydroelectric power such as the proposed aluminum smelter could become technically feasible as the power generation capacity is increased under current plans.

Guinea's formal diamond and gold industries may collapse if adequate exploration programs are not undertaken to secure continued production at current levels. The MIFERGUI-Nimba iron ore project will likely remain dependent upon a solution to Liberia's civil war.

<sup>1</sup>Where necessary, values have been converted from Guinean francs (GF) to U.S. dollars at the rate of GF825=US\$1.00, which was the exchange rate for Dec. 1992.

<sup>2</sup>"Aredor" is an acronym for Association pour la Recherche l'Exploitation du Diamants et de l'Or. Aredor Holdings Ltd. is a consortium of Australian companies Bridge Oil Ltd., 79.2%; and Bankers Trust Australia (United Kingdom) Ltd., 3.52%; Industrial Diamond Co. (Holdings) Ltd. (United Kingdom), 6%; and the International Finance Corp., 11.28%.

#### OTHER SOURCES OF INFORMATION

Ministry of Natural Resources and the Environment  
P.O. Box 295  
Conakry, Guinea

TABLE 1  
GUINEA: PRODUCTION OF MINERAL COMMODITIES<sup>1 2</sup>

(Thousand metric tons unless otherwise specified)

Commodity	1988	1989	1990	1991	1992
<b>Alumina:</b>					
<b>Production:</b>					
Hydrate	593	627	642	640	601
Calcined	589	619	631	610	561
Shipments, calcined	593	624	631	610	553
<b>Bauxite:</b>					
<b>Mine production:</b>					
Wet basis <sup>3</sup>	17,859	17,547	17,524	17,184	12,357
Dry basis <sup>4</sup>	16,073	15,792	15,772	15,466	11,121
Calcined <sup>5</sup>	130	143	140	132	96
<b>Shipments (dry basis):</b>					
Metallurgical	14,661	14,886	13,968	13,533	11,033
Calcined	136	136	133	92	95
<b>Diamond:<sup>6</sup></b>					
Gem <sup>*</sup> thousand carats	136	137	119	91	90
Industrial <sup>*</sup> do.	10	10	8	6	5
Total do.	146	147	127	97	95
Gold <sup>7</sup> kilograms	2,000	2,120	6,340	4,453	2,113

<sup>\*</sup>Estimated. <sup>7</sup>Revised.

<sup>1</sup>In addition to the commodities listed, modest quantities of crude construction materials (clays, sand and gravel, and stone) presumably are produced, but output is not reported quantitatively, and available information is inadequate to make reliable estimates of output levels; commodity includes data available through Apr. 5, 1993.

<sup>2</sup>All figures were reported by Bureau de Stratégie et de Marketing Minier of Guinea.

<sup>3</sup>Metallurgical plus calcinable ore estimated at 13% H<sub>2</sub>O.

<sup>4</sup>Data are for wet-basis ore estimated at 13% H<sub>2</sub>O, reduced to dry basis estimated at 3% H<sub>2</sub>O.

<sup>5</sup>Data are for Compagnie Bauxite de Guinée, the sole producer of calcined bauxite.

<sup>6</sup>Figures do not include undocumented artisanal production believed smuggled out of the country.

<sup>7</sup>Figures include undocumented artisanal production. Audifere de Guinea (AuG) is the only reporting gold mining company, reporting the following, in kilograms: 1988—324; 1989—1,202; 1990—1,745; 1991—1,453; and 1992—1,113.

TABLE 2  
**GUINEA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992**

(Million metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Bauxite and alumina	Compagnie des Bauxites de Guinée	Sangarédi Mine, about 242 kilometers north of Conakry. Drying and shiploading facilities are at Kamsar, 160 kilometers northwest of Conakry	12.2 bauxite.
Do.	Société d'Economie Mixte Friguia	Fria Mine and Kimbo alumina plant are at Fria, 75 kilometers north of Conakry	2.5 bauxite, .7 alumina.
Do.	Offices des Bauxites de Kindia	Kindia Mine (Debele deposit) at Kindia, about 110 kilometers northeast of Conakry	3 bauxite.
Diamond	carats	Société Mixte Aredor Guinée S.A. <sup>1</sup>	200,000.
Gold <sup>2</sup>	kilograms	Aurifère de Guinée	2,000.

<sup>1</sup>"Aredor" is an acronym for Association pour la Recherche l'Exploitation du Diamants et de l'Or. Aredor Holdings Ltd. is a consortium of Australian companies Bridge Oil Ltd., 79.2%; and Bankers Trust Australia (United Kingdom) Ltd., 3.52%; Industrial Diamond Co. (Holdings) Ltd. (United Kingdom), 6%; and the International Finance Corp., 11.28%.

<sup>2</sup>The Koron Mine was closed in Aug. 1992, but negotiations are under way to reopen the mine under a new contract.

**BAUXITE LOADED INTO RAILROAD CARS AT THE SANGARÉDI MINE**



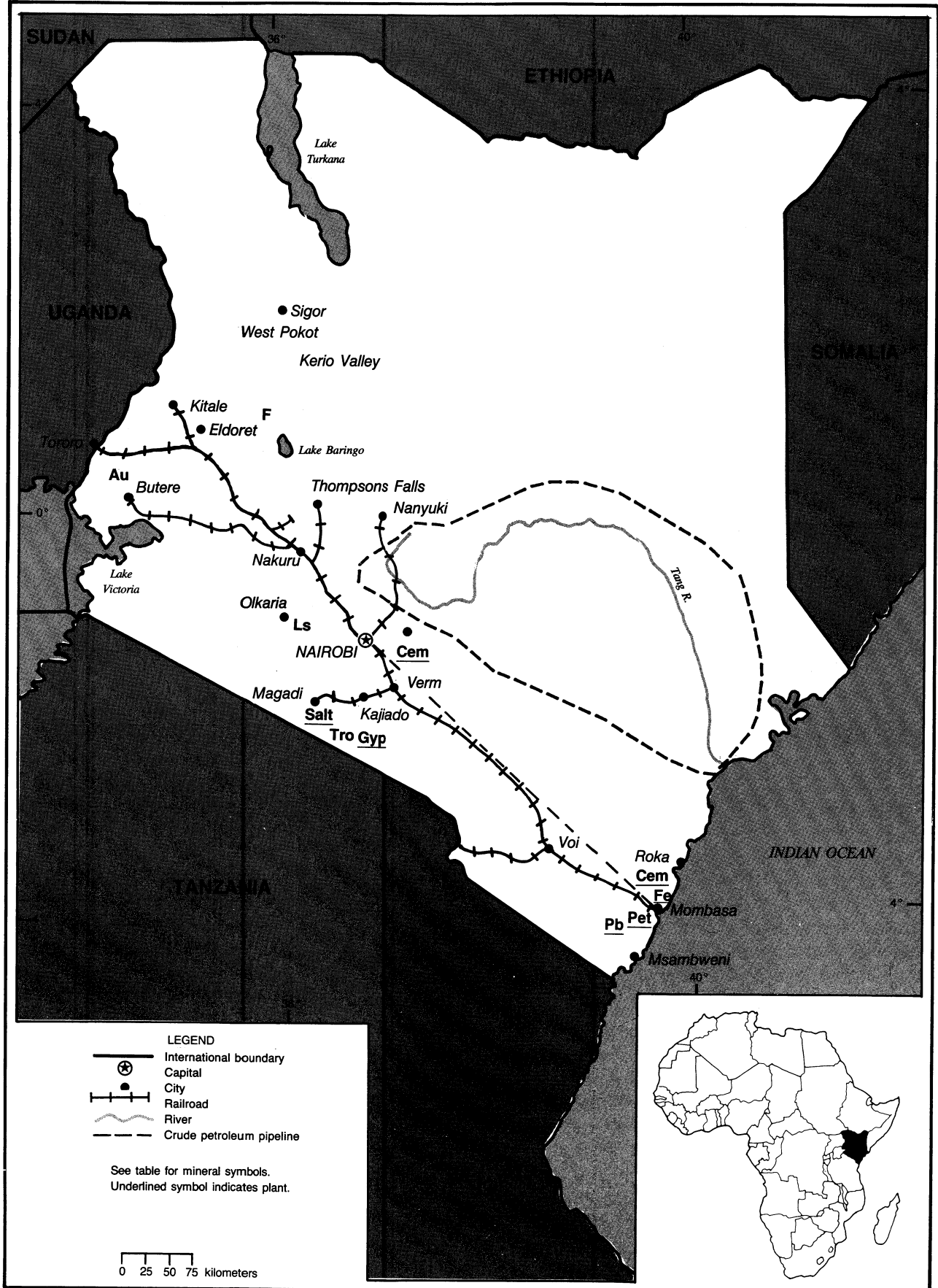




# KENYA

AREA 582,650 km<sup>2</sup>

POPULATION 26.2 million



## THE MINERAL INDUSTRY OF

# KENYA

By David Izon

Kenya depended largely on agricultural exports and tourism in 1992. The mineral industry played no major role in the mineral economy of the country. The industry accounted for less than 1% of the country's GDP of \$9.7 billion<sup>1</sup> in 1992. Major mineral commodities produced were trona (soda ash), fluorspar, and salt, accounting for about 85% of total mineral production. Kenya has limited mineral resources, but existing mineral industry was considered a well-developed industry for eastern Africa.

The country's new investment code permitted several European and Canadian mining groups to begin prospecting for gold and other mineral resources. Initial indications depicted reasonably good prospects for mining some gold deposits by open pit methods. However, it is highly unlikely that any of the deposits would be commercially viable within the next few years. Similar results could be expected of kaolin deposits at Gathita and Karundu, north of Nairobi. The reserves of the above deposits were estimated at 10 Mmt for Gathita and 5 to 10 mt for Karundu. Also, development of other mineral-bearing rocks in the Kadijo district may not come to fruition as early as desired. Petroleum products could become an important foreign exchange earner as the Government considered building a second refinery with Iran as joint-venture partner.

Investments made in Kenya were guaranteed under section 75 of the country's Constitution. This allowed for repatriation of after-tax profit and also allowed for profits to be retained that have not been capitalized.

### GOVERNMENT POLICIES AND PROGRAMS

The Government carried out a variety of tax reforms to give incentives to investors. Among such incentives were encouragement of firms to invest more using rebates rather than pay higher dividends, reduction of the corporate tax from 45% to 35%, and cutting the withholding tax from 15% to 10%. These were aimed at giving Kenya a competitive edge over its neighbors and increasing investment and employment opportunities for Kenyans. Personal income tax rates were also reduced, top rates dropping from 65% to 40%. The country's financial institutions were to be restructured to provide assistance in management and finance to small-scale businesses. Other fiscal policies included relocation of industries and commercial activities from urban areas to smaller towns.

The International Development Corp. provided \$23 million for the Government to restructure its parastatals. This would involve privatizing at least 20 out of 207 parastatals. The program was aimed at improving the efficiency, profitability, and accountability of the remaining parastatals. Under this program the Government also would phaseout subsidies, remove political interference, and establish a modern stock exchange. Kenya's economic program for 1992-93 called for activities that encouraged growth, reduced inflation and the deficit, and built up foreign reserves for the country.

The Government continued with policies that allowed investors to deduct all foreign exchange losses on their investments. Investors in cities such as Nairobi and Mombassa were allowed an

investment allowance of 35% on plant, machinery, and buildings. Rural investors were allowed 85%, and manufacturers were allowed 100% investment allowance.

### PRODUCTION

Major minerals and mineral materials produced in 1992 were cement, fluorspar, salt, and trona. Production capacity of trona was increased by 10% in 1992. However, in May 1992, Magadi Soda Ash Co. was temporarily shut down because of low demand from major buyers in the Far East. Production of salt declined in 1992. (*See table 1.*)

### TRADE

In 1992, Kenya's major mineral exports were limited to fluorspar, trona (soda ash), and salt. These contributed insignificantly to the GDP. However, export earnings from petroleum products were a source of major contribution to Government revenues. Kenya, on the other hand, spent a large portion of its export earnings on importation of oil for its refinery operations at Mombassa. Petroleum products were mainly exported to neighboring east and southern African countries, particularly Rwanda, Uganda, and Zaire.

The main trading partners were France, Germany, Italy, Japan, the United Kingdom, the United States, and neighboring African countries. Imports from the United States were mainly iron and steel, medicinal and pharmaceutical products, machinery and transport equipment, phosphate rock, and processed nonferrous minerals. Crude petroleum was imported mainly from the Middle East.

## STRUCTURE OF THE MINERAL INDUSTRY

The Government owned at least 51% of all mining companies, including the cement plants and oil refinery. Magadi Soda Co. PLC, which was acquired by Penrice Soda Products of Australia in June 1991, operated as Magadi Soda Ash in 1992. Under the new agreement, Magadi Soda Ash maintained its interest and the new parent company retained all employees. (See table 2.)

## COMMODITY REVIEW

### Industrial Minerals

**Cement.**—Bamburi Portland Cement Co. Ltd. and The East African Portland Cement Co. accounted for production of all limestone. Gypsum is produced by Athi River Mining Ltd. Total cement output was estimated at 1.3 Mmt at yearend 1992. The Government made plans to expand the cement plant at Athi River and replace necessary equipment with energy saving devices. Plans were also under way for the construction of a third cement plant by Lonrho at Koru in the Nyaza Province of western Kenya. About 20% of all cement produced was sold to Tanzania and Uganda.

**Soda Ash.**—Soda Ash (trona) continued to be one of the most important mineral commodities produced in Kenya in terms of value in 1992. Value of export earnings from soda ash was estimated at \$1.2 million in 1992. Magadi Soda was operated as Magadi Soda Ash after it was acquired in 1991. Despite the hiatus in May 1992 of operations at Magadi Soda Ash, production increased slightly above 1991 levels. The new owners of Magadi Soda Co. PLC, Penrice of Australia and the Government, planned to increase output to about 300,000 mt/a by 1995. The Magadi operation was also Kenya's largest source of crude salt.

### Mineral Fuels

Exploration activities in Kenya for crude petroleum have not been fruitful. However, petroleum products refined at Mombasa contributed significantly to Government revenues in 1992. The Government of Kenya continued in its efforts to increase revenue from refinery products by seeking ways to attract foreign investment. Negotiations were under way with Iran to form a joint-venture partnership in building a second refinery at the port. Other areas of consideration included increasing the refinery capacity and making improvements to the refining process. Also, the oil residue cracking unit of the existing plant was to be modified to increase the range of petroleum products.

### Reserves

There were no officially reported reserve data.

## INFRASTRUCTURE

The railroad enters the country near Tororo, Uganda, passes through Nairobi, and terminates at the port city of Mombasa, connecting key mining cities and districts along the way. Transportation of petroleum products from Mombassa to Nairobi is primarily by pipeline. The Government of Kenya plans to extend the Mombasa-Nairobi pipeline to western Kenya to reduce road and rail transportation. The main seaport is at Mombassa. Plans were also under way to upgrade the port at Mombassa to world class standards.

## OUTLOOK

Kenya's stable political climate should be a plus for investors who are considering development projects in the country. Long-term industrial energy conservation programs coupled with the implementation of favorable investment codes could prove beneficial to the country in the future. Development of the port in Mombassa to world class status that could handle a large volume of cargo

and freight could increase Kenya's revenue base. Government policies that are directed toward projects that will improve mineral production, increase foreign earnings, and reduce the deficit are also expected to continue.

<sup>1</sup>Where necessary, values have been converted from Kenyan shillings (KSh) to U.S. dollars at the rate of KSh40.52=US\$1.00, which was the exchange rate for Dec. 1992.

## OTHER SOURCES OF INFORMATION

Permanent Secretary  
Ministry of Energy and Mines  
P.O. Box 30582  
Nairobi, Kenya

Mines and Geological Department  
Ministry of Environment and Natural Resources  
Nairobi, Kenya

TABLE 1  
KENYA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991 <sup>*</sup>	1992 <sup>*</sup>
Barite	48	210	105	100	100
Carbon dioxide gas, natural tons	5,182	5,231	5,622	<sup>3</sup> 4,156	<sup>5</sup> 5,600
Cement, hydraulic thousand tons	1,239	1,216	1,512	<sup>3</sup> 1,423	<sup>3</sup> 1,500
Clays, kaolin	42	—	—	—	—
Diatomite	712	783	944	<sup>3</sup> 787	<sup>3</sup> 900
Feldspar	—	1,112	1,290	1,200	1,200
Fluorspar (acid grade)	<sup>3</sup> 67,351	95,181	112,295	<sup>3</sup> 77,402	81,000
Gemstones, precious and semiprecious:					
Amethyst kilograms	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )
Aquamarine do.	97	99	117	110	100
Cordierite (iolite) <sup>o</sup> do.	20	10	10	10	10
Garnet do.	835	127	90	90	90
Ruby do.	1,420	36	201	200	<sup>3</sup> 200
Sapphire do.	1,390	37	20	20	20
Tourmaline do.	23	1	9	10	10
Gold, mine output, Au content do.	17	15	25	20	20
Gypsum and anhydrite	37,965	36,478	<sup>*</sup> 36,000	36,000	36,000
Lead: <sup>o</sup>					
Mine output, Pb content	562	—	—	—	—
Metal:					
Smelter	2,000	—	—	—	—
Refined	1,800	—	—	—	—
Iron and steel: Steel, crude thousand tons	20	19	20	20	<sup>2</sup> 20
Kyanite <sup>o</sup>	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )
Lime	27,326	32,167	13,941	<sup>1</sup> 14,000	14,000
Petroleum refinery products:					
Liquefied petroleum gas thousand 42-gallon barrels	300	320	330	300	300
Gasoline do.	2,920	3,087	2,856	2,850	2,800
Jet fuel and kerosene do.	3,285	3,587	3,391	3,300	3,300
Distillate fuel oil do.	4,015	4,190	4,202	4,200	4,200
Residual fuel oil do.	4,380	4,201	4,422	4,400	4,400
Other <sup>2</sup> do.	400	766	956	950	950
Total including refinery fuel and losses do.	15,300	16,151	16,157	16,000	15,950
Salt: Crude, rock	94,682	103,220	102,100	102,000	102,000
Sodium compounds, n.e.s.:					
Soda ash	220,000	240,880	244,480	245,000	245,000
Stone, sand and gravel:					
Calcareous:					
Coral thousand tons	1,352	1,427	1,650	1,600	1,600
Limestone do.	416	16	18	20	20
Sand, industrial (glass)	<sup>7</sup> 7,000	10,841	12,344	12,300	12,300
Shale	<sup>1</sup> 130,000	118,459	115,000	115,000	115,000
Vermiculite	3,707	2,436	2,655	2,600	2,600
Wollastonite	—	142	97	100	100

<sup>o</sup>Estimated. <sup>1</sup>Revised.

<sup>1</sup>Includes data available through Mar. 3, 1993.

<sup>2</sup>In addition to the commodities listed, various crude construction materials (other clays, sand and gravel, and stone) not presented in this table presumably are produced, but quantity is not reported, and available information is inadequate to make reliable estimates of output levels.

<sup>3</sup>Reported.

<sup>4</sup>Less than 1/2 unit.

<sup>5</sup>Refinery fuel losses were as follows, in thousand barrels: 1987—625; 1988—470; 1989—653; 1990—700; 1991—700; 1992—700.

TABLE 2  
KENYA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

(Thousand metric tons unless otherwise specified)

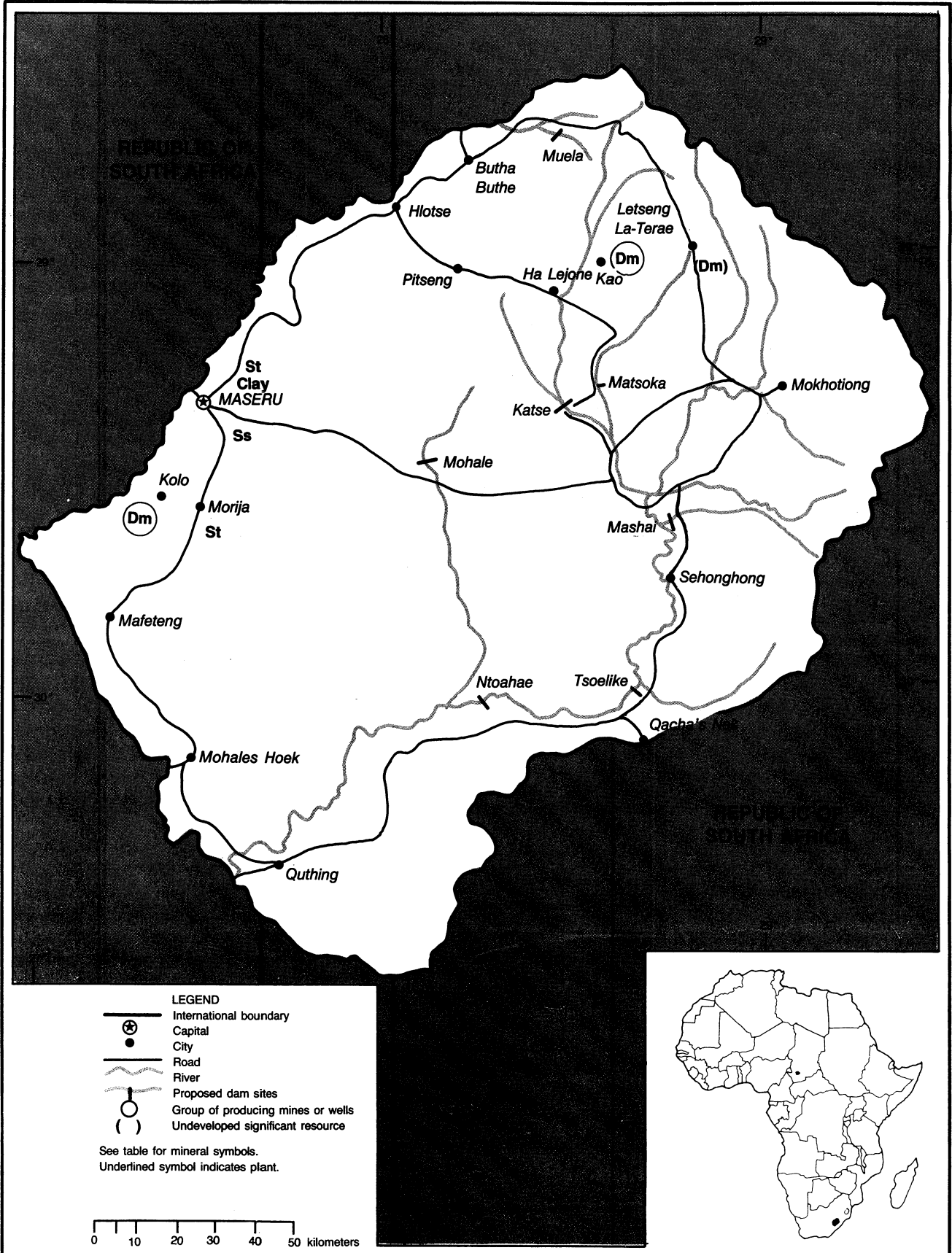
Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Cement	The East African Portland Cement Co. (Blue Circle Industries PLC, 71%; Government, 29%)	Athi River, 30 kilometers southeast of Nairobi	350
Do.	Bamburi Portland Cement Co. Ltd. (Cemential Holding AG (Blue Circle Industries plc, 71%; Government, 29%)	Mombasa	1,156
Flourspar	Kenya Flourspar Co. Ltd. (Government, 100%)	Eldoret mines: Kerio Valley, Eldoret, near processing plants: Kerio Valley; Eldoret	80
Gypsum and anhydrite	Athi Rivers Mining Ltd. (East African Portland Cement Co., 100%)	Nairobi mines: Senya, kajiado near processing plant: Athi River, Machakos District	2
Iron and steel	Kenya United Steel Co. Ltd. (E.A. Wire Industries Ltd., 81%, Government, 19%)	Mombasa	24
Soda ash	Magadi Soda Co. PLC (Penrice Soda Products of Australia, share unknown; Government, share unknown)	Magadi mines: Magadi, Kajiado, near processing plant: Lake Magadi 120 kilometers southwest of Nairobi	300
Salt	do.	do.	55



# LESOTHO

AREA 30,000 km<sup>2</sup>

POPULATION 1.8 million



## THE MINERAL INDUSTRY OF THE

# LESOTHO

By George A. Morgan

Output consisted almost entirely of gravel, sand, and stone for use in the local economy. Although the domestic mineral sector was relatively insignificant, the wages earned by about 100,000 Basotho miners in the coal and gold mines of the Republic of South Africa was the main source of foreign exchange. About 80% of the Basotho miners were concentrated in the area around Welkom, north of Bloemfontein in the Republic of South Africa. A small, unknown quantity of gem-quality diamond was produced by licensed diggers and exported. The mineral sector was estimated to account for less than 1% of a GDP of about \$420 million in 1990, the latest data available.<sup>1</sup>

The Lesotho Highland Water Project in the Maluti Mountains continued to be developed. The estimated \$4 billion project involves the construction of a series of reservoirs, tunnels, and dams to bring water to the vicinity of Johannesburg in the Republic of South Africa. Local gravel and crushed diabase are being used, and cement is imported for construction purposes.

Coal, limestone, phosphate, and uranium mineralization have been identified, but no development has occurred. Lesotho offers investors relatively low corporate tax rates of 15% and minimal controls on business operations. New investors enjoy a tax-free holiday for up to 15 years, free

access to foreign exchange, and the option to repatriate investment capital and a portion of earnings.

<sup>1</sup>Where necessary, values have been converted from Basotho maloti (M) to U.S. dollars at the rate of M2.56=US\$1.00.

### OTHER SOURCES OF INFORMATION

#### Agency

Department of Mines and Geology  
Ministry of Water, Energy, and Mining  
Maseru, Lesotho

#### Publication

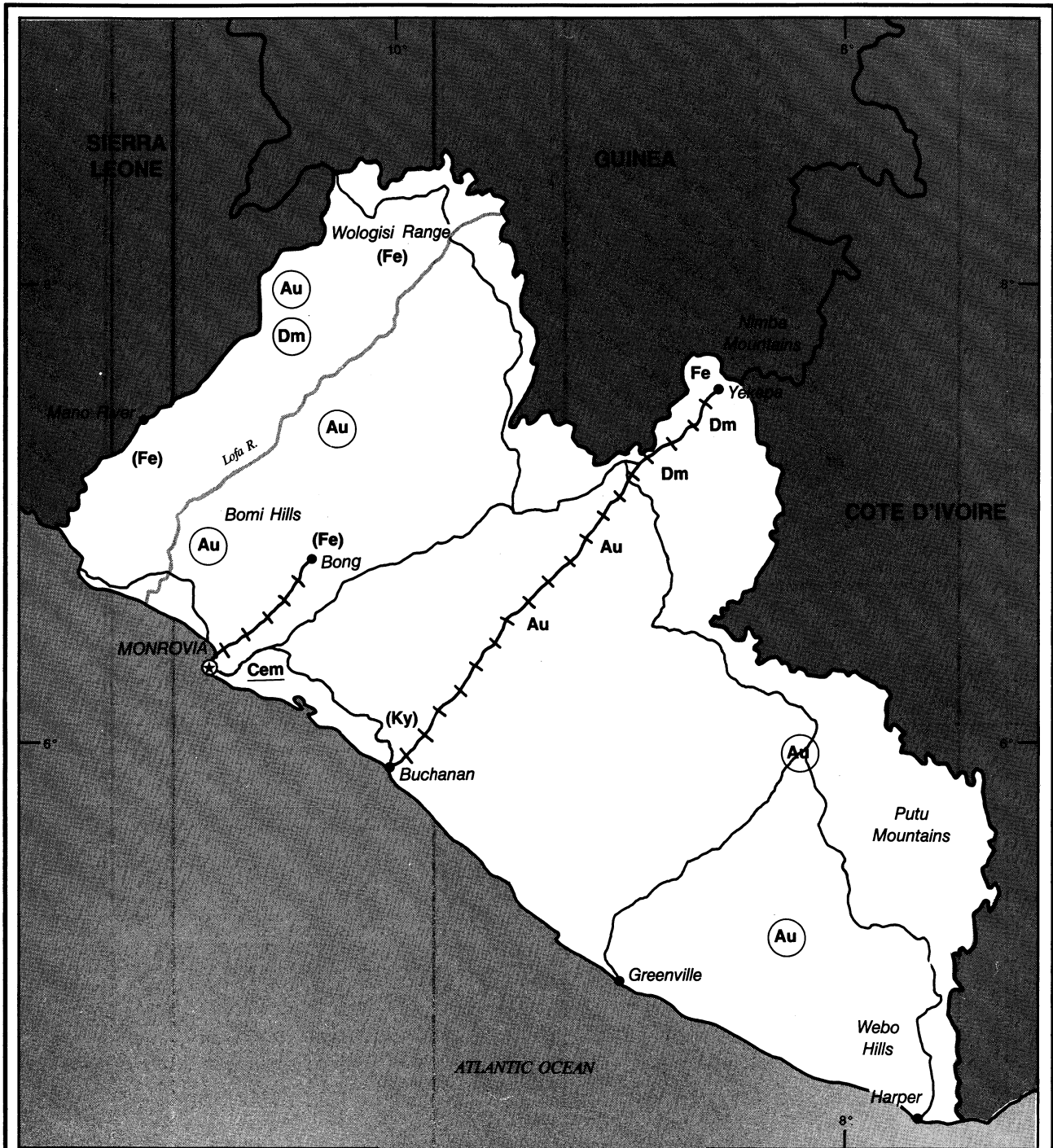
Department of Mines and Geology, Maseru:  
Annual Report of the Department of Mines  
and Geology.











# LIBERIA

AREA 111,370 km<sup>2</sup>

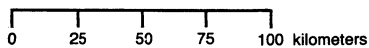
POPULATION 2.6 million



**LEGEND**

-  International boundary
-  Capital
-  City
-  Railroad
-  Road
-  River
-  Group of producing mines or wells
-  Undeveloped significant resource

See table for mineral symbols.  
Underlined symbol indicates plant.



# THE MINERAL INDUSTRY OF LIBERIA

By Hendrik G. van Oss

The mineral economy of Liberia in 1992 remained crippled owing to the civil war begun at yearend 1989. Mineral production was largely restricted to iron ore by one company, an unknown quantity of gold and diamonds by artisanal miners, and small quantities of cement by one plant. Sales of iron ore, traditionally Liberia's major mineral export, were reported to have been worth about \$20.7 million in 1992. Production and sales data for other minerals were not available; data have never been complete for gold and diamonds because of widespread smuggling of both Liberian material and that from neighboring countries. However, for the estimated production levels shown in table 1, gold exports in 1992 would have been worth about \$8 million and diamonds perhaps \$10 million. The U.S. Embassy in Monrovia projected a 1992 GDP for Liberia of \$350 million to \$400 million, significantly higher than the \$250 million estimated for 1991, but well below the \$1 billion GDP reported for 1989. Mineral

commodity imports of significance in 1992 were an unknown quantity of refined petroleum products and modest quantities of clinker for cement plant.

The formal economy continued to be dominated by the export of mineral commodities, rubber, and timber, and by license revenues from the world's largest (tonnage carried) merchant fleet. The Government was denied most income sources other than maritime revenues because virtually all of the mineral and agricultural industries were in the 95% of Liberia controlled by opposition forces. A cease-fire in the first half of 1992 allowed the resumption and/or increase in production and exports of rubber and timber, but not significantly of minerals. Buchanan was embargoed in early November by west African peace keeping forces, cutting off the country's exports of iron ore.

The Government-owned Iron Mining Co. of Liberia (LIMCO) mined two grades of iron ore near Yekepa from January through October. The last vessel

to load iron ore at Buchanan left on November 6. Stocks remaining at the port were reported to be 794,000 tons, with an additional 50,000 to 60,000 tons at Yekepa. Exports of iron ore were 1.27 Mmt, to a variety of European customers. By comparison, exports in 1991 totaled 1.02 Mmt, worth \$16.06 million, and were mainly to Sollac. The long-term sales contract with Sollac lapsed in March 1992; Sollac continued to make purchases on a spot basis.

Maintenance of the iron ore railroad allowed a number of timber companies to transport logs to Buchanan for export. Timber harvesting in 1992 was without constraint and was a source of concern to various environmental groups.

Minerals could play a key role in Liberia's future. The MIFERGUI-Nimba project would provide revenues to the Government for transshipping Guinean iron ore through Buchanan. Liberia's gold and diamond exploration potential is considered high.

TABLE 1  
LIBERIA: PRODUCTION OF MINERAL COMMODITIES

Commodity <sup>1</sup>	1988	1989	1990 <sup>*</sup>	1991 <sup>*</sup>	1992 <sup>*</sup>
Cement, hydraulic <span style="float: right;">metric tons</span>	105,800	85,300	<sup>3</sup> 48,838	<sup>1</sup> 32,311	<sup>3</sup> 8,282
Diamond: <sup>2</sup>					
Gem carats	*66,812	61,822	40,000	40,000	60,000
Industrial	*100,218	92,732	60,000	60,000	90,000
Total	167,030	154,554	100,000	100,000	150,000
Gold <sup>2</sup> <span style="float: right;">kilograms</span>	677	734	600	600	700
Iron ore <span style="float: right;">thousand metric tons</span>	12,767	11,700	<sup>3</sup> 4,050	<sup>3</sup> 1,100	—
Silica sand <sup>*</sup> <span style="float: right;">metric tons</span>	6,600	10,000	5,000	—	<sup>3</sup> 1,742

<sup>\*</sup>Estimated. <sup>†</sup>Revised.

<sup>1</sup>In addition to the commodities listed, Liberia produced a variety of crude construction materials (clays, stone, and sand and gravel), but available information is inadequate to make reliable estimates of output levels. Table includes data available through Mar. 23, 1992.

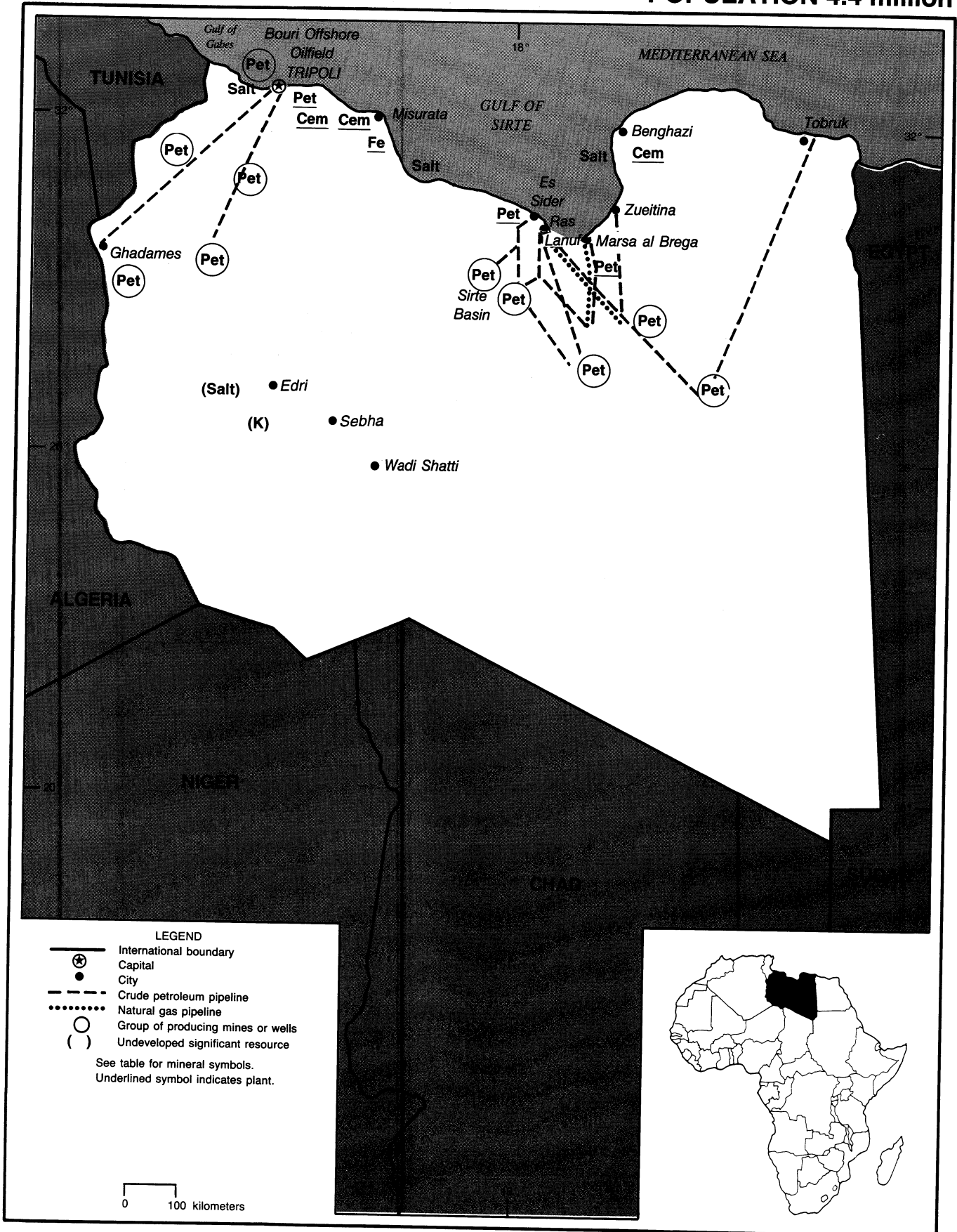
<sup>2</sup>Data through 1989 do not include smuggled production. Data for 1990-92 are estimates of artisanal production, likely smuggled out of Liberia, but which are comparable to that hitherto reported to the Government.

<sup>3</sup>Reported figure.

# LIBYA

AREA 1,759,540 km<sup>2</sup>

POPULATION 4.4 million



## THE MINERAL INDUSTRY OF

# LIBYA

By Thomas P. Dolley

Libyan petroleum production decreased marginally in 1992, but represented the first such production decrease since 1987. The production decrease can be attributed, at least in part, to Organization of Petroleum Exporting Countries (OPEC) cutbacks coupled with international economic pressures on the Government. However, petroleum production and export continued to play a predominant role in the Libyan economy. The Government reported a GDP of \$8.6 billion in 1991.<sup>1</sup> Total revenues from petroleum production and export for the years 1990 through 1991 were valued at approximately \$20 billion. The increase in world oil prices in 1990 improved Libyan petroleum revenues and placed the current account deficit into surplus at \$2.2 billion, the first positive balance in 5 years. By 1992, the Government has been unable to attract sustainable foreign investment in the petroleum sector or to dissuade negative international opinions of the Government.

During the year, Libya remained the second largest crude oil producer in Africa following Nigeria. Libya's petroleum reserves encompass the largest hydrocarbon resource on the African continent, but remain underexploited. The nonfuel sector of the Libyan mining industry was not significant on a global scale.

In 1992, international stalemate and the ensuing UN embargo against the Government could have long-term, deleterious effects on the mineral industry of Libya. The Government's refusal to extradite Libyan suspects to France, the United Kingdom, and the United States in connection with the bombings of American and French airliners, resulting in 441 fatalities in the late 1980's,

precipitated the UN Security Council sanctions that went into effect in April 1992. Major infrastructure projects within the petroleum sector, including the Great Manmade River (GMR), have been delayed or canceled. Though Libyan oil exports were not included in the UN sanctions, included in the ban were flights into and out of Libya, decreases in Libyan diplomatic missions, and a weapons embargo. Despite embargoes and sanctions, foreign nationals continued to be employed in Libya's petroleum industry and various technical infrastructure projects.

### GOVERNMENT POLICIES AND PROGRAMS

Libya gained independence from Italy on December 24, 1951. The current Government took power through the coup of September 1, 1969. The Libyan legal system is based on Italian civil law and Islamic law.

Libya is a member of OPEC. The Libyan National Oil Corp. (NOC) maintains complete control of Libyan oilfields and related investments, including marketing all the petroleum that is produced. The Government reported that the budget for the oil sector in 1992-93 would be \$3.5 billion.

The U.S. sanctions of 1986 against the Government of Libya were extended in 1992 to include the revocation of authority of certain non-Libyan foreign banks located outside the United States to clear through bank accounts residing in the United States. This action is designed to prevent such funds from being sent to or from the Government of Libya. As early as 1986, the United States froze \$2 billion worth of Libyan assets in the United States.

Additional U.S. sanctions in 1991 prohibit U.S. interests from unlicensed transactions with Government-owned companies or any properties associated with these companies. Some of these companies are affiliated with the Libyan mineral industry and included Libyan National Petrochemicals Co. (Germany); Mediterranean Sea Oil Services GmbH (Dusseldorf, Germany); Société Libyenne Centre Africaine des Mines (Bangui, Central African Republic); Tamoil Italiana SpA (Milan, Italy, and Cremona Refinery, Italy) and Umm Al-Jawaby Oil Service Co., Ltd. (London, United Kingdom). As of 1992, the Government had made no attempt to liquidate its large European assets in Tamoil Italia in response to UN sanctions. Additionally, the five U.S. oil companies that still possess assets in Libya—W. R. Grace & Co., Conoco, Marathon Oil Co., Amerada Hess, and Occidental Petroleum Corp.—remain banned by the United States from conducting business within the country. Estimated daily losses for these companies in Libya range from \$2 million to \$25 million.

Libyan overseas assets totaled \$6.5 billion in September 1991, with the money primarily utilized to service the needs of the Libyan oil industry. Prior to the imposition of UN sanctions in 1992, the Government transferred \$2 billion to \$3 billion in overseas assets from European banks to Middle Eastern banks. Additional reports state that Libyan funds have been transferred to banks in the Republic of Korea, although this transaction could be for payment to Korean contractors working on the GMR. Another step taken by the Government was to demand payment for its oil exports in Swiss francs, as opposed to U.S. dollars, because all international dollar

transactions must clear through New York City where U.S. authorities could interfere.

For many foreign companies operating in Libya, the Lockerbie affair and subsequent UN embargo have caused a scaling back or complete withdrawal of operations. In 1992, insufficient payment for services and administrative difficulties caused by the Government have created a great deal of consternation on the part of the contractors. Major infrastructure projects within Libya have been affected by these events. The Republic of Korea's Daewoo Corp. has reduced operations owing to \$1.4 billion in payment arrears by the Government. Norway's AB Nera, contracted to install control measuring and telecommunications systems on the first phase of the GMR, have suspended on-site operations. Germany's Mannesmann has terminated a joint-venture water injection program with the Arabian Gulf Oil Co. (Agoco) for certain petroleum fields in Libya owing to lack of payment. NCC construction company of Sweden has stopped a tunnel project south of Tripoli over allegations that the project could be linked to a chemical weapons plant. Continued work on any of these projects would be predicated on a resolution of the myriad political problems surrounding the Government.

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## PRODUCTION

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Nonfuel mineral activity was minimal and not significant to global markets. This activity included salt harvesting from coastal pans; quarrying of clays, gypsum, and limestone; cement production; and ammonia production. Iron and steel production remained at a level that was less than design capacity. Heavily subsidized by the Government, iron and steel production relied upon imported feed materials. (See table 1.)

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## TRADE

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The UN embargo had the most direct effect on Libyan trade in 1992. Early in the year, the trade deficit had shown partial improvement. By late in the year, the Government claimed losses of \$4.6

billion in the first 3½ months of the embargo due to restrictions on air transport and aircraft goods.

Hydrocarbons account for 95% of all Libyan exports. The two largest customers for Libyan crude oil are Italy's Tamoil Italia and Azienda Generali Italiana Petroli S.p.A. (AGIP). Furthermore, in 1992, Libya exported 1.8 billion m<sup>3</sup> of liquefied natural gas (LNG), all destined for Spain. In 1991, LNG production was 1.58 billion m<sup>3</sup>. Roughly 20% of total Libyan imports is composed of foodstuffs.

Speculation by industry analysts indicated a strategy directed toward a vertically integrated European oil company owned by Libya. Libya's parastatal Oilinvest, registered in the Netherlands Antilles, has incorporated a variety of foreign retail outlets for its crude oil exports over the past several years, and this strategy was continued in 1992. Oilinvest's acquisitions are found in France, Germany, Italy, Spain, and Switzerland. For example, Italy's Tamoil Italia, which is wholly owned by Oilinvest, currently owns more than 2,000 service stations in Italy. Tamoil purchased 20 Fina Italiana service stations on the island of Sardinia in mid-1992. Fina Italiana is the Italian subsidiary of Belgium's Petrofina. Additionally, in March 1992, Tamoil purchased 180 service stations from Italiana Distribuzione of Genoa, Italy.

Controversy surrounded U.S. restrictions on trading with Libya with the midyear joint-venture talks between Lonrho of the United Kingdom and the parastatal Libyan Arab Foreign Investment Co. (Lafico). American shareholders may be forced to sell their holdings in Lonrho. The joint-venture deal of March 26, 1992, would ostensibly cover interests in Africa and resulted in Lafico's purchase of a 33% stake, valued at \$303.5 million, in the Lonrho-owned Metropole Hotels chain. However, the deal was reputed to include Lafico's interest in purchasing a stake in the gold-producing Ashanti Mine in Ghana. Equity partnership of a Libyan company would present a problem because transfer of ownership in the Ashanti Mine would

require the prior consent of the Government of Ghana. As of yearend 1992, no approval had been sought.

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## STRUCTURE OF THE MINERAL INDUSTRY

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Libya possesses a predominantly state-run, socialist economy, and the mineral industry sector is no exception. Generally, petroleum exploration and production-sharing, along with any proposed mining activities, were based on the Fiscal Provisions, Revenue and Financial Law of July 1, 1977. As a result of the global petroleum market slump of 1980, prior legislation was amended. The Government canceled the majority of previously awarded acreage. The new production-sharing patterns were based on the following criteria: 85% to 15% in the Government's favor for highly significant hydrocarbon prospects, 81% to 19% for moderately significant oil prospects, and 75% to 25% for less significant oil prospects. These criteria were intended for foreign companies that wanted to pursue a more aggressive exploration program. In the past several years, more flexibility had been introduced to these production-sharing patterns to attract additional investment following the departure of some foreign operators. Libya continued to rely on foreign expertise and technical personnel to develop its petroleum and mineral industry.

The NOC was the parastatal created by the Government in 1970 to oversee petroleum and natural gas exploration, production, and marketing. AGIP maintains the largest petroleum output of the foreign producers by virtue of its Bouri offshore oilfield production, but other significant foreign operators included France's Société National Elf Aquitaine and Germany's Veba AG and Wintershall AG. (See table 2.)

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## COMMODITY REVIEW

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### Metals

During the year, Libyan Iron & Steel

Co.'s (Lisco) planned multimillion dollar expansion project at Misurata was put on hold pending the outcome of the UN embargo. After international contractors submitted bids in early 1992, a \$224 million contract was awarded to a European consortium headed by Austria's Voest Alpine Industrienanlagenbau in February 1993. This action indicates the Government's willingness to commit to large-scale projects despite the UN embargo. In the past decade, Voest Alpine was in charge of the installation of the two extant direct reduction modules at Misurata.

The Misurata expansion project calls for the installation of a new direct reduction plant with a production capacity of 650 kmt/a of hot-briquetted iron. The majority of the new product output will be exported to Italy and Spain. The 3-year expansion project will bring the Misurata steel plant's capacity up to 2 Mmt/a. The installation of the third module will greatly increase storage capacity on-site at Misurata and allow full utilization of capacity at the steel melting shops.

### Industrial Minerals

Italian geologists first studied the saline deposits of Libya in 1926, followed by significant work done by the U.S. Geological Survey from 1954 to 1958. The work done by the U.S. Geological Survey forms the basis of the following current knowledge of these deposits.<sup>2</sup>

Saline and potash deposits in Libya are found in two different depositional environments. The first are sabcha, which occur as lagoonal deposits along the shore of the Mediterranean Sea through the infiltration of seawater over sand barriers followed by evaporation in coastal depressions. The majority of these deposits are found in the vicinity around Tripoli and Benghazi and along the western coast of the Gulf of Sirte. These deposits have been utilized for years as a source for common salt. Additionally, the salts are recovered using several evaporating pans in a basin or a canal-fed depression.

The second type of environment for

the formation of salts are in the desert interior where meteoric waters dissolve salts from the surrounding sediments and transport them to the basinal depressions, with the brine evaporating on the surface. The desert interior areas are west and south of Edri and Sebha. The brines found there contain  $MgSO_4$ ,  $MgCl_2$ ,  $NaCl$ ,  $KCl$ , and carnallite ( $KMgCl_3 \cdot 6H_2O$ ). Private firms that have investigated these areas have stated that selective mining of the minerals is possible.

### Mineral Fuels

In 1992, Libya's petroleum resource potential remained largely underexploited. Libya's first oil well went into production in 1956 on a concession granted to the Libyan American Oil Co. During the year, the Government postponed until 1994 the planned increase in petroleum production output. Low global oil prices and quotas set by OPEC caused the Government to reassess its plan to increase production to 2 Mbbbl/d.

**Petroleum.**—Various exploration agreements between international firms and Libya were made during 1992; however, UN sanctions have slowed an already stagnant development process. By yearend 1992, the joint-development zone between Libyan and Tunisian offshore areas could be delayed for an indefinite time owing to the UN sanctions. The 7 November concession, which covers 3,000 km<sup>2</sup>, was to be exploited by the Joint Oil Co. (JOC) with equity ownership of 50% by NOC and 50% by the Tunisian parastatal *Entreprise Tunisienne d'Activités Pétrolières*. More than one-half of this concession lies in Libyan waters. JOC, capitalized at about \$5 million, was incorporated in August 1988 and located on the Tunisian tourist island of Djerba. Because of its Tunisian registry, JOC was thought to be invulnerable to UN sanctions; however, the company was blacklisted by the UN for violating the embargo. Further development has also been offset by Tunisia's own busy exploration program.

Libya's offshore project, the Bouri Field, contains the largest hydrocarbon

reserves and the largest offshore platform in the Mediterranean. The Bouri Field is managed by Italy's Azienda Generali Italiana Petroli S.p.A. subsidiary Agip Name. Agip Name was negotiating with NOC to upgrade its 1974 production-sharing agreement concerning the Bouri Field. Over the next 4 years Agip Name wishes to increase production from the current 280 kbbbl/d to about 680 kbbbl/d from its two fields, Bouri and the onshore Bu Attifel Field in the Sirte Basin.

Canada's International Petroleum Corp. (IPC) signed a third round exploration and production-sharing agreement with NOC in May 1992. This contract was the first signed after a hiatus of 18 months of unsigned bidded concessions for NOC. With this signing, IPC holds the largest concession of all foreign multinational oil corporations operating in Libya.

**Petrochemicals.**—Libya's total throughput refining capacity is 348,400 bbl/d. A decision on the construction of a 20-kbbbl/d refinery at Sebha is expected in 1993. The Libyan client is the Azzawiya Oil Refinery Co., and two of the main bidders are France's Hydrocarbon Engineering and Spie Batignolles. Additionally, the Government announced at midyear 1992 that the refurbishment of the Marsa al Brega LNG complex will be completed by yearend 1993 by Technip of France. The complex is designed to produce 3.5 billion m<sup>3</sup>/a of LNG and 40 kbbbl/d of butane and propane.

### Reserves

Libya possesses the largest hydrocarbon reserves in Africa. Despite the NOC's 1990 study on Libyan petroleum reserves, which indicated 45 to 50 billion bbl of oil, most international observers would place the reserve estimate at about 23 billion bbl. Natural gas reserves are estimated at 1.2 trillion m<sup>3</sup>.

Libya possesses other industrial mineral resources, including gypsum, magnetite, phosphate rock, potash, sodium chloride, and sulfur, for which

reserves have not been officially reported. These resources remain largely untapped due to lack of international capital investment and ready markets along with high development costs.

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## INFRASTRUCTURE

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Highways within Libya totaled 32,500 km, of which 24,000 km is paved. Transportation of petroleum and natural gas was primarily through a network of pipelines from wellhead to processing and shipping points that were located primarily on the Mediterranean coast. Crude oil pipelines totaled 4,383 km, and natural gas pipelines totaled 1,947 km. Petroleum products traversed 443 km of pipeline.

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## OUTLOOK

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The Government's new 5-year plan, to run from 1992-96, calls for further development of the industrial sector. The plan includes the rehabilitation and maintenance of various industrial plants, improving local skills and develop electrical power. Any forthcoming developmental plan within Libya will inevitably be dependent on international perceptions and policy directed at the Government. Libya's petroleum resources still remain underutilized, primarily due to trepidation on the part of foreign investors to commit to long-term projects. NOC plans to raise oil production to 2 Mbb/d in 1993, but this plan is contingent on the timely development of upgraded oilfields. Continued austerity budgets imposed by the Government would circumvent these developments. Furthermore, UN sanctions, which include a global boycott of Libyan oil exports and a global ban on sales of oil technology equipment to Libya, coupled with the freezing of Libyan financial assets, could be a factor in 1993. However, European support for such a boycott would seem unlikely due to a large dependence on Libyan oil imports.

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<sup>1</sup>Where necessary, values have been converted from Libyan dinars (LD) to U.S. dollars at the rate of LD0.35047=US\$1.00.

<sup>2</sup>Goudarzi, G., Report on Marada, Pisida, Idri, and

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TABLE 1  
LIBYA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

Commodity <sup>2</sup>	1988	1989	1990	1991	1992 <sup>*</sup>
Cement, hydraulic thousand metric tons	2,700	2,700	2,700	2,369	2,300
Gas, natural: <sup>o</sup>					
Gross million cubic meters	11,886	13,782	12,000	13,600	13,600
Marketed <sup>3</sup> do.	5,495	6,452	6,500	6,500	6,500
Dry do.	5,400	5,900	6,200	6,200	6,200
Gypsum <sup>o</sup> thousand metric tons	180	180	180	180	180
Iron and steel:					
Metal:					
Direct-reduced iron <sup>o</sup> do.	90	90	4500	4780	4850
Crude steel <sup>o</sup> do.	10	10	492	4718	4822
Lime <sup>o</sup> do.	260	260	260	260	260
Nitrogen: N content of ammonia do.	217	212	200	200	200
Petroleum:					
Crude thousand 42-gallon barrels	374,125	412,450	501,510	550,785	544,945
Refinery products:					
Gasoline do.	10,220	9,125	10,950	11,000	11,000
Kerosene and jet fuel do.	4,015	12,775	13,505	13,000	13,000
Distillate fuel oil do.	17,155	25,550	30,295	30,000	30,000
Residual fuel oil do.	14,600	27,740	33,215	33,000	33,000
Other do.	3,285	18,250	18,980	19,000	19,000
Refinery fuel and losses do.	2,000	3,650	4,380	4,000	4,000
Total do.	51,275	97,090	111,325	110,000	110,000
Salt thousand metric tons	12	12	12	12	12
Sulfur, byproduct of petroleum and natural gas <sup>o</sup> do.	14	14	14	14	14

<sup>o</sup>Estimated. <sup>\*</sup>Revised.

<sup>1</sup>Table includes data available through Jan. 1993.

<sup>2</sup>In addition to the commodities listed, a variety of construction stone, brick, and tile were produced, but available information was inadequate to make reliable estimates of output levels. Natural gas liquids were also produced but were blended with crude petroleum and were reported as part of that total.

<sup>3</sup>Excludes gas reinjected into reservoirs.

<sup>4</sup>Reported figure.



TABLE 2  
LIBYA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

(Thousand metric tons unless otherwise specified)

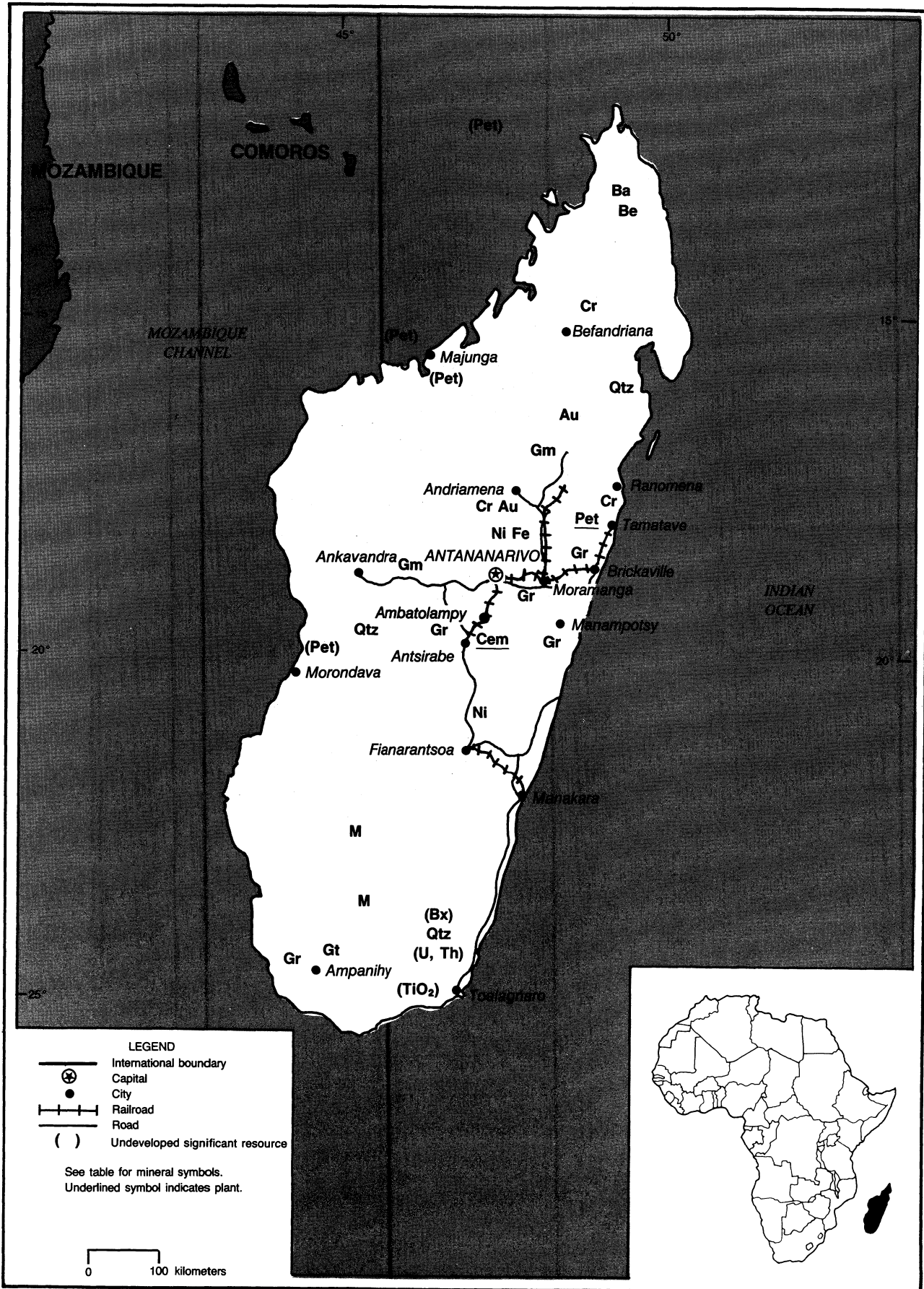
Commodity	Major operating companies (ownership)	Location of main facilities	Annual capacity
Cement	Libyan Cement Co. (100% Government ownership)	Hawari, near Benghazi	1,500
Do.	National Cement and Building Materials Co. (100% Government ownership)	El Margueb and Lebda	1,400
Do.	El Fataiah Cement (100% Government ownership)	Derna	1,000
Iron and steel, crude	Misurata Iron and Steel Complex (100% Government ownership)	Misurata	1,100
Petroleum, crude	Libyan National Oil Corp. (NOC) (100% Government ownership)	Mainly Sirte Basin	657
Do.	Agip-North Africa Middle East (85% NOC, 15% Azienda Generali Italiana Petroli (Agip), Italy)	Bouri offshore oilfield, Bu Attifel onshore oilfield, Rimal Katib onshore oilfield	19.3, 50, 2.3
Do.	Elf Aquitaine-Libya (85% NOC, 15% Société National Elf Aquitaine, France)	El-Meheiriga onshore oilfield	.3
Petroleum, refining	Azzawiya Oil Refining Co. (100% Government ownership)	Azzawiya	44
Do.	Ras Lanuf Oil and Gas Processing Co. (100% Government ownership)	Ras Lanuf	73.4
Do.	Sirte Oil Co. (100% Government ownership)	Marsa al-Brega	3.1



# MADAGASCAR

AREA 581,540 km<sup>2</sup>

POPULATION 12,596,263



# THE MINERAL INDUSTRY OF MADAGASCAR

By Thomas P. Dolley

The Democratic Republic of Madagascar, the fourth largest island in the world, the size of the States of California, Oregon, and Washington combined, experienced another difficult economic year in 1992. A transitioning Government, coupled with popular demonstrations for political reform, curtailed any significant economic growth. Protracted antigovernment strikes also occurred in 1992. The performance of Madagascar's mineral sector reflected the poor economic year. In March 1992, new mining legislation was suspended by the Government due to illegal handling of mineral resources for export. Additionally, a loss of revenue was reported due to clandestine export of gold.

Railways, roadways, and port facilities have fallen into disrepair, having a detrimental effect on trade. In 1992, a drought coupled with famine hurt the agricultural sector. Reports alluded to foreign exchange reserves being as low as \$125,000 surfaced during the year.<sup>1</sup> The mineral industry, which is an important source of trade revenue for Madagascar, is neither regulated nor possesses significant infrastructure for further development. Without financial assistance from foreign donors, the Government faces a daunting task of repairing Madagascar's economy.

## GOVERNMENT POLICIES AND PROGRAMS

Madagascar was a former French colony that gained its independence on June 26, 1960. The Malagasy legal system is based on French civil law. The Government nationalized all mineral resources, with the exception of graphite and mica, in 1975. In 1990, the Government, in cooperation with the

Federation of Mine Associations (FEDMINES), ratified the Mining Code law No. 90-017. Beginning in 1991 and continuing into 1992, the new transitional Government in Madagascar was supportive of the opinions of smaller domestic mining operators. These domestic mining operators opined that the Mining Code Law of 1990 was inequitable and gave preference generally to larger foreign operators. Subsequently, in August 1992, a National Council for Mines was formed and consisted of equitable representation from both the public and private sectors. The new council proposed a new mining code, which was also immediately criticized for favoring small mining operators over larger projects. The new code also allows a greater role for the mines police to curtail illegal mining and smuggling. The World Bank and France's Bureau de Recherches Géologiques et Minières (BRGM) conducted a study of the new code and recommended a more balanced mining legislation. Additionally, the World Bank is examining the possible privatization of the Government's Office Militaire National pour les Industries Stratégiques (OMNIS) and its production subsidiaries. Further evaluation will be performed before the transitional Government renders a final decision.

The Petroleum Code, law No. 80-001 of June 6, 1980, provided for two different types of production-sharing contracts. The first type of contract covered equity ventures between foreign oil operators and OMNIS. The Government maintained 51% ownership, and cost and production-sharing were financed by income tax payments and royalties based on achieved rates of return. The second type of contract was a risk service contract in which the foreign

oil company assumed all exploration and exploitation costs. Such costs would be repaid through a royalty on production of 10% to 20% for a crude oil discovery and 5% to 20% for a natural gas discovery.

## PRODUCTION

Mineral commodity production in 1992 was mixed within Madagascar's semiprecious stone industry. Causative factors are that a significant portion of the semiprecious stone industry's production is clandestine and unreported. The Government would like to streamline this industry, including further regulation, and thus gain lost revenue from this resource. Of the major mineral commodities, chromite production increased slightly; however, graphite production decreased significantly owing to a global downturn in demand. (See table 1.)

## TRADE

Total chromite ore exported in 1992 was 45,575 tons, with chromite concentrate exports at 62,600 tons. The combined revenues generated for Madagascar chromite exports in 1992 exceeded \$7.8 million. Total graphite exports for 1991 totaled 12,600 tons. Flake and fine graphite exports for 1992 declined to 7,577 tons, valued at about \$5.5 million.

The value of U.S. imports of Malagasy products has risen from \$41.5 million in 1990 and \$46.6 million in 1991 to \$53.5 million for 1992. However, the value of U.S. exports to Madagascar has fluctuated from \$11.5 million in 1990 and \$14.1 million in 1991 down to \$6.1 million in 1992.

## STRUCTURE OF THE MINERAL INDUSTRY

The chromite industry is controlled by the parastatal Société Kraomita Malagasy (Kraoma). Graphite and mica production is owned and operated by foreign entities, but the Government asserts control on these operations in the form of taxes, royalties, and official approval of all foreign exchange transactions. OMNIS is primarily involved in research, joint ventures, and promotion of Madagascar's mineral potential. Furthermore, OMNIS also could be the target of privatization in the future. (See table 2.)

## COMMODITY REVIEW

### Metals

**Chromite.**—Madagascar's chromite ore is mined from the area around Andriamena. Chromite output has been produced by Kraoma since 1976. Kraoma had operations at Andriamena and at Befandriana, 400 km north of Tananarive, until 1987. In 1987, the mine at Befandriana was shut down. The remaining mine is the open pit operation at Andriamena with a production capacity of 300,000 mt/a. The ore is crushed, washed, and passed through a dense medium separation unit, then a gravimetric separation unit, followed by a dephosphorizing unit. Beneficiation improvements have enabled Kraoma to produce chromite containing 0.002% to 0.003% phosphorus, bettering the typical chromite grade of 0.007% phosphorus. The latter grade is considered undesirable by global consumers of chromite. The resultant concentrates grade 44% Cr<sub>2</sub>O<sub>3</sub>. The establishment of a ferrochrome plant for Madagascar has been debated since the mid-1970's, but current global markets have forestalled diversification into ferrochrome production.

**Titanium.**—Canada's Quebec Iron & Titanium (QIT), wholly owned by the United Kingdom's RTZ Corp. PLC, has long sought to exploit the ilmenite sands of Madagascar. The ore grades 60%

TiO<sub>2</sub>, with smaller amounts of zircon, rutile, and anatase. Under QIT's plan, the material would be shipped to Quebec for beneficiation at pigment plants using a chloride method of production. However, no distinct environmental regulations exist to control damage to coastal wetlands caused by the ilmenite mining. Strong opposition exists in Madagascar against the project, based on environmental concerns. Additionally, the construction of adequate infrastructure to support the project is expensive, coupled with the approaching on-line status of similar projects throughout the world that could possibly lower the global price of TiO<sub>2</sub>. Owing to these factors, near-term exploitation of the ilmenite sands of Madagascar is remote at best.

### Industrial Minerals

Despite a troubling period for the global graphite market, Madagascar has remained a modest, though important, producer of high-quality flake graphite. In recent years, the worldwide graphite market has experienced a downward slide in prices and a profound reduction in demand. Madagascar's graphite industry appeared to have survived these recent calamities, but a downturn in both production and exports hurt the industry in 1992.

Société Minière de la Grande Ile (SMGI) operates graphite mines at Ambatonitamba, Sandraka, and Vohipatakana. By yearend 1992, SMGI was seeking a partner for its new 225-km<sup>2</sup> concession to expand its current operations. The total capacity of SMGI's Ambatonitamba processing operations is about 10,000 mt/a. Further reserve analysis at Ambatonitamba has revealed an additional 1 Mmt of crystalline flake graphite. New flotation equipment at the mine allows production of material with a carbon content lower than 90%. SMGI's total output from all of its operations amounts to 6,000 mt/a, primarily for use in crucibles and refractories. Other graphite deposits in the Manampotsy and Ambatolampy districts are on the eastern slope of the central highlands of Madagascar.

### Mineral Fuels

The Malagasy petroleum sector was on the verge of a major restructuring during the year. Madagascar has no domestic production of hydrocarbons and depends on imports for its petroleum needs. Import sources for this petroleum are problematic, owing to Madagascar's weak financial situation. The World Bank's International Development Agency is funding \$47 million to help restructure the petroleum industry. Privatization of the oil refinery at Tamatave and its distribution network are to be a part of the restructuring. France's Société National Elf Aquitaine had already expressed interest in being a shareholder.

### Reserves

Chromite reserves in Madagascar total 2,100,000 tons of contained chromium, or less than 1% of the world total. Graphite deposits and minerals associated with pegmatite deposits historically have been exploited in Madagascar. The Government stated that Madagascar had significant deposits of bastnasite, bauxite, chromite, ilmenite, and iron ore. Other essentially undeveloped deposits of lignite, steam coal, and radioactive minerals also are known from the island. Total minable reserves of radioactive minerals are undetermined. Copper-nickel accumulations exist, but economic deposits have yet to be discovered. Semiprecious gemstone deposits were extensively mined and exported in Madagascar; however, the Government wished to organize and streamline the industry to better exploit these resources. Additionally, significant underexploited hydroelectric generation potential exists in the island nation, estimated at 3,500 MW. By yearend 1992, recent geological investigations indicated diamond deposits on the banks of the Matitanana River in southeastern Madagascar. Other precious stones were indicated such as emeralds, rubies, and sapphires.

## INFRASTRUCTURE

Total installed electrical generation

capacity was 119 MW. Railroads totaled 1,020 km of 1-m-gauge track. The road system totaled 40,000 km, including about 4,700 km of paved roads and 800 km of crushed stone, gravel, or stabilized earth roads, with the remainder improved or unimproved earth. However, roads and railways have deteriorated and are in need of maintenance. Irrigation infrastructure remained one of the most developed in Africa. The Malagasy labor force is estimated at 5.7 million.

Currently covering about 125,000 km<sup>2</sup>, timber is an important energy source on the island; however, unplanned harvesting has led to deforestation and soil erosion in parts of Madagascar.

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## OUTLOOK

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The formation of a coalition Government and bureaucratic restructuring were precipitated by popular protest. As the Government attempts to reconstruct the country's economy, it will have to responsibly balance the value of mining against the potential environmental damage. The environmental degradation diminishes the GDP by about 15% per year or \$290 million. Madagascar had a world record soil erosion rate, and deforestation had already destroyed 80% of the forest lands.

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<sup>1</sup>Where necessary, values have been converted from Madagascar francs (FMG) to U.S. dollars at the rate of FMG1,852.9=US\$1.00.

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Jeannot Rasoanaivo  
Geological Department  
Boite Postale 322 Ampandrianomby  
Antananarivo 101, Madagascar  
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Office Militaire National pour les Industries  
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Madagascar

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TABLE I  
MADAGASCAR: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Kilograms unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992 <sup>3</sup>
<b>METALS</b>					
Beryllium: Beryl in quartz concentrates, industrial and ornamental	3	154	3,345	3,000	3,000
Chromium: Chromite concentrate, gross weight metric tons	64,177	62,540	73,000	<sup>3</sup> 63,000	<sup>3</sup> 69,123
Gold, mine output, Au content <sup>4</sup>	90	45	<sup>2</sup> 216	200	200
Rare-earth minerals:					
Bastnasite*(60% REO) metric tons	5	5	5	5	5
Monazite* (55% REO)	100	100	100	100	100
<b>INDUSTRIAL MINERALS</b>					
Abrasives, natural: (industrial only) <sup>5</sup>	10,000	10,000	10,000	10,000	10,000
Cement, hydraulic <sup>6</sup> metric tons	50,000	60,000	60,000	60,000	60,000
Clay, kaolin do.	365	1,315	485	<sup>3</sup> 496	<sup>3</sup> 756
Feldspar <sup>7</sup>	5,000	5,000	5,000	4,000	4,000
Gemstones:					
Amazonite	525	23,885	2,185	2,000	2,000
Amethyst:					
Gem	1,700	3	1,713	1,700	1,700
Geodes <sup>8</sup>	9,000	9,000	<sup>3</sup> 86	80	80
Citrine	112	754	50	<sup>3</sup> 6	6
Cordierite	886	4,051	1,556	<sup>3</sup> 20	<sup>3</sup> 7
Garnet	6	23	6,905	6,000	<sup>3</sup> 300
Tourmaline	2,367	97	54	<sup>3</sup> 302	<sup>3</sup> 257
Graphite, all grades metric tons	<u>14,106</u>	<u>15,863</u>	<u>18,036</u>	<u><sup>3</sup>14,079</u>	<u><sup>3</sup>8,910</u>
Mica, phlogopite:					
Block do.	5	7	93	90	<sup>3</sup> 4
Scrap do.	605	899	538	500	<sup>3</sup> 716
Splittings and sheet do.	8	162	90	90	<sup>3</sup> 78
Total do.	618	1,068	721	680	798
Ornamental stones:					
Agate	13,886	9,005	4,696	<sup>3</sup> 9,463	<sup>3</sup> 5,990
Apatite	2,090	9,016	1,139	<sup>3</sup> 4,001	4,000
Aragonite metric tons	<sup>5</sup> 500	2,187	786	<sup>3</sup> 126	120
Calcite do.	1,243	1,373	3,757	<sup>3</sup> 1,412	1,400
Celestite	34,511	28,398	26,000	26,000	<sup>3</sup> 1,320
Jasper	21,030	30,137	23,560	<sup>3</sup> 11,694	<sup>3</sup> 68,300
Labradorite	27,748	23,015	24,000	<sup>3</sup> 35,010	<sup>3</sup> 61,654
Other gem and ornamental <sup>9</sup> metric tons	250	250	250	250	250
Quartz:					
Crystal	22,136	40,875	32,000	32,000	32,000
Geodes	2,700	<sup>2</sup> 2,700	2,700	2,500	2,500
Hematoid	9,089	5,795	3,157	<sup>3</sup> 560	<sup>3</sup> 330
Piezoelectric	153	163	160	<sup>3</sup> 66,200	66,000
Rose quartz	360,290	64,384	10,832	<sup>3</sup> 4,802	<sup>3</sup> 27,666
Smelting <sup>10</sup>	100,000	100,000	<sup>3</sup> 179,521	180,000	180,000
Other ornamental	<sup>5</sup> 5,000	6,578	14,360	<sup>3</sup> 1,267	<sup>3</sup> 3,600
Tourmaline	520	3,140	4,076	<sup>3</sup> 302	300
Salt, marine <sup>11</sup> metric tons	30,000	30,000	30,000	30,000	30,000

See footnotes at end of table.

TABLE 1—Continued  
MADAGASCAR: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Kilograms unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992 <sup>3</sup>
<b>INDUSTRIAL MINERALS—Continued</b>					
<b>Stone:</b>					
Calcite, industrial <sup>a</sup> metric tons	2,000	2,000	2,000	2,000	2,000
Dimension, marble, other <sup>a</sup> do.	3,000	3,000	3,000	3,000	3,000
Marble, cipoline do.	4	5	1	1	1
<b>MINERAL FUELS AND RELATED MATERIALS</b>					
<b>Petroleum refinery products:</b>					
Distillate fuel oil thousand 42-gallon barrels	664	540	798	<sup>3</sup> 922	900
Gasoline do.	451	219	405	<sup>3</sup> 434	400
Kerosene and jet fuel do.	303	139	253	<sup>3</sup> 291	290
Residual fuel oil do.	979	329	504	500	500
Other do.	96	14	26	20	20
<b>Total</b> do.	<b>2,493</b>	<b>1,241</b>	<b>1,986</b>	<b>2,167</b>	<b>2,110</b>

<sup>a</sup>Estimate.

<sup>1</sup>Table includes data available through June 1993.

<sup>2</sup>In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (other clays, sand, gravel, and other stone) presumably are produced, but output is not reported and available information is inadequate to make reliable estimates of output levels.

<sup>3</sup>Reported figure.

TABLE 2  
MADAGASCAR: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

(Thousand metric tons unless otherwise specified)

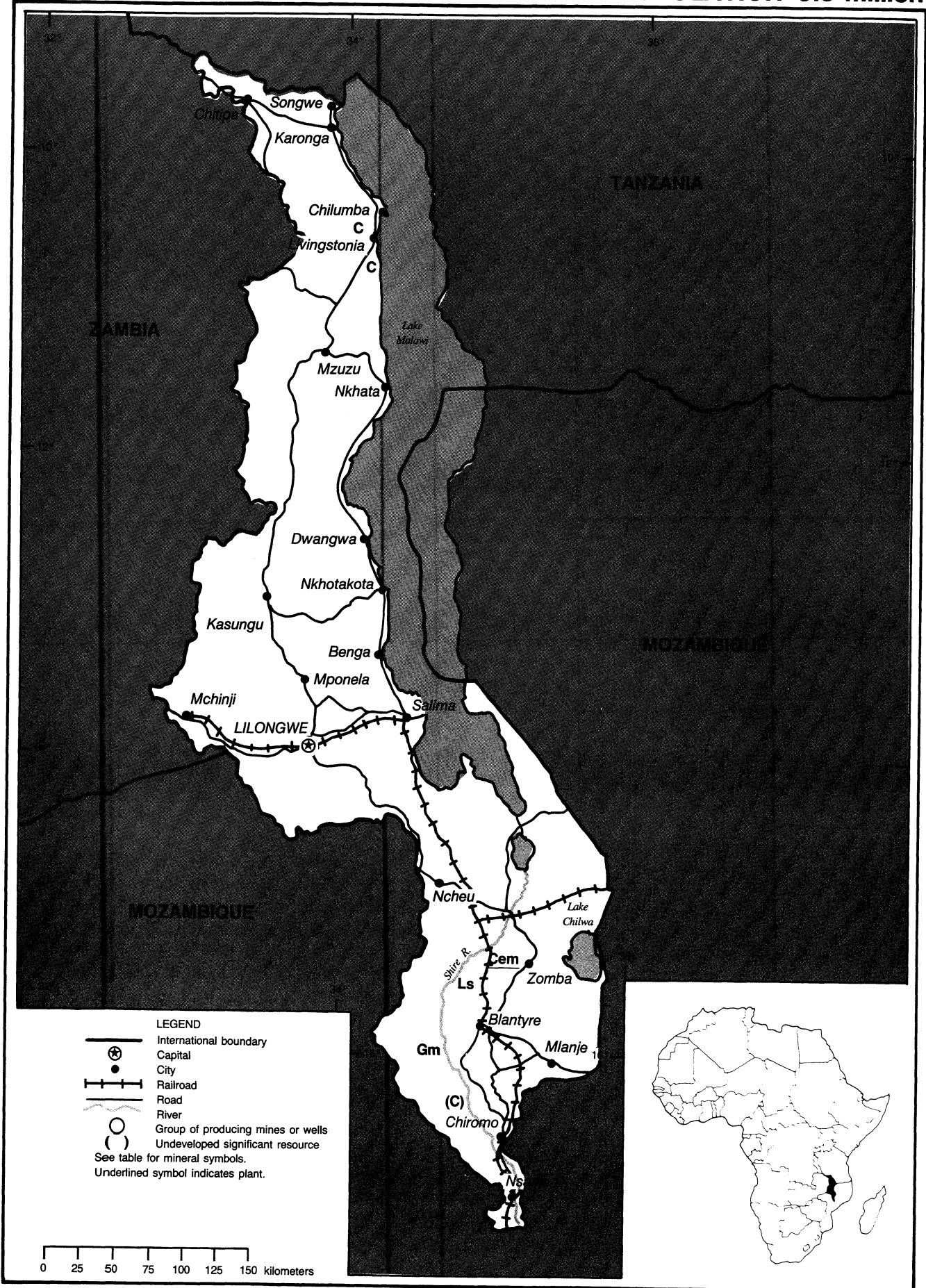
Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Chromite	Kraomita Malagasy (Government, 100%)	Andriamena	175.
Graphite	Etablissements Gallois (private—French, 100%)	Artsurakambo Mine, Brickaville Marovintsy Mine, Vatomaniry	4.8. 3.6.
Do.	Societe Miniere de la Grande Ile (Societe Participation Industrielle et Miniere, France, 100%)	Ambatomitamba Mine, Tamatave	6.
Do.	Etablissements Izouard (private—French, 100%)	Faliarno Mine, Moramanga	2.
Mica	Societe des Mines d'Ampandrandava (Societe Participation Industrielle et Miniere, France, 100%)	Ampandrandava Mine and Sakamasy Mine	.6 phlogopite. .6 phlogopite.



# MALAWI

AREA 119,000 km<sup>2</sup>

POPULATION 9.5 million



## THE MINERAL INDUSTRY OF

# MALAWI

By George A. Morgan

The mineral sector accounted for an estimated 1% of the GDP in 1992. Coal was the most important mineral produced, as it was used in the country's lime and cement industries. Exportable minerals were rubies and sapphires. Total exports were estimated at \$500 million. (See tables 1 and 2.)

Recent changes in the investment code have not spurred development, owing to an unsettled political situation. The Government devalued the kwacha<sup>1</sup> by 22% in June and removed price controls on most products. However, wage demands in several large cities ended in rioting and the damage of some businesses.

The 1992-93 budget included a reduction in income and corporate taxes, with the corporate rate reduced to 35%. Expenses incurred by manufacturing enterprises in the 18 months prior to the start of an operation may be deducted. Excise duties on local materials purchased for local manufacturing were also abolished.

The outlook for the minerals sector, as well as for the economy in general, was dependent upon growth in demand by neighboring countries. Of particular concern was a resolution to the conflict in Mozambique, a major country of transshipment for Malawi's trade.

<sup>1</sup>Where necessary, values have been converted from Malawian kwacha (MK) to U.S. dollars at the rate of MK2.63=US\$1.00.

TABLE 1  
MALAWI: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992
Cement, hydraulic	65,597	77,000	<sup>3</sup> 99,349	120,000	120,000
Coal	39,376	41,700	<sup>3</sup> 41,380	45,000	45,000
Dolomite <sup>3</sup>	2,500	2,500	<sup>3</sup> 2,483	2,500	2,500
Stone: Limestone for cement	105,000	113,000	<sup>3</sup> 145,000	175,000	175,000
Gemstones: Ruby and sapphire <sup>3</sup>					
grams	<sup>3</sup> 1,096	<sup>3</sup> 500	500	1,000	1,000
Lime <sup>3</sup>	3,000	3,460	<sup>3</sup> 4,096	<sup>3</sup> 4,000	4,000

<sup>3</sup>Estimated. <sup>2</sup>Revised.

<sup>1</sup>Includes data available through Apr. 27, 1993.

<sup>2</sup>In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (clays, sand and gravel, and other stone) presumably are produced, but output is not reported quantitatively, and available information is inadequate to make reliable estimates of output levels.

<sup>3</sup>Reported figure.

TABLE 2  
MALAWI: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

(Thousand metric tons unless otherwise specified)

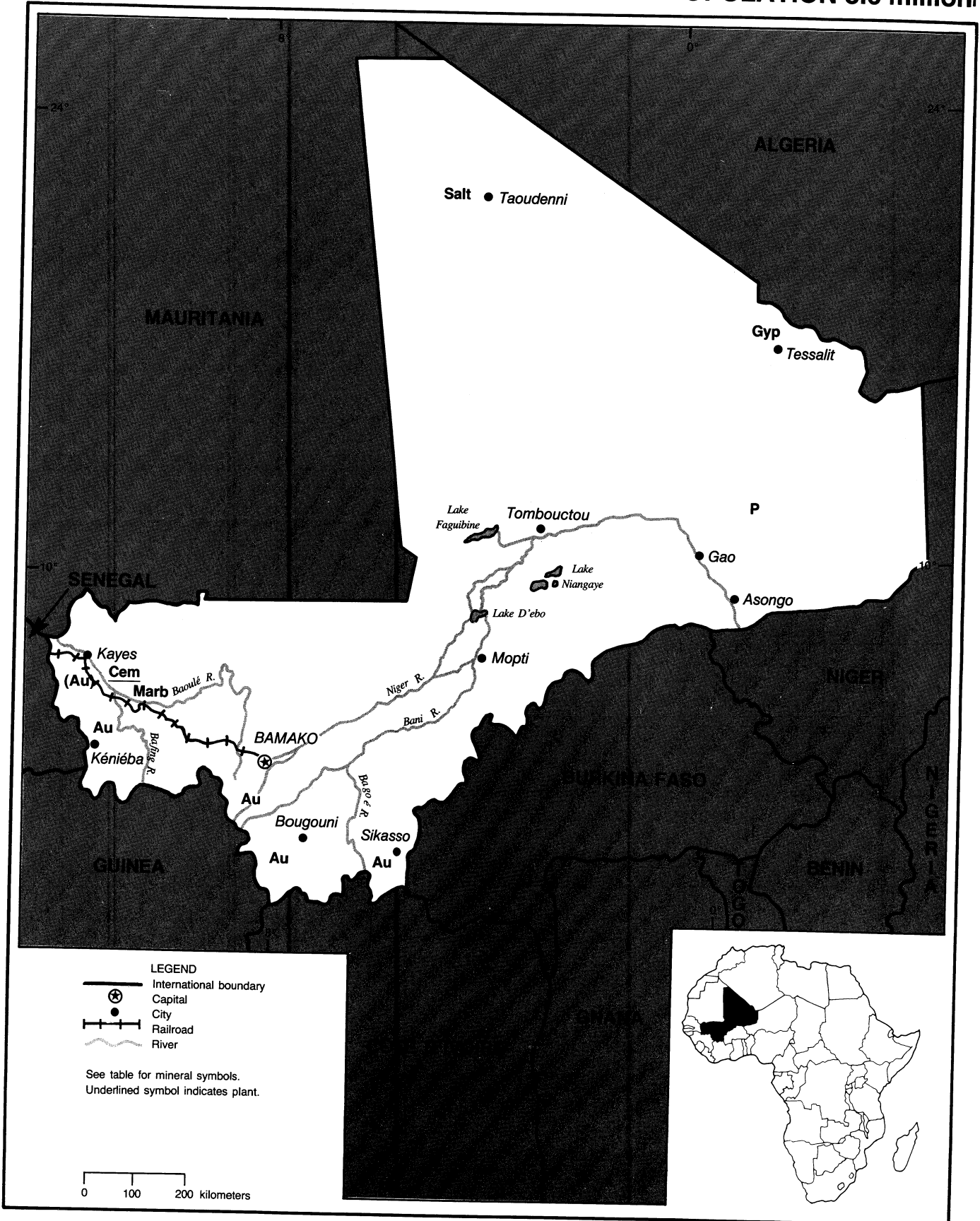
Commodity	Major operating companies	Location of main facilities	Annual capacity <sup>1</sup>
Cement	The Portland Cement Co. (private, 100%)	Plant at Zomba	120,000
Coal	Mining Investment and Development Corp. (Midcor) (Government, 100%)	Kaziwiziwi Mine near Livingstonia	45,000
Do.	do.	Mchenga Mine near Livingstonia	10,000
Gemstones grams	Gem Co. of Malawi (Midcor, 100%)	Chimwadzulu Mine near Blantyre	1,000
Lime	Numerous small-scale private producers	Chenkumbi Hills, 36 kilometers southeast of Ncheu	2,000
Do.	do.	Lirangewe area near Blantyre	2,000
Limestone	The Portland Cement Co. (private, 100%)	Changalumi Quarry near Zomba	200,000

<sup>1</sup>Capacity is based on output.

# MALI

AREA 1,241,232 km<sup>2</sup>

POPULATION 8.6 million



## THE MINERAL INDUSTRY OF

# MALI

By Hendrik G. van Oss

Although Mali has a wide variety of mineral deposits, only gold was mined at a significant scale in 1992. Gold sales (all as exports) in 1992 were reported to have been worth \$59.7 million, about 97% of the value of the country's estimated total mineral commodity output, and about 18% of the country's total exports. Gold was Mali's third most valuable export commodity, ranking only behind cotton and livestock, and in this context belied its modest standing when compared with the country's GDP at factor costs of \$2.67 billion.<sup>1</sup>

Gold was produced by one formal mine in 1992 and by a large number of artisanal workers. Another formal mine, which ceased production in early 1991, was on care-and-maintenance status in 1992. Mali also produced small quantities of construction materials and cement, as well as gypsum and salt, although production data for these commodities were lacking. The country's modest output of phosphate rock and marble was reported to have ceased, probably in 1991. Most of Mali's mineral deposits other than gold were uneconomic for lack of infrastructure.

Mali's geology is varied but is dominated by Precambrian rocks in the southwestern and central parts of the country and Paleozoic to Cenozoic rocks over the remainder. Of greatest economic importance are a number of belts of early Proterozoic granitic rocks and greenstones, the latter belonging to the Birimian Series, that occur in the west and southwest, especially near Kéniéba, Bougouni, and Sikasso. The greenstones, as elsewhere in west Africa, host gold deposits, commonly in shear zones and quartz veins. A number of gold deposits were being evaluated during the year. Apart from gold, diamond-bearing

kimberlites near Kéniéba were attracting renewed exploration interest during the year. Iron ore deposits also are known in this area, but are currently uneconomic, as are large but low-grade bauxite deposits. A small area of Birimian rocks south-southeast of Gao hosts a large but presently uneconomic manganese deposit. An ultramafic intrusive about 80 km southwest of Sikasso has platiniferous nickel-copper mineralization, but the potential resource there has yet to be determined.

In northeast Mali, overlapping into Algeria, Precambrian granitic and volcanic rocks are exposed in the Adrar des Iforas near Tessalit. A wide variety of minerals have been found in this region, including copper, gold, tin, uranium, and zinc. The remoteness of the area has made exploration very difficult and would make economic exploitation of most of the deposits prohibitively expensive.

Paleozoic and younger sedimentary rocks, particularly in northern and eastern Mali, host a number of industrial mineral deposits, some of which are or have been exploited on a small scale. Paleozoic limestone deposits in western Mali are also exploited to a limited degree. The petroleum potential of Mali's sedimentary rocks has attracted some small exploration interest in the past.

### GOVERNMENT POLICIES AND PROGRAMS

The Government embarked on a program to upgrade and better coordinate existing geological data on the country, both to attract foreign exploration and mining investment and to stimulate and make more efficient Mali's artisanal mining sector. Funding for this program

was being obtained from foreign financial agencies, notably the World Bank. An early outcome of this effort and of negotiations with the country's largest mining company was the revision of the mining law. The new code, Ordonnance No. 91-065/P-CTSO, was signed into law in September 1991, but was expected to be slightly revised to be more equitable to domestic mining entities and artisanal miners and to address objections to certain tax provisions and inconsistencies in the code.

Petroleum exploration and exploitation remain regulated by Decree No. 30 of May 23, 1969, and by Decree No. 21, April 20, 1970. The current investment code is law No. 86-39/An-RM of March 8, 1986; this replaced the 1976 Investment Code.

In common with other countries in west Africa, the degree of Government equity and management participation in the mining sector was being reduced through a privatization program, and certain moribund parastatal operations, notably in gold and industrial minerals, were being liquidated. Of greatest significance was the Government's attempt to privatize the Kalana gold mine, which ceased production in May 1991 when the mine's operational and technical support agreement with the U.S.S.R. terminated and was not renewed. Notwithstanding the privatization program, the Government has the right to a 10% equity share in all new mining ventures and has the option to purchase a further 10%. This option has been exercised with the Syama Mine, the country's remaining formal gold producer.

Mining is overseen by the Direction Nationale de Géologie et des Mines (DNGM), which is part of the Ministry

of Industry, Hydraulics, and Energy. In 1990, a quasi-independent entity, Programme pour le Développement des Ressources Minières (PDRM), was formed as part of the DNGM. The PDRM was set up with the assistance of the UN Development Programme (UNDP) and maintains the UNDP laboratory and field exploration facilities and staff set up in the late 1980's as part of a major regional exploration program conducted by the UNDP. The UNDP exploration program identified numerous mineral occurrences, including the gold deposit that was later developed by BHP-Utah International as the Syama Mine. PDRM facilities and equipment are available for hire to the private-sector exploration community.

## PRODUCTION

Gold production increased significantly from the (revised) levels in 1991 (*see table 1*). This was entirely due to improved output from the Syama Mine, which became Mali's sole formal gold producer following the closure of the Kalana Mine in early 1991. Syama's output in 1992 was 3,227 kg, about 30% higher than that in 1991. The remainder of Mali's gold production was from artisanal production.

## TRADE

Mali's mineral commodity trade in 1992 remained dominated by exports of gold and by imports of petroleum products, cement, and fertilizers. As in past years, there was believed to be significant smuggling of gold into Mali, particularly from Burkina Faso; data on this trade were not available. Mali's international trade is by rail to the port facilities at Dakar, Senegal; and by truck to Abidjan, Côte d'Ivoire; Lomé, Togo; and Cotonou, Benin. There continued to be no significant mineral trade between the United States and Mali.

Exports in 1991 of gold mined in Mali were worth about \$60 million and were adversely affected by the continued closure of one of the two formal mines in the country and by depressed world gold

prices. Mali relied totally on imports for the country's petroleum products needs. In 1992, these imports were worth about \$52.5 million, about 8% of total imports.

## STRUCTURE OF THE MINERAL INDUSTRY

Mali's formal mining sector in 1992 was dominated by gold production from a single gold mine (*see table 2*.) Another formal mine, a parastatal operation, was idle while the Government sought a buyer for the property. Reportedly, the parastatal mine continued to employ its full complement of workers. There was also gold production by artisanal miners. Gypsum and salt were produced in limited quantities by one mine each. A number of small operations produced construction materials such as sand and gravel and stone.

Only about 1% of Mali's total labor force of approximately 2.6 million is in industry. The formal mining and related industries employ approximately 1,600 persons, of whom about 600 are employed by the gold mines. Estimates of the number of artisanal miners have ranged widely from 50,000 to 100,000 persons, many of whom, however, would work only part-time and/or on a seasonal basis, and would derive their primary income from agriculture.

## COMMODITY REVIEW

### Metals

The Syama gold mine, 75 km southwest of Sikasso, managed a significant increase in production, largely through improved grade control necessitated by lackluster world gold prices. As in 1991, production was entirely from open pit oxide reserves and amounted to just under 3,000 kg. Originally, the company envisioned mining the Syama deposit's sulfide gold reserves through a combination of open pit and underground methods. Partly because of poor world gold prices, it was decided to expand the open pit mining plans to include the bulk of the sulfide

ore. Proceeding to the new phase of mining required renegotiating the corporate structure of the mining company; this was ongoing in 1992 and was expected to result in an operating company having equity distributed among BHP International Minerals, 65%; the Government, 20%, and the International Finance Corp., 15%.

The parastatal Kalana Mine, which had operated under Soviet technical management since its opening in late 1984, ceased operations in April 1991 following the expiration of the operating contract and the departure of the Soviet technical staff. Owing to the breakup of the U.S.S.R., the contract was not renewed. Since its startup, the mine had experienced a wide variety of technical problems relating to poor ore reserve determination, poor grade control and other mine planning and operational factors, excessive water influx, inappropriate mill design, and excessive staffing levels. Mine output and mill throughput never exceeded the 42,331 tons of ore mined and processed in 1988, well below the complex's design capacity. Gold production and recovery data are conflicting, but it appears to have never reached, and was commonly well below, the 500 kg/a commonly quoted as the low end of the capacity range. Following the cessation of mining, the mine was put on a care-and-maintenance basis, which has largely involved attempting to keep the workings from flooding—water influx is 400 to 500 m<sup>3</sup>/h. It was reported that some artisanal miners were able to gain access, from time to time in 1991 and 1992, to the underground workings; the amount of gold produced by such activity was unknown but was likely small.

A drilling program to better define the Kalana Mine concession's reserves was under way at the time of the mine's closure and continued into mid-1991. The Government was seeking a buyer for the mine and the concession, the future of which appeared to depend on the property's open pit potential. No purchaser had been found as of yearend 1992.

A number of companies were involved in gold exploration in Mali during 1992.

The most active company was BHP International Minerals, which optioned the Loulo deposit near Kéniéba and obtained gold exploration concessions elsewhere in that area and elsewhere in the country. Anglo American Corp. obtained the Sadiola concession about 50 km southwest of Kayes toward yearend or early in 1993. Mink Mineral Resources of Canada was seeking a partner for its Niaouléni concession in the Kangaba area, southwest of Bamako.

### Reserves

Mali is a well-mineralized country but mineral exploration and development however, have been hindered by the lack of infrastructure which alone renders most of the known deposits uneconomic. Reserves have been delineated only for certain gold deposits and a few deposits of industrial and construction minerals. In addition, resources have been delineated for bauxite, iron, and manganese.

According to BHP-Utah International, the proven oxide ore reserves at the Syama Mine at yearend 1989 were 2.1 Mmt grading 3.7 g/mt of gold. These reserves were sufficient for a 3-year open pit operation; however, approximately 2 Mmt of additional oxide reserves have been delineated since that time, sufficient to carry the oxide mining phase through mid-1994. In addition, the deposit had reserves of open pit minable mixed oxide-sulfide and sulfide ore amounting to about 7 Mmt grading about 6.5 g/mt gold.

Original reserves for the Kalana-I deposit, upon which the existing mine was based, were about 1.5 Mmt grading 14.78 g/mt gold. Less than 15% of this inventory had been mined at the time of the mine's closure in 1991, but ore reserves accessible by the existing workings had been virtually exhausted and had proven to have grades generally well below those originally determined. Additional drilling was done in 1990 to redetermine ore reserves to 50 m below the existing workings. The inventory determined was almost 800,000 tons grading about 17 g/mt, but apparently did not take into account mining dilution or nugget effects, and would thus be suspect

in light of the grade control problems experienced by the mine. Another deposit nearby, Kalana-II, was drilled by the Soviets but never exploited. It is generally agreed that its reserves need to be reevaluated. The open pit potential of the Kalana concession has not been determined.

The only other gold deposits for which reserves are reasonably well known are the Loulo deposits, numbered 0 to 3, about 30 km northwest of Kéniéba. According to the Government, these contain a total resource of about 6.4 Mmt grading 4.38 g/mt of gold. The largest of the deposits is Loulo 0, which has about one-third of the total inventory. In late 1988, the Société Minière de Loulo, a joint venture between the Government, 51%, and Compagnie Française de Mines of France, 49%; was formed to exploit the property. The economic viability of the deposit had not been demonstrated as of yearend 1992, but additional drilling was to be conducted by BHP International Minerals.

Mali has a number of industrial mineral deposits, some of which are or have been exploited on a small scale. Mali's phosphate resources are in the southeast part of the country and have been delineated only for the Tamaguilelt deposit. This was mined on a small-scale basis until about 1991 and had a resource of about 10 Mmt grading 31.4% P<sub>2</sub>O<sub>5</sub>. Mali has large deposits of limestone and dolomite, some of which are suitable for cement and others which are suitable for ornamental stone (marble). The cement plant at Diamou exploits the Gangontéry I deposit, which has a resource of about 7 Mmt. The In Kereit gypsum deposit near Tessalit has a resource of 370,000 tons and is being exploited on a small scale. Salt is mined on a small scale in northern Mali; salt resources in this area amount to about 53 Mmt. The same area also has gypsum deposits. The economics of exploiting most of Mali's industrial mineral deposits were uncertain; most have been described in a Government publication.<sup>2</sup>

Apart from gold, Mali's metallic mineral deposits have not been exploited, largely owing to the lack of infrastructure

and, for some commodities, the existence of better deposits elsewhere in west Africa. The Balé iron deposit, 200 km west-northwest of Bamako, has, according to the Government, a resource of 146 Mmt grading 50% to 60% iron within a larger inventory of lower grade material. The Ansongo manganese deposit, about 20 km southeast of Ansongo, contains a resource of about 3 Mmt grading in excess of 40% manganese, and 4.5 Mmt grading 30% to 40% manganese. Western Mali contains a number of low- to medium-grade bauxite deposits. Tonnages range from 10 to 580 Mmt, and grades typically are in the range of 20% to 48% alumina.

No reserves of energy minerals have been established, although occurrences of uranium mineralization, oil shale, and lignite are known.

### INFRASTRUCTURE

In common with much of west Africa, Mali's transportation infrastructure is underdeveloped. The country's only railroad consists of a 642-km segment of the 1,286-km, 1-m-gauge line connecting Bamako with Dakar, Senegal. Railroad service is subject to frequent and lengthy interruptions during the rainy season. Mali's highway network totals 15,700 km, of which 11% is paved. The railroad and the major roads into Côte d'Ivoire are used to import mineral commodities, particularly fuels, as well as equipment and supplies.

Data on Mali's electricity capacity vary; most sources list the country's total installed capacity at about 90 MW. The country's three hydroelectric plants accounted for 57 MW of the total. The Sélingué plant, at 45 MW, is the largest plant, but commonly produces below capacity owing to drought-induced low water levels in its reservoir and an incomplete powerline network. The rest of Mali's electricity is generated by thermal plants. The Mantantali Dam, about 250 km west of Bamako, was completed in 1988 and is to have a plant of 91-MW capacity. Mali is to receive about 50% of the output, with the rest going to Senegal and Mauritania. Owing

to a dispute among these countries over routing of the transmission lines, installation of the generating equipment has been indefinitely delayed.

Both the Kalana and Syama Mines have their own diesel generators; fuel for these was a major component of mining costs at both mines, although shortly before its closure in 1991, the Kalana Mine was linked to the Sélingué power grid.

## OUTLOOK

Gold will continue to dominate Mali's mineral industry for the foreseeable future, and the potential for discovery

and development of additional gold deposits is high. Reevaluation of the country's diamond potential offers the possibility of the country becoming a modest diamond producer over the intermediate term. Limited local markets and a general lack of infrastructure will continue to hamper the development of the country's known resources of other minerals, except for a few on a very modest scale.

<sup>1</sup>Where necessary, values have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF264.69=US\$1.00.

<sup>2</sup>Direction Nationale de la Géologie et des Mines, 1987, Mineral Resources of Mali: United Nations UNDP/DTCD MLI/85/007 Project, 64 pp.

## OTHER SOURCES OF INFORMATION

Direction Nationale de la Géologie et des Mines

B.P. 223

Bamako, Mali

Société Nationale de Recherches et d'Exploitation des Ressources Minières du Mali

B.P. 2

Kati, Mali

TABLE 1  
MALI: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990 <sup>3</sup>	1991 <sup>3</sup>	1992 <sup>3</sup>	
Cement, hydraulic	25,000	20,000	20,000	20,000	20,000	
Gold: Mine output, Au content <sup>3</sup>	kilograms	2,650	3,000	5,200	4,900	5,700
Gypsum <sup>4</sup>	720	700	700	700	700	
Phosphate rock <sup>4</sup>	10,000	10,000	10,000	<sup>5</sup> —	—	
Salt <sup>4</sup>	4,500	4,500	5,000	5,000	5,000	
Silver <sup>4 6</sup>	kilograms	150	180	270	210	200
Stone: Marble	155	155	160	<sup>5</sup> —	—	

<sup>4</sup>Estimated. <sup>5</sup>Revised.

<sup>1</sup>Includes data available through May 19, 1993.

<sup>2</sup>In addition to the commodities listed, Mali produced clay, other stone, and sand and gravel for local construction purposes, but information is inadequate to make reliable estimates of output levels.

<sup>3</sup>Includes estimate (Government estimate 1988 and 1989) of artisanal production and may include some gold smuggled into Mali. The Kalana Mine accounted for about 18% in 1988, 13% in 1989, 8% in 1990, about 2% in 1991, and less than 1% in 1992. The Syama Mine began gold production in 1990 and accounted for about 42% of the total output that year, 49% in 1991, and 57% in 1992.

<sup>4</sup>Reported figure.

<sup>5</sup>Revised to zero.

<sup>6</sup>Estimated silver content of doré bullion.

TABLE 2  
MALI: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

(Metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Cement	Société des Ciments du Mali (majority Government owned)	Cement plant at Diamou, about 50 kilometers southeast of Kayes	*50,000
Gold, fine kilograms	Société de Gestion et d'Exploitation des Mines d'Or de Kalana <sup>1</sup> (Government, 100%)	Kalana underground mine, 110 kilometers southwest of Bougouni	<sup>2</sup> —
Do.	Société des Mines de Syama (BHP International Minerals, United States, 100%) <sup>3</sup>	Open pit gold mine at Syama, 75 kilometers southwest of Sikasso	2,500
Gypsum	Plâtre de Tessalit (Government, 100%)	Gypsum mine near Tessalit, 450 kilometers north of Gao	*1,000
Salt	Sel gemme de Taoudénit (Government, 100%)	Taoudénit salt mine, near Taoudenni	*6,000

\*Estimated.

<sup>1</sup>The Kalana Mine ceased formal production in May 1991 and has been on a care-and-maintenance status since.

<sup>2</sup>The Kalana Mine's mill was designed to process 50,000 mt/a ore to produce 500 to 1,000 kg/a.

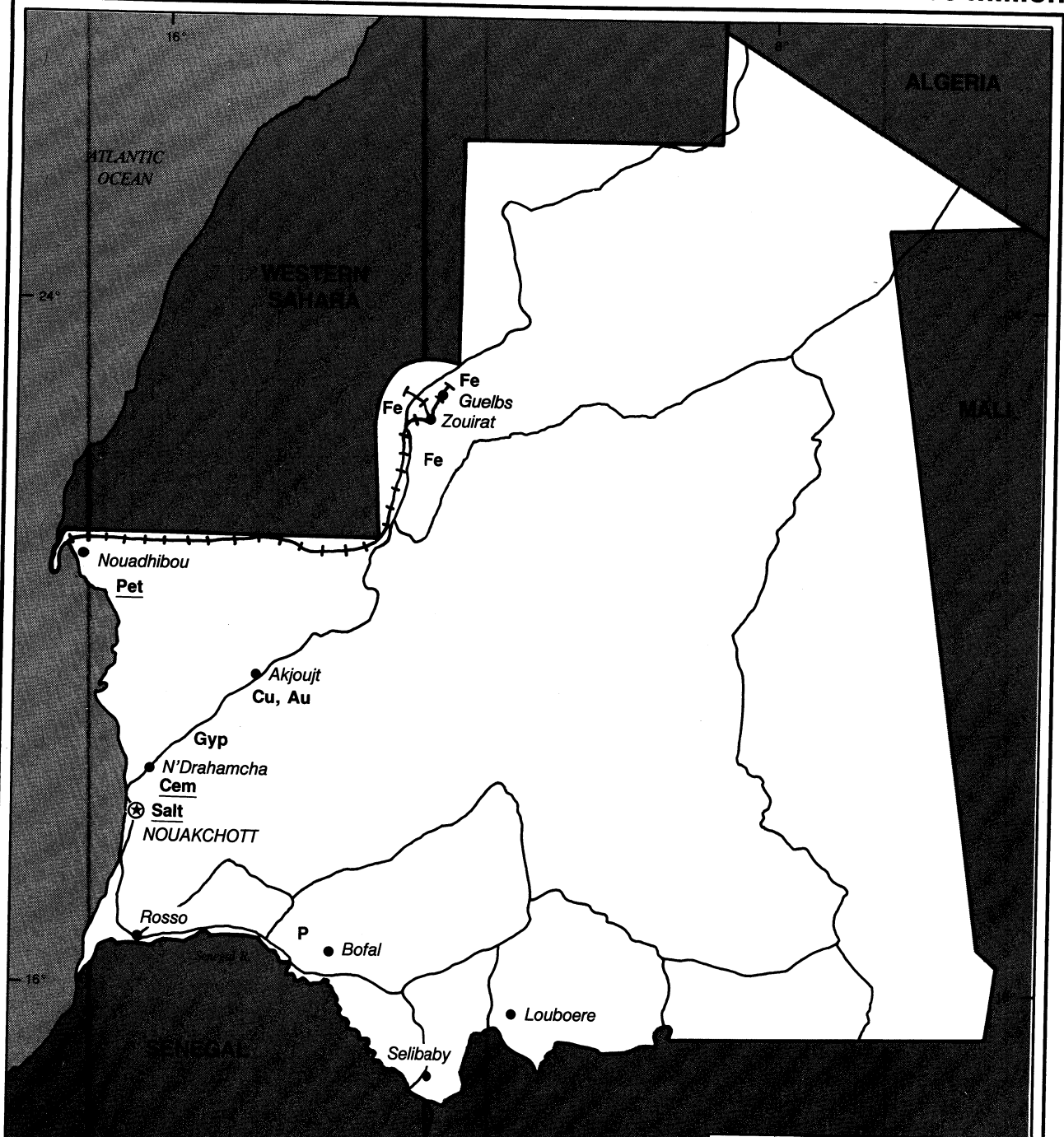
<sup>3</sup>The Malian Government was to have had 35% of the mine but, for financial reasons, BHP has had 100% control since the mine's startup in 1990. A new corporate structure was being formulated at yearend 1992 that would be: BHP, 65%, Government, 20%; the IFC, 15%.



# MAURITANIA

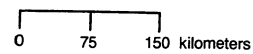
AREA 1.03 million km<sup>2</sup>

POPULATION 2.06 million



- LEGEND**
- International boundary
  - ⊛ Capital
  - City
  - +— Railroad
  - Road

See table for mineral symbols.  
 Underlined symbol indicates plant.



# THE MINERAL INDUSTRY OF MAURITANIA

By Bernadette Michalski

Iron ore mining and beneficiation was the dominant mineral industry in Mauritania, accounting for 47% of export earnings in 1992. Gold recovery commenced from the Akjoujt copper mine tailings in 1992. Cement, gypsum, and salt also were produced. The nation's sole petroleum refinery, supplied by imported crude oil, accounted for about one-half of the nation's petroleum product requirements.

Mining accounted for 12% of the GDP while industrial production accounted for 21% of the GDP. Public and private investment programs focused on fisheries, iron ore mining, gold recovery from copper mine tailings, intensified hydrocarbon exploration, and infrastructure development.

## GOVERNMENT POLICIES AND PROGRAMS

The Government's economic reform package is entitled "Program for Consolidation and Growth." Its main objective continues to be the introduction of greater liberalization of the economy. Eager to attract private funds, the Government liberalized the investment code, guaranteeing the freedom of repatriation of profits and capital without limitations. Another reform was adopted in October 1992 that devaluated the local currency by 22% to win favor with international financial institutions.

## PRODUCTION

The extraction and beneficiation of iron ore remains the nation's leading mineral industry. In 1992, the bulk of iron ore production was derived from the Tazadit Mine. Reduced output from the El Rhein Mine in The Guelbs was only

partially compensated by the opening of the D'kheilet surface mine in late 1992. Production from the M'Haoudat Mine should commence in 1993, supplementing production from the mines near exhaustion in the Kedia d'Idjill region. Improved output figures are anticipated for 1993.

Gold extraction from the Akjoujt copper mine tailings commenced with the bulk of production destined for export. (See table 1.)

## TRADE

Mauritania's most vital mineral export commodity continues to be iron ore. Exports dropped to 8.1 Mmt valued at \$165 million in 1992, considerably below 1991 exports of 10.5 Mmt valued at \$198 million. The reduced export volumes resulted from decreased output from mines nearing depletion and technical difficulties at the El Rhein Mine concentrator. Shipments were for the most part delivered to the steel mills of the EC. Leading importers in 1992 were Italy at 1.9 Mmt, France at 1.8 Mmt, Belgium-Luxembourg at 1.6 Mmt, and the United Kingdom at 1.0 Mmt. Other importers, by order of volume, were Spain, the United States, Germany, Japan, Pakistan, Portugal, and the Netherlands. Export earnings should improve in 1993 as new mines are brought into production.

In 1992, gold was added to the list of mineral export commodities. Exports were reported at 826 kg valued at nearly \$7 million. Other mineral exports were possibly small quantities of plaster products.

Petroleum product imports in 1992 were approximately 1.5 Mbbl and accounted for almost one-half of

consumption; the remainder was supplied from the refining of imported crude oil. Other mineral imports included about 12,000 mt/a of salt.

## COMMODITY REVIEW

### Metals

**Gold.**—Gold recovery operations by Mines d'Or d'Akjoujt (MORAK) from the tailings of the Akjoujt copper mine were under way. Investment capital for the project included a \$3 million loan from the World Bank's International Finance Corp. matched by \$3 million advanced by MORAK shareholders in proportion to their equity. The mine tailings total 2.5 Mmt with an average gold content of 3.1 g/mt. Gold output was approximately 900 kg in 1992. Virtually all of the production was exported. The small scale of the project will not seriously impact Government revenues or the balance of trade but it does represent new foreign investment and a diversification of the country's exports.

**Iron Ore.**—Iron ore mining operations were conducted by Société Nationale Industrielle et Minière (SNIM) in northwestern Mauritania. A surface mine was brought into production in 1992 with output in the first full year of production approaching 2 Mmt. Site preparation for the 30-Mmt ore body containing 64% to 67% Fe at D'kheilet, 8 km southeast of the Tazadit pit, was completed in 1 year. Development expenses here were minimized by the proximity of the Tazadit ore crusher and rail loading equipment.

Production from M'Haoudat, 60 km northeast of Zouirat and 30 km from the

existing railway, is expected in 1993, and peak output from this ore body is planned at 6 Mmt/a. Construction of the railroad from El Rhein to the M'Haoudat deposit was under way in 1992, offering no major problems in view of the flat terrain between the two points.

The Alexandria National Iron & Steel Co. and the Holding Co. for Metallurgical Industries, both of Egypt, along with Enterprise Nationale de Siderurgie and Ferphos of Algeria have joined SNIM in signing a protocol agreement on the construction of an iron ore pelletizing plant. The plant's capacity is projected at 5 Mmt/a of 68% Fe pellets. The product market has been identified as direct reduction plants in several Arab countries. The project involves mining and beneficiation at Ayouj, 30 km north of F'Derik and 650 km from the Port of Nouadhibou. Mining is anticipated at the rate of 11 Mmt/a. The pellet plant construction site is to be determined after a feasibility study considering both the mine site and Nouadhibou as optimum locations for the plant.

### Industrial Minerals

Production for the present is limited to gypsum and salt extracted by Société Arabe des Industries Metallurgiques Maritano-Koweitiennes (SAMIA). Gypsum is extracted from the N'Drahamcha quarry, 50 km northeast of Nouakchott. Salt is recovered from coastal areas near Nouakchott. Gypsum output satisfies local demand. Salt production, however, does not meet the fishing industry's heavy requirements, resulting in annual imports of about 12,000 tons.

Although promising phosphate rock deposits have been discovered in remote regions of southern Mauritania, their development would require high infrastructure costs. Exploitation of the deposits for direct application to soils as a fertilizer remains, however, under consideration. (See table 2).

### Mineral Fuels

**Petroleum.—Exploration.—** Exploration activities continued by Texaco and Amoco in the southern and central coastal waters, progressing as required by the terms of their respective exploration agreements.

**Refining.—**Mauritania's sole refinery, Nouadhibou, is owned by the Société Mauritanienne d'Industrie de Raffinage (SOMIR) and operates under the technical management of Naftal, an Algerian oil corporation. The 20,000-bbl/d-capacity refinery supplies about one-half of the nation's demand for refined products.

### Reserves

Information was limited to copper, gold, iron ore, phosphate rock, and salt. In addition to the iron ore reserves listed in table 3, iron ore reserves in the western Guelbs are described as probable and reported at 980 Mmt by SNIM. (See table 3.)

### INFRASTRUCTURE

A major barrier toward investment and development is the limited infrastructure. Commonly, it is the poor infrastructure that has rendered all but the largest deposits uneconomic. There are only two paved high-quality long-distance roads in Mauritania. Internal air transport is the quickest and in some cases the only viable mode of transport. Mauritania's single railroad specializes in carrying iron ore to Nouadhibou.

The nation's road system totals 7,525 km, of which 1,685 km is paved and 1,040 km is surfaced with gravel or crushed stone. The sole railroad in Mauritania is owned and operated by SNIM for the transport of iron ore from the mines to the export terminal. The 1.435-m standard-gauge railroad extends over 700 km from M'Haoudat to the port at Nouadhibou.

### OUTLOOK

Existing and proposed mining operations suggest an improved outlook for the nation's economy. During 1992, the EC provided \$3.5 million for a prospecting program for identifying gold and silver deposits that will be slated for private investment and development. Fortunes are, however, largely dependent on the successful development of the M'Haoudat iron ore project, which would ensure continued mining for the next 20 years. The development of the M'Haoudat deposit was the Government's largest project in 1992. The first portion of the financing, \$90.25 million, was released. The improved outlook at SNIM offers much needed stability to the economy. However, the ultimate success of this project is dependent on favorable world iron ore prices.

Border disputes between the Governments of Senegal and Mauritania have not as yet been resolved, contributing to tensions between the two Governments. Other factors bearing on the availability of financial support for the mineral economy are the nation's heavy external debt burden and significant fiscal balance of payments deficits.

<sup>1</sup>Where necessary, values have been converted from Mauritanian ouguiya (UM) to U.S. dollars at the rate of UM79.3 = US\$1.00.

### OTHER SOURCES OF INFORMATION

Société Nationale Industrielle et Minière (SNIM)  
20 Rue de la Paix  
Paris, France 75002

TABLE 1  
MAURITANIA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

Commodity <sup>2</sup>		1988	1989	1990	1991	1992 <sup>3</sup>
Cement <sup>3</sup>	metric tons	90,000	90,000	90,000	90,000	90,000
Gypsum <sup>4</sup>	do.	6,000	6,400	8,000	2,839	<sup>5</sup> 3,084
Iron and steel:						
Iron ore:						
Gross weight	thousand tons	10,004	12,110	11,590	10,246	<sup>5</sup> 8,202
Iron content <sup>5</sup>	do.	6,500	7,150	6,800	6,500	5,330
Petroleum refinery products	thousand 42-gallon barrels	2,000	1,515	2,000	1,800	2,000
Salt <sup>6</sup>	metric tons	5,500	5,500	5,500	5,500	5,500

<sup>6</sup>Estimated.

<sup>1</sup>Table includes data available through Mar. 15, 1993.

<sup>2</sup>In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (clays, sand and gravel, and stone) presumably are produced, but output is not reported quantitatively, and available information is inadequate to make reliable estimates of output levels.

<sup>3</sup>From imported clinker.

<sup>4</sup>May include about 3,000 tons of plaster in 1988-90.

<sup>5</sup>Reported figure.

TABLE 2  
MAURITANIA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Cement	Societe Ciment de Mauritanie (Government, 71%; private 29%)	N'Drahamcha	60.
Copper, 25% concentrate	Mines d'Or Akjoujt (MORAK) (Societe Arabe des Mines de'Inchirri, 45%; Minroc Holdings of Australia, 42.5%; International Finance Corp. World Bank, 12.5%)	4 kilometers west of Ajkoujt	65.
Gold kilograms	do.	do.	1,250.
Gypsum	Societe Arabe des Industries Metallurgiques (Societe Nationale Industrielle et Miniere, 50%; Kuwait Foreign Trading, Contract and Investment Co., 50%)	N'Drahamcha	120.
Iron ore	Societe Nationale Industrielle et Miniere (SNIM) (Government, 77%; Kuwait Real Estate Investment Consortium, 7.6%; Arab Mining Co., 6%)	Kedia d'Idjill	9,000. 60%-65% Fe.
Do.	do.	The Guelbs	2,000. 37% Fe.
Petroleum products thousand barrels	Societe Mauritanienne d'Industrie de Raffinage (Government, 100%)	Nouadhibou	7,300.
Salt	Societe Arabe des Industries Metallurgiques (Societe Nationale Industrielle et Miniere, 50%; Kuwait Foreign Trading, Contract and Investment Co., 50%)	2 kilometers north of Nouakchott	6.

TABLE 3  
MAURITANIA: RESERVES OF MAJOR MINERAL COMMODITIES FOR 1992

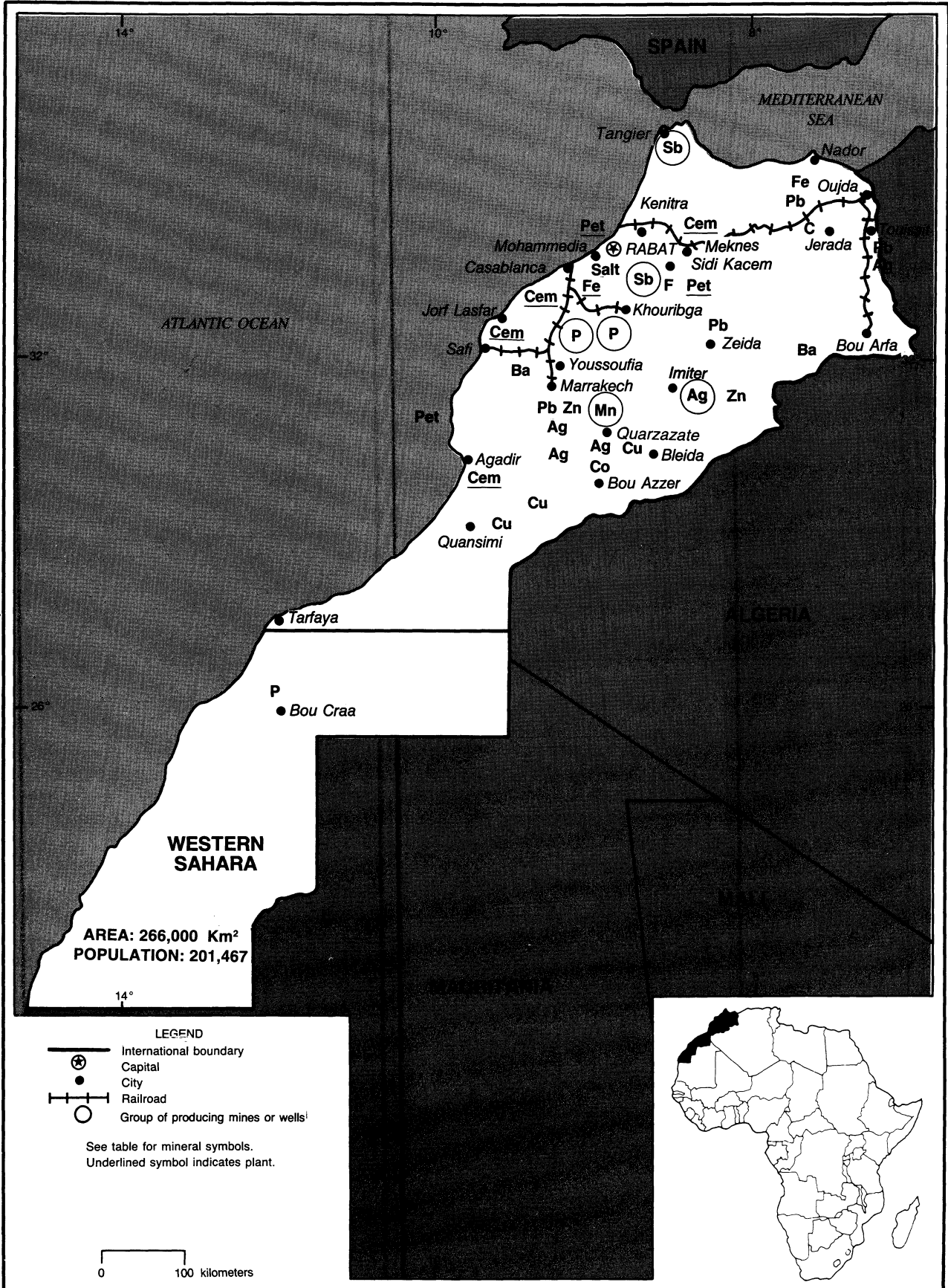
(Million metric tons unless otherwise specified)

Commodity	Reserves
Copper	100 ore at 2.25% Cu.
Gold	100 ore at 1.17 grams Au per ton. 2.5 tailings averaging 3.1 grams Au per ton.
Iron ore	155 hematite at 60% to 68% Fe. 531 magnetite at 36% to 40% Fe.
Phosphate rock	100 ore at 20% P <sub>2</sub> O <sub>5</sub> .
Salt, rock	452 ranging from 89% to 98% NaCl.

# MOROCCO AND WESTERN SAHARA

AREA 446,550 km<sup>2</sup>

POPULATION 26.7 million



**WESTERN SAHARA**

AREA: 266,000 Km<sup>2</sup>  
POPULATION: 201,467

**LEGEND**

- International boundary
- Capital
- City
- Railroad
- Group of producing mines or wells<sup>1</sup>

See table for mineral symbols.  
Underlined symbol indicates plant.

0 100 kilometers

# MOROCCO AND WESTERN SAHARA

By Thomas P. Dolley

## MOROCCO

The Kingdom of Morocco remained a world leader in the production of nonfuel minerals in 1992. As of 1991, the mineral industry of Morocco, which is controlled by the Government, accounted for a 0.9% share of the total global output of nonfuel minerals. Additionally, Morocco is the largest producer of nonfuel minerals among North African nations. Phosphate mining accounted for 94% of an industry that produced a variety of minerals. By yearend 1992, a significant global drop in demand and the concomitant drop in prices hurt Morocco's receipts for phosphate product exports for the year.

Morocco is a significant producer of antimony, barite, copper, fluorspar, iron ore, lead, manganese, salt, silver, and zinc. Indeed, exploitation of copper and silver in Morocco dates back to antiquity, as evidenced by ancient tailings piles and underground workings.

The mineral sector of Morocco remains committed to substantial investment in the industry, despite some global downturns or oversupply in certain mineral commodities. Mining is Morocco's largest foreign exchange earner, and mining activity usually accounts for 3.5% of the GDP. This percentage increases to more than 9% of GDP if downstream products of the mineral industry are included. The estimated Moroccan GDP for 1992 was \$28 billion.<sup>1</sup> According to official statistics, the 1992 GDP dropped by about 3% from the previous year. This was due to the agriculture sector's contribution to the GDP declining from 21% to 15%. The agriculture sector's

loss was caused by a drought in 1992 and was ongoing into 1993. Morocco's trade revenue thus was negatively affected by the importation of millions of tons of food to offset the downturn. Total external debt for Morocco was slightly more than \$21 billion. The last external debt rescheduling was in February 1992, coupled with a \$2.7 billion debt writeoff by Saudi Arabia, ostensibly to reward Morocco's support of coalition forces in the Persian Gulf War. Government-funded construction projects continued to be curtailed, continuing a trend that began in 1991. Businesses were also affected by a more conservative bank lending policy. Per capita GNP for 1992 in Morocco was \$1,030. Unemployment in urban areas is estimated at 20%, and there was considerable underemployment in rural areas.

Positive economic development was exemplified by an increase in total foreign investment from \$375 million in 1991 to \$504 million in 1992. France is the most heavily vested of foreign interests in Morocco at \$118.6 million in 1992, followed by Spain at \$95 million. The United States increased investment capital from \$10.6 million in 1991 to \$34.4 million in 1992.

## GOVERNMENT POLICIES AND PROGRAMS

Morocco gained independence from France on March 1, 1956, and achieved independence for territories controlled by Spain on April 7, 1956. The nation became the Kingdom of Morocco on August 11, 1957. The Government is a constitutional monarchy. The year 1992 was highlighted by the Government's

repeal of laws limiting foreign ownership in Moroccan companies.

Current mining legislation in Morocco is based on Mining Code Bill No. 1-73-412 of August 13, 1973. This legislative series is also known as the 1973 Law on Moroccanization, which had sections repealed in 1990 and 1992. In 1990, the mining law was revised so that the Government was required to respond within 2 months to any foreign investment proposal and, if not, the contract presumably would be null and void. Generally, any mining law revisions were intended to expedite the bureaucratic process. Additionally, under the revisions, if a foreign mining company determined that a deposit under investigation is uneconomic, it could withdraw from Morocco with no penalty.

Regulations concerning the management of petroleum and natural gas resources were revised in June 1991 to provide further incentives for international companies. The revised law reduced the Government's share in agreements with international operators from 50% to 35%. Additionally, the law provided for corporate tax relief. Exploration activity will be fully deductible for more than 10 years for newcomer contracts and more than 3 years for preexisting operators in Morocco. Upon the discovery of a commercial hydrocarbon resource, concessionary fees for the corporation are not required for the first 28 Mbbl of oil or natural gas produced. Furthermore, the petroleum tax is waived covering the initial 3 years of production. To complement these new measures, exploration permit sizes were reduced to 2,000 km<sup>2</sup> from 5,000 km<sup>2</sup>, and the

minimum duration of an agreement was reduced from 15 years to 8 years. In 1992, the Government abrogated the 1974 Moroccanization Law, which pertained to petroleum refining and distribution. These latter legal changes were designed to allow foreign companies to participate in the privatization of parastatals in the petroleum sector. The Moroccan mining laws stipulate the conditions for investment for a foreign operator, which in general have become more liberal with the more recent amendments.

## PRODUCTION

In the face of declining international markets in 1992, production of most ferrous and nonferrous metals declined, along with most industrial mineral commodities. There were, of course, some exceptions, notably cobalt, where increases in production were driven by the rising global market price. Morocco continued to expand nonferrous metal production capacity during the year, in anticipation of the nation's emergence as a major producer in the Mediterranean basin. Morocco remained a major world producer of phosphate rock and fertilizers, including phosphoric acid, diammonium phosphate (DAP), and triple superphosphate (TSP). Fertilizer production for 1992 totaled 2,241,000 tons. (See table 1.)

## TRADE

The value of all Moroccan exports dropped in 1992 to about \$4 billion. The value of all Moroccan imports in 1992 was \$7.4 billion. Historically, the export of mineral commodities plays a significant role in the Moroccan economy. Phosphate products are the most important exports and include bulk phosphate rock, phosphoric acid, and fertilizers. Morocco is the world leader in phosphate exports. However, the phosphate sector's share of total exports has declined from 43% in 1983 to about 24% by yearend 1992. The value of exported Moroccan phosphate products dropped from \$1.2 billion in 1991 to slightly more than \$1 billion in 1992. Of

these phosphate products, the value of exported fertilizers declined by the greatest percentage. The international price for phosphate was \$42.5/mt at the beginning of 1992 and continued to fall throughout the year. The price decline continued, dropping to \$38/mt in May 1993, and covered additional products such as phosphoric acid, DAP, TSP, and potassium chloride (KCl). As of 1992, all exported mineral commodities were subject to a 0.5% value added tax, which fluctuates according to the current world market value for that particular mineral commodity. Additionally, approximately 40% of Morocco's resurgent tile and ceramics industry is exported, mainly to markets in North Africa, Europe, and the Middle East. U.S. imports of Moroccan fluorspar, grading more than 97% calcium fluoride (CaF<sub>2</sub>), declined from 10,950 tons in 1990 to 9,828 tons in 1991, the last year for which data are available.

Morocco exports cement to both Spain and Algeria. Morocco exported 7,877 tons of cement to Spain and 19,141 tons of cement to Algeria in 1991. However, in 1992, Moroccan cement exports had only one destination, to Spain, at 1,486 tons. Moroccan imports of clinker and white cement were 233,526 tons in 1991 and increased to 400,000 tons in 1992.

Due to a lack of domestic hydrocarbon resources, Morocco imports a vast percentage of its petroleum needs. The petroleum importation has had a perennially negative effect on the nation's balance of trade. In 1991, total petroleum imports were 35,339,255 bbl, of which slightly more than 12 Mbbbl was imported from the United Arab Emirates. In 1992, total petroleum imports were 47,098,499 bbl, of which slightly more than 16 Mbbbl was imported from Saudi Arabia.

Total Moroccan coal imports dropped 13%, from 1,398,264 tons in 1991 to 1,215,225 tons in 1992. The United States remained the leading coal supplier to Morocco in 1992, despite an 80,000-ton drop in tonnage from the previous year. The United States supplied 63% of total Moroccan coal imports. The electrical generation sector of the Moroccan economy utilized 577,075 tons

of coal, and the cement sector utilized 606,577 tons of coal in 1992.

Labor is a significant export and foreign exchange earner for Morocco. Historically, the exported labor is primarily to European destinations as opposed to exportation to other Arab states. Remittances from these workers amounted to about \$14.6 billion from 1973 to 1989.

## STRUCTURE OF THE MINERAL INDUSTRY

The mining industry of Morocco is controlled by the Government, specifically the Directorate of Mines, which is a department of the Ministry of Energy and Mines. The Directorate of Mines is charged with the elaboration and application of the national mining policy, in addition to the drafting and application of legislation and regulations pertaining to mining activities. The Directorate of Mines also controls the various parastatals and public companies involved in the mining industry, including the promotion of mining. Additionally, the Directorate of Mines manages mining properties, labor concerns, commercialization, and studies in mining, mineralogy, and metallurgy. Geographic administration is designed so that 15 different mining districts exist within Morocco. In total, the mining industry employed about 60,000 people, including 6,800 engineers and technicians. Approximately 12,000 laborers were involved in artisanal mining.

Established in 1928, the Bureau de Recherches et de Participations Minières (BRPM) is an autonomous public corporation involved directly or indirectly in the majority of all Moroccan mining enterprises, excluding hydrocarbons and phosphates. BRPM employs about 1,330 people, including 150 engineers. Founded in 1920, the parastatal Office Cherifien des Phosphates (OCP) manages and controls phosphate mining and is the world's largest producer of phosphate rock. OCP controls all aspects of the phosphate industry, including research, exploitation, and the production of

derivative products, such as fertilizers. OCP employs 30,000 people, including 700 engineers and technicians. Created in 1960, La Centrale d'Achat et de Développement de la Région Minière de Tafilalet et de Figuig (CADETAF) promotes the working of artisanal mines of barite, lead, and zinc in the regions of Tafilalet and Figuig. CADETAF provides technical, commercial, and social assistance to the artisanal miners. The Government parastatal that controls hydrocarbon exploration and production is the Office National de Recherches & d'Exploitations Pétrolières (Onarep).

Omnium Nord Africain (ONA) is the largest private company in Morocco. Additionally, ONA was one of the largest private African companies in Africa outside of the Republic of South Africa. The company is active in four areas: agricultural distribution, finance, mining, and high technology. As a conglomerate, ONA planned to invest more than \$700 million from 1992 through 1994. In 1991, ONA's business assets were valued at more than \$1.5 billion with a profit of \$62.6 million. ONA's mining subsidiary, Pole Mines, contributed 5.7% or \$87.9 million to ONA's 1991 profits and \$79.2 million to the 1992 profit total. Pole Mines is involved in four significant Moroccan mining ventures. Pole Mines' equity ventures include the newly opened polymetallic Douar Hajar Mine with Cie. Minière de Guemassa (CMG); the Bleida copper mine with Société Minière de Bou-Gaffer (SOMIFER); the globe's only primary cobalt mine at Bou Azzer operated by Compagnie de Tifnout-Tiranimine (CTT); and the El Hammam fluorspar mine operated by Société Anonyme de Entreprises Minière (SAMINE). All of the latter joint ventures are with BRPM. The only other joint venture in which Pole Mines is not the sole operator is the silver mine at Imiter, operated by Société Metallurgique d'Imiter (SMI) with equity ownership by BRPM. Pole Mines also is involved in chemicals, engineering contracting, mineral exploration, and transport.

Privatization within Morocco is ambitious with respect to the different types of industries that are included in the

program. Approximately 112 companies valued at \$2 billion are expected to be privatized by yearend 1995. In 1992, external financing as direct investment offset the current account deficit of \$500 million. However, foreign investment covered only 50% of the current account deficit in 1992. Some of the privatization schemes include elements of the mineral industry. The companies and their estimated values were as follows: the cement manufacturer Cimenterie de l'Oriental at \$71.5 million, gas distributor Société Pétroles du Maghreb at \$14.3 million, the petrochemicals company Société Nationale d'Electrolyse et de Pétrochimie at \$42.5 million, gas distributor Compagnie Marocaine des Hydrocarbures at \$11.6 million, and coal distributor Sococharbo at \$5.5 million. (See table 2.)

## COMMODITY REVIEW

Geologically, Morocco is divided into four main provinces. The Anti-Atlas and Saharan province is dominated by Precambrian basement rocks associated with Precambrian through Paleozoic sediments. The Atlantic Meseta province is dominated by deformed Paleozoic rocks. The Atlas province is dominated by the Atlas Mountain range, deformed by the Alpine orogeny. Finally, the Rif province is composed of rocks tectonically influenced by the Sole orogeny and continuous with the Betic Cordillera of Spain. This province covers the entire northern part of Morocco and is representative of the Alpine orogeny at its most western extent in the Mediterranean.

### Metals

**Cobalt.**—CTT operates the world's only primary cobalt mine at Bou Azzer. Silver and chromium ore also are won from the mine. The cobalt concentrate produced grades in excess of 10% Co. Geologically, the cobalt ore was associated with copper-iron-nickel arsenides in altered igneous rocks of an ophiolite complex.

During 1992, further exploration

around the mine was initiated in conjunction with Zaroubzhgeologia, a company of the former U.S.S.R. Specifically, the areas west and east of the mine, at Bou-Offroh and Aït Ahmane, are the targets for intensive exploration. Additionally, a new company was formed in 1992, Compagnie Minière de Bou Azzer, to conduct a feasibility study on further beneficiation of CTT's cobalt concentrate. Other projects associated with cobalt are being planned.

**Lead and Zinc.**—CMG's Douar Hajar Mine, approximately 30 km south of Marrakech, officially opened in December 1992; however, the mine had been producing ore for several years. CMG had equity ownership of 74% by ONA and 26% by BRPM. The Douar Hajar Mine will effectively double Morocco's nonferrous metal production. Additionally, the mine is the second largest zinc mine after Ireland's Tara Mine in the European and Mediterranean region. Most of the concentrates produced were exported to the European market. In 1992, production rates at Douar Hajar were 130 kmt/a of Zn, 32 kmt/a of Pb, and 12 kmt/a of Cu. The anticipated mine life is 16 years, with polymetallic reserves of 12 Mmt.

At Douar Hajar, initial testwork from the pilot plant was not very successful because the metals were tightly bound to the sulfides in the rock, making beneficiation difficult. Using in-house development, CMG employed differential flotation and catalytic activation to achieve recoveries of 85% for lead, 70% for copper, and 90% for zinc. The process basically was as follows: (1) lime was added to a 10-mm feed of ore to the ball mill. The mixture was then cycloned down to a 10-micron size. (2) In flotation tanks, cyanide was added to chemically depress copper and zinc to allow for lead recovery. (3) Lead was collected. Zinc was depressed with the addition of lead nitrate. Copper was activated and collected. (4) Zinc was activated and collected with the addition of copper sulfate. Additionally, lime was also added between the copper and zinc circuit to raise the pH to 12. The concentrate



grades were as follows: lead concentrates of 60% to 70% Pb; copper concentrates of 25% to 35% Cu; and zinc concentrates of 50% to 54% Zn. In 1992, recoveries utilizing differential flotation were 92% Zn, 90% Pb, and 60% Cu. The concentrates produced are 65% Pb, 26% to 28% Cu, and 52% to 55% Zn, with the Zn undergoing a further magnetic separation process that will increase the Zn concentrate grade by 1% to 2%.

### Industrial Minerals

**Cement.**—Moroccan cement production continued to exhibit sustained growth over the past several years. Cement consumption rose 10% in 1992 to more than 6.3 Mmt. Total cement milling capacity was about 2.5 Mmt/a and cement kiln capacity was 2.2 Mmt/a. In 1992, France's Ciments Français inaugurated a new 600-kmt/a cement plant at Safi which is operated by Ciments du Maroc at an investment of more than \$106 million. This facility can be upgraded to 1 Mmt/a, depending on fluctuating regional market conditions. The cement plant at Agadir, originally built in 1952, has been refurbished and now has a capacity of 1 Mmt/a. Additionally, Ciments d'Agadir was merged with Cimasfir to form Ciments du Maroc. Ciments Français has a 53.2% equity ownership in Ciments du Maroc, whose market share equals 17% of Moroccan cement sales. Indeed, Ciments Français is the leading private group operating within Morocco's cement and concrete industry and has been involved in the country since 1952. By yearend 1992, Ciments Français employed 910 personnel in Morocco and expected profits of about \$89 million. Ciments Français' other interests in Moroccan cement include a 20% holding in Société des Ciments de Marrakech (ASMAR), ostensibly by purchasing Lafarge Coppée's of France 10% share of ASMAR's plant. Ciments Français holds a 37% interest in Société des Ciments D'Agadir and a 100% interest in Procimar. Though ready-mix concrete use in Morocco is currently low, Ciments Français is investing to keep pace of

new construction growth in Morocco. Since 1988, the company has invested in concrete plants and trucks that are near the major urban areas of Agadir, Casablanca, Fez, Marrakech, Rabat, and Safi.

Ciments Français' new operation is about 35 km north of Safi and 80 km south of Jorf Lasfar. Both of these areas are important ports on Morocco's Atlantic coast. The plant includes a clinker kiln line of Krupp Polysius design, supervised by Polysius SA of France, including a five-stage precalcining tower with a capacity of 500,000 mt/a of clinker.

**Fluorspar.**—Fluorspar production increased dramatically over the previous year from the El Hammam Mine, which is operated by SAMINE. SAMINE is also charged with fluorspar processing and marketing. The fluorspar processing plant capacity was 120,000 mt/a. The mine is 45 km from Meknes and produced a product grading 97.5%  $\text{CaF}_2$ . SAMINE's total investment from 1989-91 in the development of El Hammam was \$10.5 million. Part of this expenditure was for the preparation of a new mining site and to fund exploration in areas adjacent to El Hammam.

**Phosphate Rock.**—Phosphate rock is mined in several regions of Morocco; however, the most actively mined area is the Khouribga region. Khouribga represents the single largest phosphate-producing area in the world. Two open pit mining operations at Khouribga account for approximately 50% of all phosphate rock mined in Morocco. Other phosphate rock mining centers in Morocco are at Ben Guerir, Youssoufia, and at Bou Craa in the Western Sahara. Morocco's share of the global phosphate market is about 31%, despite depressed international markets. Phosphate rock production was valued at about \$475 million in 1992.

OCP's main expansion plans included doubling phosphate fertilizer production at the Jorf Lasfar plant on the Atlantic coast. By yearend 1992, OCP had ordered its seventh Marion dragline, to

join the other six Marion draglines already in service. This model 195-M crawler dragline, built by Marion Div. of Indresco Inc. of the United States, was scheduled to be delivered in 1993. The new dragline will be utilized at the Sidi Chenane mine and is equipped with a 12-m<sup>3</sup> bucket and a 46-m boom. Additional advanced features on the dragline include static power conversion and a personal computer-based diagnostics system.

### Mineral Fuels

Currently, Morocco is not self-sufficient in hydrocarbon resources. Petroleum imports have offset negatively the balance of trade for the past several years. Crude petroleum refining capacity is about 155 kbb/d. In 1990, the last year that such data were available, total petroleum product demand was 117 kbb/d.

During 1992, research indicated that northern Morocco could be a significant source of hydrocarbons, amounting to reserves of 800 Mbbl to 1 billion bbl of crude oil, along with appreciable natural gas.<sup>2</sup> Furthermore, the first oil well was drilled in this area in 1890. In 1934, a development well in the Tselfat Field flowed at a rate of 1,500 bbl/d. Some further successful discoveries were made in the 1950's, but exploration faltered due, in part, to the complexity of the geology of northern Morocco. A joint exploration program was conducted in the 1970's by BRPM and France's Société Nationale Elf Aquitaine. The results were inconclusive.

### Reserves

The Government's estimated reserve of phosphate rock was approximately 22 billion tons. Estimated proved crude oil reserves total 2.1 Mbbl. Proven natural gas reserves total 1.2 billion m<sup>3</sup>. Sufficient reserves existed to sustain base metal production into the 21st century.

### INFRASTRUCTURE

The railroad network totaled 1,893 km

of 1.435-m standard-gauge single track. The highway infrastructure totaled 59,198 km, of which 27,740 km was paved. Crude oil pipelines totaled 362 km, and natural gas pipelines totaled 241 km. Morocco's merchant marine fleet was comprised of 51 ships totaling 487,479 dwt. Of these ships, there were 3 petroleum tankers and 11 chemical tankers. Major Moroccan ports are at Agadir, Casablanca, Jorf Lasfar, Kenitra, Mohammedia, Nador, Safi, and Tangier. OCP is conducting a feasibility study on the construction of a terminal to import up to 1 Mmt/a of sulfuric acid. The terminal would be built at Jorf Lasfar, but would not be operational before 1994. The nation's electrical generation capacity in 1992 was 2,270,000 kW.

By yearend 1992, the European Bank of Investment granted a \$98.4 million loan for the modernization of Morocco's telecommunications network to Europe. Approximately 80% of Morocco's telecommunications traffic was with the EC.

## OUTLOOK

The Government's medium- and long-term objectives for mineral development in summary are to: intensify mining research efforts; maintain and reinforce existing mineral production; expand or develop new mineral production capacity; and increase the production of value added mineral products and beneficiation. The Government also desires to eliminate its equity ownership in the mineral industry, excluding phosphate, primarily via privatization. The importation of significant amounts of hydrocarbons in 1992 continues to be a trade liability.

In the 1990's, the Mediterranean basin should represent a geographically and economically advantageous region for Morocco to operate in. Further industrialization would seem to be the key for Morocco's successful negotiation of a partnership agreement with the embryonic EC. Additionally, through privatization and alleviation of public-sector debt, the Government can form an economically cooperative framework of trade and development with the EC. Industry

analysts feel that the initial benefit for Moroccan relations with the EC will be a higher political profile for Morocco, which could lead to greater economic stability and investment.

## WESTERN SAHARA

Predominantly a hot, dry desert country, Western Sahara has a total land area of 266,000 km<sup>2</sup>. The region has been claimed and administered by Morocco since the mid-1970's. Peace talks aimed at a referendum to decide the fate of the Western Sahara have remained stalled. The talks involve the UN, Morocco, Algeria, and guerillas of the Polisario Front. The population, as of mid-1992, was 201,467.

In the Western Sahara, rainfall is negligible and most foodstuffs must be imported. Economic activity, including all trade, is controlled by the Moroccan Government. Fishing and phosphate mining are the main industries and sources of revenue. However, state-of-the-art irrigation technology is being used to develop the agricultural sector in Western Sahara. Produce from the area is exported to France. The only significant mineral production in the region is from the phosphate mine at Bou Craa. Production data from Bou Craa are included in total Moroccan phosphate output. Total phosphate rock production from Bou Craa was 1.3 Mmt in 1992. In 1992, ore that was produced there is of 79% to 80% bone phosphate of lime (BPL) grade, all for export.

<sup>1</sup>Where necessary, values have been converted from Moroccan dirhams (DH) to U.S. dollars at a rate of DH8.56=US\$1.00.

<sup>2</sup>Bhattacharjee, Kumar S. Northern Morocco Has Ingredients for Fruitful Exploration, Deserves a Modern Look. *Oil and Gas Journal*, Sept. 7, 1992, pp. 54-56.

## OTHER SOURCES OF INFORMATION

### Agencies

Association of African Geological Surveys  
Association des Services Géologiques  
Africains  
M. Beisaid, Institut de Géologie, Nouveau  
Quartier Administratif

Agdal-Instituts, B.P. 6208  
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Groupe Office Chérifien des Phosphates  
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Angle route d'El Jadida et boulevard de la  
Grande Ceinture  
Casablanca, Morocco  
Telephone: 23-00-25, Fax: 23-06-35  
Groupe ONA  
52 Avenue Hassan II  
Casablanca, Morocco  
Telephone: 011-212-2-224102, Fax: 011-212-2-261064  
Ministère de l'Energie et de Mines  
5 Rue de Rich, Tour Hassan  
Rabat, Morocco  
Office des Changes  
31, Rue Patrice Lumumba, B.P. 71  
Rabat, Morocco  
Telephone: 72-12-85, 73-19-72, 73-15-42;  
Telex # 362 59

### Publications

Le Secteur Minière Marocain Situation et Perspectives, Ministère de l'Energie et des Mines, Rabat, Morocco.  
Statistique de Commerce Extérieur  
Rabat, Morocco.

TABLE I  
MOROCCO: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>  
(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992 <sup>*</sup>
<b>METALS</b>					
<b>Antimony concentrate:</b>					
Gross weight	555	316	426	200	200
Sb content	250	142	192	90	90
Chromite	1,000	1,000	300	500	500
<b>Cobalt concentrate:</b>					
Gross weight	2,384	1,144	1,830	2,953	<sup>3</sup> 4,194
Co content	253	121	194	325	461
<b>Copper:</b>					
Concentrates, gross weight	41,001	44,033	45,332	42,220	<sup>4</sup> 38,114
Matte, gross weight	2,981	2,126	2,322	2,492	<sup>2</sup> 2,177
Cu content, concentrates and matte	15,396	15,988	16,411	15,838	14,317
<b>Iron and steel:</b>					
<b>Iron ore:</b>					
Gross weight	114,209	175,600	147,825	98,676	<sup>8</sup> 82,625
Fe content	69,668	107,116	90,173	60,192	51,227
<b>Metal:<sup>o</sup></b>					
Pig iron	15,000	15,000	15,000	15,000	15,000
Steel, crude	7,200	7,200	7,200	7,200	7,000
<b>Lead:</b>					
<b>Concentrate:</b>					
Gross weight	100,221	93,513	95,529	102,389	<sup>3</sup> 104,939
Pb content	72,159	67,329	68,781	73,720	76,605
Cupreous matte, Pb content	775	553	604	648	566
<b>Metal:</b>					
Smelter, primary only	<u>68,410</u>	<u>63,676</u>	<u>64,512</u>	<u>70,606</u>	<u><sup>6</sup>68,563</u>
<b>Refined:</b>					
Primary	68,410	<sup>6</sup> 63,000	<sup>6</sup> 64,000	<sup>7</sup> 70,000	<sup>6</sup> 68,000
Secondary <sup>o</sup>	2,000	2,000	2,000	2,000	2,000
Total <sup>o</sup>	<u>70,410</u>	<u>65,000</u>	<u>66,000</u>	<u>72,000</u>	<u>70,000</u>
Manganese ore, largely chemical-grade	30,100	32,000	49,450	59,255	<sup>3</sup> 44,320
Mercury, byproduct	kilograms	NA	NA	20,000	20,000
<b>Silver:</b>					
Ag content of concentrates and matte	do.	57,448	50,221	53,708	91,115
Ag content of mine and smelter bullion	do.	168,767	186,390	187,400	<sup>7</sup> 143,900
Total	do.	<u>226,215</u>	<u>236,611</u>	<u>241,108</u>	<u>213,286</u>
<b>Zinc concentrate:</b>					
Gross weight	21,304	33,913	36,860	47,709	<sup>4</sup> 42,649
Zn content <sup>o</sup>	10,865	18,652	18,799	24,331	22,604
<b>INDUSTRIAL MINERALS</b>					
Barite	321,562	370,000	363,580	433,325	<sup>3</sup> 401,000
Cement, hydraulic	thousand tons	4,220	<sup>4</sup> 4,200	<sup>4</sup> 4,200	<sup>6</sup> 3,340
<b>Clays, crude:</b>					
Bentonite	3,445	3,970	4,000	9,228	<sup>8</sup> 8,137
Fuller's earth (smectite)	52,694	48,820	45,230	37,552	38,000
Montmorillonite (ghassoul)	4,367	4,133	4,427	3,900	<sup>2</sup> 2,670
Feldspar <sup>o</sup>	1,000	1,000	1,000	1,000	1,000

See footnotes at end of table.

TABLE 1—Continued  
**MOROCCO: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>**  
(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992 <sup>3</sup>
<b>INDUSTRIAL MINERALS—Continued</b>					
Fluorspar, acid-grade	100,500	105,000	86,500	74,600	<sup>3</sup> 85,500
Gypsum <sup>4</sup>	450,000	450,000	450,000	450,000	450,000
Mica <sup>5</sup>	1,500	1,500	1,500	1,500	1,500
Phosphate rock (includes Western Sahara) thousand tons	25,015	18,067	21,396	17,900	<sup>3</sup> 19,145
P <sub>2</sub> O <sub>5</sub> content do.	<sup>6</sup> 8,061	<sup>6</sup> 5,781	<sup>6</sup> 6,906	<sup>6</sup> 5,700	<sup>6</sup> 6,178
Salt, rock	132,661	89,075	124,909	108,806	<sup>3</sup> 164,528
<b>MINERAL FUELS AND RELATED MATERIALS</b>					
Coal, anthracite thousand tons	637	504	526	551	<sup>3</sup> 576
<b>Gas, natural:</b>					
Gross million cubic meters	83	62	62	38	<sup>3</sup> 24
Dry do.	57	37	37	22	14
<b>Petroleum:</b>					
Crude thousand 42-gallon barrels	151	102	114	83	<sup>3</sup> 67
<b>Refinery products:<sup>7</sup></b>					
Distillate fuel oil do.	14,454	15,968	13,505	15,162	<sup>3</sup> 16,386
Gasoline do.	2,769	2,897	3,285	2,331	<sup>3</sup> 3,860
Jet fuel do.	1,640	1,684	1,825	1,461	<sup>3</sup> 1,705
Kerosene do.	347	386	365	341	<sup>3</sup> 351
Other do.	2,100	2,100	5,840	1,765	<sup>3</sup> 2,698
Refinery fuel and losses do.	1,500	1,500	1,460	688	<sup>3</sup> 172
Residual fuel oil do.	13,000	13,000	14,235	14,000	14,000
Total do.	35,810	37,535	40,515	35,748	39,172

<sup>1</sup>Estimated. NA Not available.

<sup>2</sup>Includes data available through Oct. 1993.

<sup>3</sup>In addition to the commodities listed, a variety of crude construction materials is produced, but available information is inadequate to make reliable estimates of output levels. Limestone quarried for cement manufacture is substantial; however, information is inadequate.

<sup>4</sup>Reported figure.

<sup>5</sup>Includes the following types of concentrates: copper (34,483 tons at 37% Cu); gold-silver-copper (3,631 tons at 9.9% Cu, 120 grams per ton Au, 870 grams per ton Ag).

<sup>6</sup>Cupreous matte containing 58% Cu, 26% Pb, 1,500 grams per ton Ag.

<sup>7</sup>Contained in copper concentrates and matte identified in footnotes 4 and 5 above and in lead concentrates (104,939 tons at 600 grams per ton Ag).

<sup>8</sup>Contained in a presumably mine-produced bullion: 103 tons at 99.7% Ag and lead smelter product 42 tons at 99.8% Ag.

TABLE 2  
**MOROCCO: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992**

(Metric tons unless otherwise specified)

Major commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Barite	Compagnie Marocaine des Barites (COMABAR) (50% BRPM)	Near Marrakech	270,000 concentrate.
Cobalt	Compagnie Tifnout Tiranimine (CTT) (40% BRPM)	Bou Azzer	5,000 concentrate, 150,000 ore.
Copper	Société Minière de Bou Saffèr (SOMIFER) (34% BRPM)	Bleida	50,000 concentrate.
Do.	Société Minière Marocaine (SOMIMA) (75% BRPM)	Quansimi	NA.
Do.	Société du Développement du Cuivre Near Quansimi de l'Anti-Atlas (SODECAT) (99% BRPM)		NA.

See footnotes at end of table.

TABLE 2—Continued  
**MOROCCO: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992**

(Metric tons unless otherwise specified)

Major commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Fluorspar	Société Anonyme de Entreprises Minières (SAMINE) (35% BRPM)	Near Khouribga	70,000 concentrate.
Lead	Compagnie Minière de Guemassa (CMG) (74% ONA, 26% BRPM)	Near Marrakech	130,000 Zn concentrate, 32,000 Pb concentrate, 12,000 Cu concentrate.
Do.	Compagnie Minière de Touissit (CMT) (50% Compagnie Royale Asturienne des Mines SA, Belgium)	Touissit	73,000 concentrate.
Do.	Société de Développement Industrie et Minière (50% BRPM)	Zeida	40,000 concentrate.
Manganese	Société Anonyme Cherifienne d'Etudes Minières (SACEM) (43% BRPM)	Near Quarzazate	130,000 concentrate.
Phosphate	million metric tons Office Cherifien des Phosphates (OCP) (100% Government ownership)	Khouribga and Youssoufia	25 concentrate.
Silver	Société Metallurgique D'Imiter (SMI) (69% BRPM, 31% ONA)	Near Quarzazate	73,000 ore.

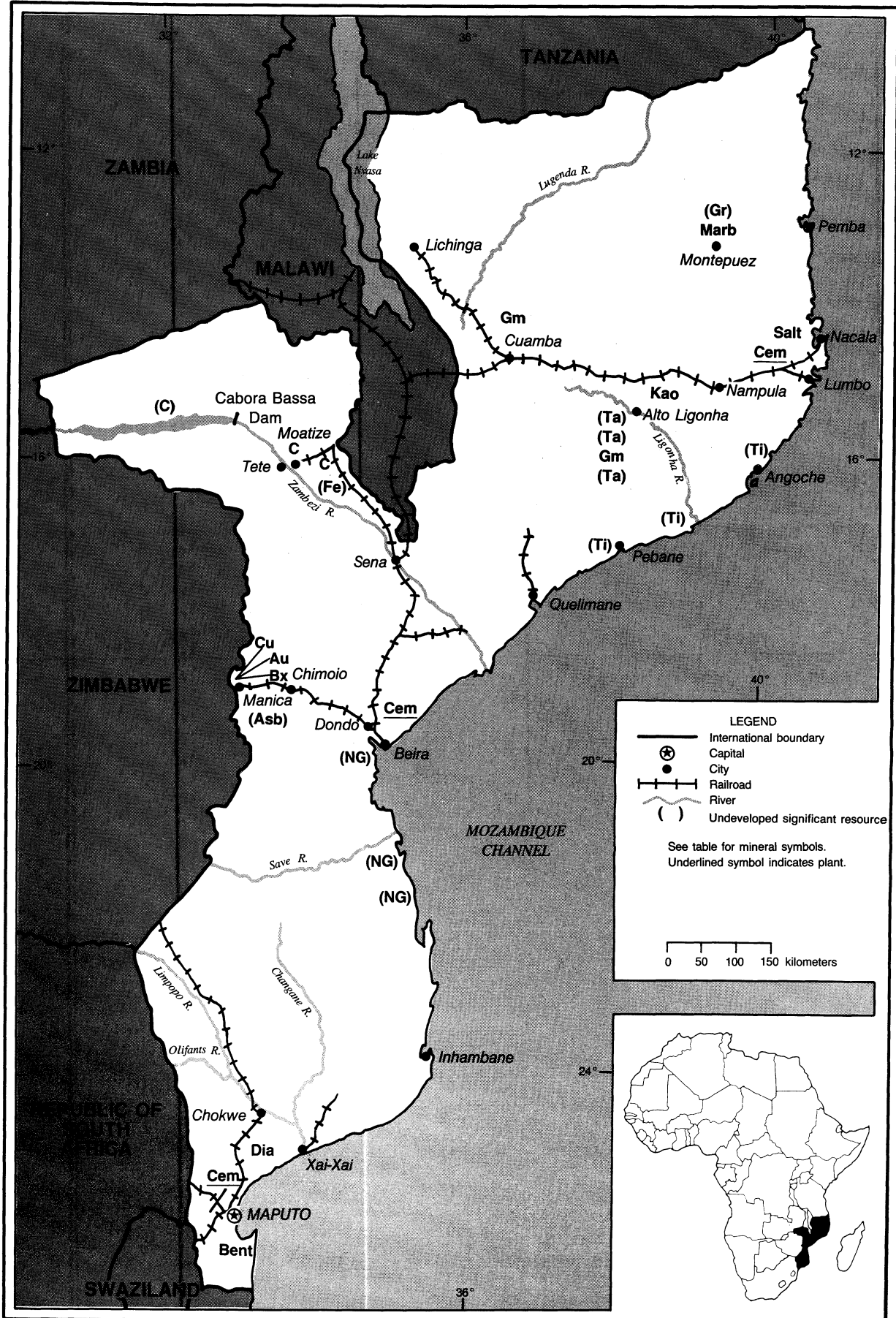
NA Not available.



# MOZAMBIQUE

AREA 801,590 km<sup>2</sup>

POPULATION 15.5 million



# THE MINERAL INDUSTRY OF MOZAMBIQUE

By Hendrik G. van Oss

The mineral industry of Mozambique in 1992, while continuing to provide much needed foreign exchange, was completely overshadowed by political developments. In October, a peace accord was signed between the Government and opposition forces, in theory bringing to a close a 16-year period of post-Independence civil strife. The improved security conditions brought on by the accord were welcome news to a long-beleaguered mining industry, as well as to the transportation and power generation sectors. A significant response to improved security was a reported increase in exploration license applications to the Government.

Output of primary minerals was mixed, with improvements seen, in the main, in gem and dimension stone production. (See table 1.) Primary mineral commodity sales, including faceted gemstones, were worth an estimated \$6 million, about the same as in 1991. Production data for cement and salt were not available, but output was likely worth an additional \$4 million, mostly in cement. Most of Mozambique's primary mineral production was exported; this trade amounted to an estimated 3% of total exports. Offsetting these values was the need to import finished cement, clinker for domestic cement production, and virtually 100% of the country's mineral fuel, fertilizer, and steel needs. These imports are estimated to have totaled about \$120 million, about 12% of total imports. There were no data available on Mozambique's GDP in 1992, but it was likely unchanged significantly from the \$1.5 billion in 1991.<sup>1</sup> As in past years, Mozambique's production economy was dominated by agriculture, which rebounded during the year with the ending of a multiyear drought.

Mozambique's ports and railways have traditionally been major components of the trade infrastructure of southern Africa. The transshipment of goods, particularly mineral commodities, to and from the country's inland neighbors has been an important source of foreign exchange, averaging about \$25 million/a in recent years, but reportedly having been in excess of \$100 million before Independence. Although still adversely affected by the ongoing insurgency, the transportation sector showed improvement in 1992—the result of ongoing port and railroad rehabilitation projects and a partial cease-fire signed toward yearend 1990. However, full advantage of infrastructural improvements was not realized because of economic difficulties experienced by Mozambique's inland neighbors. These difficulties were in part occasioned by drought-induced food and power shortages, but also because low world prices for certain export commodities could not support higher transport tariffs imposed by the Government.

Wages in the Mozambique mineral and mineral transshipment industry are estimated to have totaled about \$5.5 million in 1992, substantially unchanged from the previous year. Data were unavailable for 1992, but officially repatriated wages earned by Mozambique mine workers in the Republic of South Africa were reported to have been \$55.3 million in 1991. It is likely that unofficial repatriation of wages from these workers was of similar magnitude. These wages supported an estimated 300,000 persons in Mozambique.

The complexity of Mozambique's geology is reflected in the wide variety of mineral deposits found in the country. Many of these are associated with, or derived from, the Precambrian,

dominantly granitic, rocks that make up much of the northern one-half of the country. Complex pegmatites within this terrane, especially near Alto Ligonha, contain significant resources of tantalum with associated subordinate columbium, antimony, and bismuth, as well as rare-earth element minerals, lithium minerals, industrial and gem grades of quartz and beryl, and gem tourmalines. Farther to the north, granitic gneisses host potentially important graphite deposits. Metasedimentary inliers to this crystalline terrane host some locally important metamorphic deposits, notably of marble and garnet. Metasedimentary rocks near Manica host stratabound and vein gold deposits and some copper deposits. Lode and placer gold deposits have been mined in the past from this region, and currently one placer mine is operating there. Small bauxite deposits are also found in this area, including one that is currently being mined. Iron deposits in the area are not of economic grade. Precambrian gabbroic rocks found near Tete and Moatize host large low-grade iron-titanium deposits.

Near Tete, there is a 50- to 100-km-wide east-west strip of Permian rocks bounded by the Zimbabwe border on the west and south and by the Malawi border on the east. These rocks are of the Karoo System and contain major coal deposits, some of which are currently exploited on a small scale.

Rimming the Precambrian terrane on the Indian Ocean coast are Tertiary and Quaternary clastic rocks and sediments. The latter host economically important concentrations of titaniferous minerals (ilmenite and rutile), zircon, and monazite, derived from the granitic hinterland.

Most of the rest of the country is made up of Cretaceous and younger sedimentary rocks. These host a number



of deposits of industrial minerals, especially clays and diatomite. In the coastal area near Beira are structural basins that are prospective for petroleum and natural gas. The basins are associated with normal faults related to the East African Rift system. The country's natural gas reserves are in this area.

## GOVERNMENT POLICIES AND PROGRAMS

The Government continued its campaign to attract foreign investment in Mozambique's underdeveloped industrial sector. Mining is seen as having exceptional potential for expansion, both through the rehabilitation of existing mines and through the development of new reserves—most notably coal, natural gas, gemstones, and titaniferous sands. Because mineral commodity transportation comprises much of the commerce for the country's railroads and major ports, rehabilitation of this transportation infrastructure is considered vital to the economic health of the country.

The current mining law of Mozambique is law No. 2/86 of April 16, 1986, as modified by the mining law regulations, Decree No. 13/87 of February 24, 1987. The mining law provides for the formation of either wholly foreign-owned mining companies or joint ventures with the Government. Fiscal incentives in the law include a set 50% tax on profits and the right to repatriation of profits after tax. Also included are exemptions from import duties on mining equipment and from export duties on minerals. Provision is made for accelerated depreciation of capital investments. Royalties range from 3% to 10% of gross revenues, depending on the mineral(s) produced. A new mining law, rumored to both address some problems with the 1986 legislation and to reflect anticipated political changes, was being drafted. Petroleum and natural gas exploration and exploitation are governed by law No. 3/81 of October 3, 1981. Negotiations for hydrocarbon exploration leases are handled by the parastatal Empresa

Nacional de Hidrocarbonetos de Moçambique (ENH).

## PRODUCTION

As in the previous year, the production of most mineral commodities in 1992 was affected by equipment and power problems and by civil strife. Coal mining continued on a caretaker basis only; output, derived entirely from washed stocks, fell 75%. The railroad to the coal mines remained closed owing to security problems, and shipments from the mine continued to be by truck, at great expense. Cement production was from only one of the country's three cement plants and suffered further from inadequate foreign exchange to import clinker. Output from the country's only formal gold mine, in its second full year of production, fell significantly below expected levels.

Although data were limited, production of rough gemstones increased significantly in 1992, owing to the opening of an emerald (plus other beryls) mine near Alto Ligonha. Data were unavailable on the production of tantalum minerals and of dumortierite, both of which had small output reported for 1991—the first reported in several years. Dumortierite is believed to have been mined in 1992, but the same is less clear for tantalum (as microlite). The formal tantalum mines of Marropino, Morrua, and Muiane were all shut and severely damaged by insurgent activity in 1986. Two companies began exploring these deposits in 1991, with a view to reopening the mines, and the 1991 and estimated 1992 outputs were likely of a test or exploratory nature or could have been derived from stockpiles.

Marble output increased significantly, owing to rehabilitation work at the mine near Montepuez.

## TRADE

Only limited trade data for 1992 were available, but overall trade levels appear to have been slightly higher than those in 1991. Total exports are estimated to have amounted to about \$165 to \$170 million, of which mineral commodities amounted

to about 3%. Revenues from mineral transshipments are estimated to have increased only slightly to about \$25 million, largely due to higher transit tariffs. The amount of minerals transshipped was less than expected given the greatly improved security conditions in the country and the ongoing rehabilitation of the transportation infrastructure. This disappointing performance was mainly attributed to economic hardship in the neighboring countries. Agricultural output and revenues in these countries were at low levels, largely owing to multiyear drought conditions. Industrial output was down, particularly in Zimbabwe, in part because of drought-induced power shortages, but also because of low world prices for many industrial commodities. This was especially noticeable in asbestos and ferroalloy transshipments from Zimbabwe and the Republic of South Africa, and copper railings from Zambia. Coal transshipped from the Republic of South Africa and, to a lesser degree, from Zimbabwe declined in 1992, largely owing to competition from other coal ports in the region, most noticeably Richards Bay in the Republic of South Africa. However, coal transshipped from Swaziland increased modestly, notwithstanding the midyear closure of the only coal mine in that country. Granite transshipments from Zimbabwe were recorded in 1992, against none in 1991. Low agricultural and industrial revenues also affected the transshipment of imports to Mozambique's neighbors.

Imports of mineral commodities for domestic consumption are estimated to have amounted to about \$130 million, up about 10% from the previous year. Petroleum products imports fell by about 15% and are estimated to have accounted for about 80% of the total mineral imports. The import increases were largely of fertilizers, occasioned by better rainfall in 1992, and of both clinker and finished cement. Imports for the cement industry were, however, constrained by lack of funds. Electricity imports are estimated to have been worth about \$15 million.

## STRUCTURE OF THE MINERAL INDUSTRY

The mining industry of Mozambique remained underdeveloped, with most commodities produced by single operations only. The Government, through the Empresa Nacional de Minas, controlled a number of operations (see table 2.), but the degree of Government participation in the mining sector overall was falling. Foreign companies controlled the country's production of bauxite, gold, and much of its gemstones. Anticipated near-term new or additional production of bentonite, coal, diatomite, graphite, gold, and titaniferous sands was expected to be without significant Government equity participation. (See table 2)

## COMMODITY REVIEW

### Metals

**Aluminum.**—Kaiser Aluminum Co. held discussions with the Government to explore the possibility of building a 250,000 mt/a aluminum smelter either in Beira or Maputo. The smelter would take advantage of cheap electricity from the Cabora Bassa hydroelectric powerplant, which was expected to resume full-capacity generation once security conditions allowed the restoration of transmission pylons. Alumina for the smelter would be imported.

**Gold.**—Lonrho's placer gold mine near Manica performed below expected levels in 1992, evidently because of continuing technical problems. The plant reportedly also was being used to process gold concentrates brought in by artisanal miners in the area. Operation of the mine was reported to have been transferred during the year to a South African contractor.

Exploration for gold was ongoing during the year in the Manica area, both by Lonrho and other companies. A concession to start open pit operations at the old Monarch underground gold mine, idle since the 1950's, was announced, but no details were available.

**Tantalum.**—Exploration at the Marropino, Morrua, and Muiane mines near Alto Ligonha was reported to be ongoing during the year by Associated Ore & Manganese Ltd. of the Republic of South Africa and by the Mozambique company MINEX. Some modest production of microlite, evidently as a test run, was reported in 1991 and probably took place in 1992 as well.

**Titanium.**—BHP International Minerals signed an option with Kenmare Resources Plc toward the development of the Congolone titaniferous sands deposit, about 190 km southwest of Nacala, near Angoche. As part of the option, BHP was to do additional reserve delineation drilling at Congolone and, if the results were favorable, was to drill certain resources north of Congolone to prove additional reserves. By so doing, BHP would earn a 75% equity stake in the venture. Reserves already delineated by Kenmare were reported to be adequate for an annual production of about 450,000 tons of heavy mineral concentrates, mostly ilmenite.

In 1992, Edlow Resources Ltd. of the United States finalized joint-venture negotiations with Genmin of the Republic of South Africa toward the development of the large Pebane titaniferous sands deposit. Genmin, as part of the buy-in agreement, was to do reserve delineation drilling, commencing in 1993.

### Industrial Minerals

**Bentonite.**—Although bentonite production was nil during the year, interest was shown in future production by both South African and Egyptian companies.

**Cement.**—The Matola cement plant outside of Maputo was to be rehabilitated with French assistance. The plant's clinker-grinding capacity was to be increased to 1.3 Mmt/a from the current theoretical level of 600,000 mt/a. The Salamanga limestone quarry to the south, which used to feed the cement plant's kilns, also was to be rehabilitated. The quarry had been inoperative since 1984, when the connecting railroad was

destroyed by insurgents. Since then, the cement plant had operated on imported clinker. The plant closed in 1991, owing to lack of funds for such imports.

**Gemstones.**—Late in 1991, the parastatal gemstone mining and cutting company Gemas e Pedras Lapidadas E.E. signed a joint-venture agreement with an Israeli company to reopen an emerald mine in the Gilé District about 70 km south of Alto Ligonha. The mine, which had shut down in 1986 for security reasons, resumed operations in 1992. Gemstones in addition to emerald were reportedly produced by the mine, but data for these were not available.

**Graphite.**—Grafites de Ancuabe, a joint venture among Kenmare Resources Plc of Ireland, 65%; the Government, 25%; and the Commonwealth Development Corp., 10%, was formed during the year to exploit the Ancuabe graphite deposit north of Montepuez. Additional funding for the project was provided by the European Development Bank. Production of large flake graphite, at a rate of 5,000 to 10,000 mt/a from about 50,000 mt/a of ore, was to start in 1994.

### Mineral Fuels

A Norwegian-funded project to build a 135-kW powerplant to use natural gas from the Pande Field, about 170 km south of Beira, was largely completed in 1992. The nearby towns of Vilankulos and Inhassoro were to be supplied electricity by the plant; Vilankulos was connected during the year. This was the first commercial use of Pande gas. A much more ambitious project, to connect the gasfield with the Republic of South Africa, was set into motion in February with the signing of a development agreement between ENH and SASOL Ltd. of South Africa. Financing was being sought for the project.

### Reserves

Mozambique is a mineralogically diverse country; deposits that are or have been exploited include asbestos, various

clays, coal, copper, fluorspar, gemstones, gold, graphite, marble, rare earths, and tantalum. Output has generally been from small deposits, and reserve data are unavailable for most of these commodities.

Mozambique has large coal reserves, mostly in the Tete area. Exploitation to date has been confined to Moatize, where proven reserves, according to various Government publications, amount to several hundred million tons. The Government estimates, however, that the true exploitable resources of the Moatize and similar sedimentary basins in the region amount to at least 2 billion tons. The reserve potential of the region has attracted a great deal of attention from international coal companies in recent years, and the Government, along with Brazil's Companhia Vale do Rio Doce (CVRD), Lonrho, and Trans Natal Corp. of the Republic of South Africa, formed an informal joint venture to promote the large-scale development of the coal resources of the Moatize area. The venture was to seek approximately \$40 million, and possibly an operational partner, to undertake a full feasibility study. In 1991, CVRD completed a prefeasibility study which established that reserves were adequate to support a long-term output of 22 Mmt/a (9 Mmt/a salable). Several ore-shipping options were explored, and the study confirmed that extensive new railing and port coal-loading infrastructure would be required to support open pit coal mining on such a scale.

Mozambique's total resources of titaniferous sands have yet to be established but are believed to be large. This is based on the results of the two exploration programs completed in 1990, the areal extent of the country's exposed granitic terrane, and the long coastline receiving sediment input from that terrane. Proven reserves for Kenmare's Congolone deposit were announced toward yearend 1989 as 166.8 Mmt of dredgeable ore grading 3.25% heavy minerals. The recoverable heavy-mineral concentrate grades 77.35% ilmenite, 6.88% zircon, 1.66% rutile, 0.24% monazite, and 13.87% gangue minerals—mostly magnetite, kyanite, and

sillimanite. Resource estimates for Edlow's Pebane concession, based on prefeasibility work completed in 1990, were about 250 Mmt grading 5% heavy minerals, mostly ilmenite. Both projects have attracted international mining company joint-venture partners.

To date, economic crude petroleum resources have yet to be discovered. Mozambique has significant natural gas resources, most notably in the Pande Field. ENH claims that its recent work has confirmed recoverable reserves in the Pande Field of 40 billion m<sup>3</sup> and hopes to prove much higher reserves.

Numerous gold occurrences are known in Mozambique, notably in the Alto Ligonha and Tete regions and, especially, in the Manica area. In the past, small lode and placer mines have operated in the country, but exploration in recent decades has been very limited and little drilling has been done. Lonrho's gold reserves at its Chua River placer deposit had not been announced at yearend 1992.

Reserves of pegmatitic minerals such as beryl, columbite-tantalite, rare earths, spodumene, and tourmaline are difficult to determine. Few of Mozambique's numerous known occurrences of these, including placer deposits, have been explored in detail. In recent years, only the Muiane, Marropino, and Morrua pegmatites have been mined, chiefly for tantalum minerals. Current reserve data are unavailable for these three mines, the workings of which require extensive rehabilitation. Based on Government-supplied pre-1986 tantalum mineral production capacity data for the Muiane, Morrua, and Marropino deposits, it can be estimated that a 10-year reserve for these would total 1,000 to 1,500 tons of combined microlite and tantalite.

Mozambique has significant graphite resources, some of which were mined in the past. Most of the known occurrences are near Tete or in the northeast part of the country. According to the Government, graphite ore reserves, grading approximately 6% to 10% graphite, much of it coarse flake, exceed 10 Mmt. However, recent exploration for graphite in northeast Mozambique by Kenmare Resources reportedly has delineated resources of approximately 15

Mmt of ore grading about 2% to 5% carbon.

## INFRASTRUCTURE

Mozambique has 3,140 km of 1.067-m gauge railroads and 148 km of 0.762-m narrow gauge. Except for some spur lines to plantations and a few factories, the country's railroads are in six routes or "corridors." These routes are, from north to south, the Nacala Corridor, linking Nacala to Malawi; the Sena Corridor, linking Beira, via Dondo, to the coalfields at Moatize and to Malawi; the Beira Corridor, linking Beira to Zimbabwe; the Limpopo Corridor, linking Maputo with Zimbabwe; the Ressano Garcia line, linking Maputo to the Republic of South Africa; and the Goba line, linking Maputo to Swaziland.

Rehabilitation work was largely completed in 1991 on the Beira Corridor and, owing to continued improved security conditions, progressed rapidly in 1992 on the other lines, except for the Sena Corridor. By yearend, rehabilitation of the Nacala Corridor was about 70% complete, although it did carry traffic throughout the year. The Limpopo Corridor rehabilitation was expected to be complete by early 1993. The other lines required less work, except, again, for the Sena Corridor. The portion of this line to Malawi was contemplated for rehabilitation, but that to the Moatize coalfields was not, pending funding for massive development of coal reserves in the Moatize area. Such would require an entirely new railroad.

Rehabilitation and expansion of the port facilities at Maputo-Matola and at Beira continued.

In 1992, Mozambique's installed electrical generating capacity remained unchanged at 2,323 MW, of which 2,040 MW was accounted for by the Cabora Bassa hydroelectric plant. Sabotage of the main powerline pylons continued to prevent any export of Cabora Bassa electricity. Data on electrical generation were not available for 1992, but amounted to about 1,745 GW·h in 1991. Cabora Bassa's output was likely unchanged significantly in 1991 and 1992 from the 1990 output of only 94.4 GW·h

and remained for consumption by the cities of Tete, Quelimane, and Nampula. With the prospect of the end of fighting in Mozambique, both the Republic of South Africa and Zimbabwe were negotiating to purchase electricity from Cabora Bassa. An accord was signed early in the year to allocate 500 MW of Cabora Bassa's output capacity to Zimbabwe. This project would involve about \$200 million in new powerlines to connect with that country's grid and would generate about \$100 million/a in revenues. This cheap electricity, less than \$0.03/kW·h, attracted interest from South Africa, which had hitherto been reported as being no longer interested in this electricity source. It also attracted the interest of a major aluminum company, which was considering building a 250,000 mt/a aluminum smelter in Mozambique. Supplying Zimbabwe, the Republic of South Africa, and a large aluminum smelter would exceed the current capacity of the Cabora Bassa powerplant; however, the capacity could be doubled with the installation of additional turbines.

## OUTLOOK

There is considerable international interest in Mozambique's mineral potential, but large-scale investment in the mining sector is dependent on the end of major civil strife. The most likely mineral production developments in the near term will be for Mozambique to become a significant producer of titanium minerals and a modest producer of gemstones, gold, graphite, and, possibly, tantalum. It appears unlikely that significant improvement in coal output will be forthcoming from the current mines, given the uneconomic prospects for rehabilitating the railroad to the mining operations and the poor condition of the mines themselves. Large-scale development of coal in Mozambique would require major rail and port infrastructural development. The funding for this is uncertain. Cement production could greatly increase once the plants regain access to local limestone for the manufacture of clinker. Another long-term development would be large-scale

exploitation of the country's natural gas resources.

Transport sector rehabilitation should significantly increase the volume of goods transshipped through Mozambique and the revenues derived therefrom. Competition for this trade from other regional transportation routes, in part developed or improved in response to the problems with the Mozambique infrastructure, may prove to be a problem.

Given the significant impact of the repatriated wages from Mozambique mine workers employed in the Republic of South Africa, the prospect of continuing mine closures and massive layoffs, particularly in the gold sector, in the latter country is of concern.

<sup>1</sup>Where necessary, values have been converted from Mozambique meticalis (M) to U.S. dollars at the rate of M2,433.34=US\$1.00 for 1992 and M1,434.50=US\$1.00 for 1991.

## OTHER SOURCES OF INFORMATION

Ministério dos Recursos Minerais  
Direcção Nacional de Minas  
C.P. 2904, Maputo, Mozambique  
Telephone 258-1-427-121/420-024  
Fax 258-1-429-046  
Departamento de Cartografia e Produção de  
Cartas  
Direcção de Geologia Regional  
Instituto Nacional de Geologia  
C.P. 217  
Maputo, Mozambique  
Empresa Nacional de Hidrocarbonetos de  
Moçambique  
C.P. 2904  
Maputo, Mozambique

TABLE I  
MOZAMBIQUE: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992
Bauxite	6,548	5,501	7,186	7,760	8,340
Cement, hydraulic	69	75	79	30	30
Clays:					
Bentonite	986	126	—	682	—
Coal, bituminous	23,856	62,010	40,411	50,832	12,620
Copper:					
Ore, gross weight <sup>3</sup>	10,300	6,500	3—	—	—
Concentrate:					
Gross weight	660	420	3133	—	—
Cu content <sup>4</sup>	139	88	28	—	—
Gemstones:					
Cut stones, all types	26,552	19,766	13,385	12,906	8,447
Aquamarine	—	—	<sup>4</sup> NA	<sup>4</sup> NA	<sup>5</sup> 20,000
Beryl, morganite	—	913	<sup>4</sup> NA	<sup>4</sup> NA	<sup>5</sup> 5,000
Emerald	—	36	<sup>4</sup> NA	—	75,000
Dumortierite	—	—	—	73	<sup>5</sup> 50
Garnet <sup>5</sup>	2,026	1,966	2,558	1,281	1,500
Tourmaline	—	966	<sup>4</sup> —	<sup>4</sup> —	<sup>5</sup> 100,000
Gold <sup>6</sup>	—	—	63	394	296
Marble	940	687	488	238	919
Salt, marine <sup>6</sup>	37,500	40,000	40,000	40,000	40,000
Tantalum, microlite concentrates	—	—	—	266	<sup>5</sup> 100

<sup>1</sup>Estimated. <sup>2</sup>Revised.

<sup>3</sup>Data available through July 7, 1993.

<sup>4</sup>In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (other clays, sand and gravel, and stone) presumably are produced, but output is not reported quantitatively, and available information is inadequate to make reliable estimates of output levels.

<sup>5</sup>No mining occurred at the Mundonguara Mine, the country's sole copper producer, during 1990. Copper concentrate was produced from stockpiled ore.

<sup>6</sup>Production of gem beryls (aquamarine, emerald, morganite) was reported as not available, and that of tourmaline as nil. Although reported production of cut stones could have been from stockpiles, it is surmised that some of these stones were indeed mined in 1990-91. Information is inadequate to make reliable estimates of output levels.

<sup>7</sup>Facet-grade. In addition, there was waste garnet production, in kilograms, as follows: 1988--15,834; 1989--8,211; 1990--4,786; 1991--2,400; 1992--3,000.

<sup>8</sup>Does not include artisanal gold production, for which there were no data.

TABLE 2  
MOZAMBIQUE: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

(Metric tons unless otherwise specified)

Commodity		Major operating companies and major equity ownership	Location	Annual capacity
Bauxite		E.C. Meikle Plc of Zimbabwe	Open pit mine just west of Manica	10,000* bauxite.
Bentonite		Empresa Nacional de Minas (Government, 100%)	Luzinda deposit, 35 kilometers southeast of Maputo	1,000.*
Cement		Cementos de Moçambique (Government, 100%)	Cement plant at Dondo	75,000* <sup>1</sup> cement.
Do.		do.	Cement plant at Matola	100,000* <sup>1</sup> cement.
Do.		do.	Cement plant at Nacala	50,000* <sup>1</sup> cement.
Coal		Empresa Nacional de Carvão de Moçambique (Government, 100%)	Underground mines near Moatize	60,000* bituminous coal.
Gemstones		Niame Ltda. (Hagura of Israel and the Government)	Emerald and other beryl deposits near Alto Ligonha	NA.
Do.		Empresa Nacional de Minas (Government, 100%)	Several small-scale lode and placer operations near Alto Ligonha (beryl, tourmaline) and Cuamba (garnet)	NA.
Gold	kilograms	Aluviões da Manica Lda. (Lonrho Plc, United Kingdom, 80%; Government, 100%)	Placer operation near Manica	1,200* bullion.
Marble	cubic meters	Empresa Nacional de Minas (Government, 100%)	Quarry 5 kilometers north of Montepuez	2,500* blocks.
Salt		Numerous operations (mostly private)	Small seawater evaporation operations near most coastal cities	40,000.*

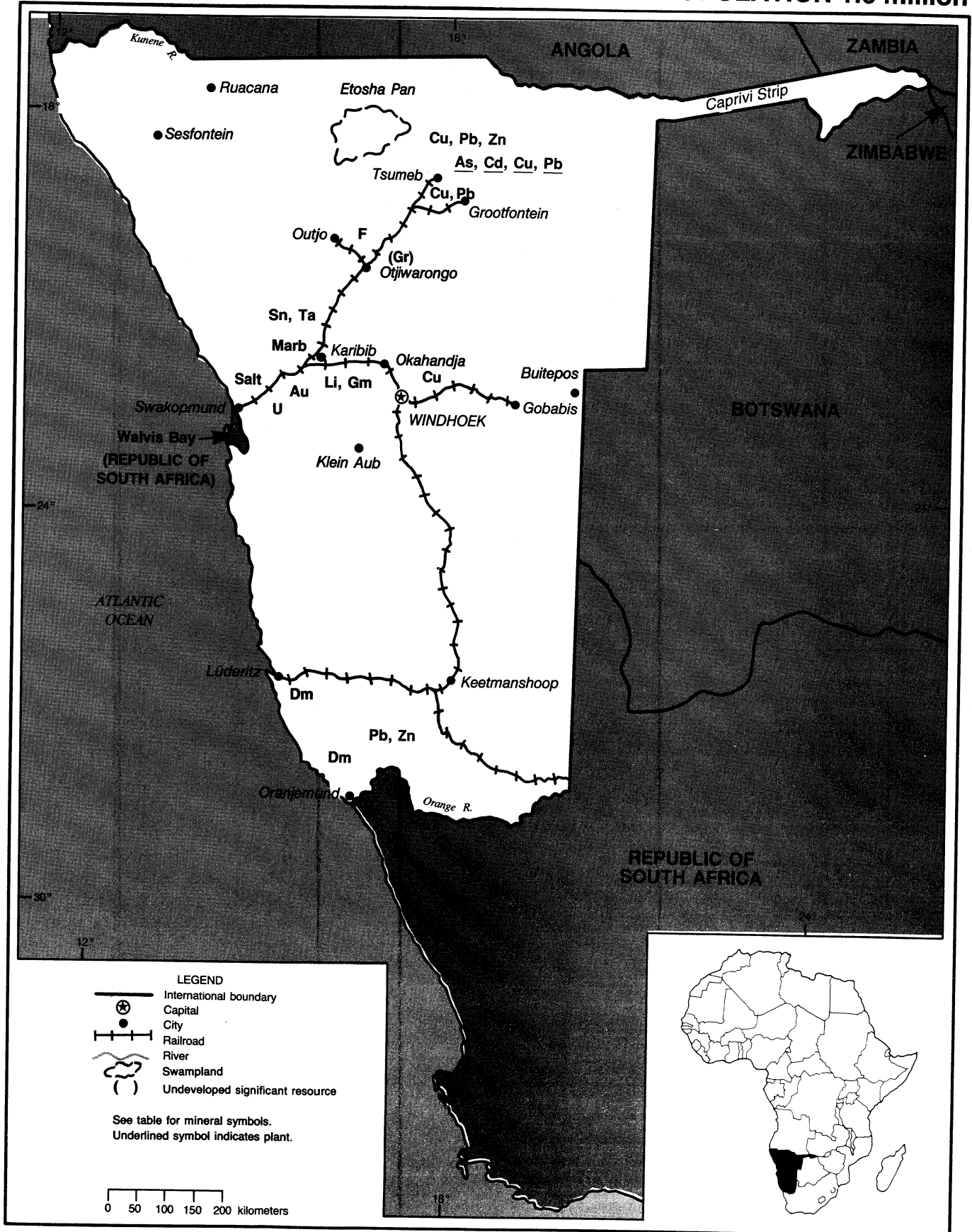
\*Estimated. NA Not available.

<sup>1</sup>Reportedly, only Nacala plant was in operation in 1992; the others were closed due to lack of funds to import clinker.

# NAMIBIA

AREA 824,290 km<sup>2</sup>

POPULATION 1.6 million



## THE MINERAL INDUSTRY OF

# NAMIBIA

By Michael M. Heydari

Namibia produced about 30 different minerals in 1992, the most important, in order of value, being diamond, uranium, copper, silver, lead, zinc, gold, pyrite, and salt. There were 45 active mines in 1992. Among major commodities, only diamond had substantially higher output and sales compared to those of 1991. Namibia was Africa's second largest producer of lead, third largest producer of cadmium, and fourth largest source of copper and zinc.

The mining industry accounted for about 20% of the GDP at a factor cost of \$2.1 billion—surpassing all other sectors in relative share of the GDP—and about 63% of foreign exchange earnings.<sup>1</sup> The industry was the largest taxpayer, its capital investment was second only to that of the Government, and it was the largest employer after the Government and agriculture. The mineral sector employed more than 13,000 workers, about 6% of the formal-sector work force, in 1992. However, mining's contribution to the GDP, foreign exchange earnings, and employment levels has decreased steadily from that of 1980. This is because exploration has not been conducted on a sufficient scale to ensure that new mineral deposits are discovered and developed to replace production as the older mines close.

A conference on mining investment in Namibia was held in Windhoek in March 1993 to focus attention on Namibia's mineral potential and to promote foreign participation in the Namibian mining sector. Eleven U.S. firms were represented in the conference. During the conference the Government and EC signed a financing agreement for a \$47 million mining sector grant to Namibia. The grant was approved by the European

Development Fund Committee to stimulate, restructure, and broaden the country's depressed mining sector. A total of \$34 million is earmarked for concessional loans to finance private-sector exploration and mine development efforts. About \$10 million is to be used by the Namibian Geological Survey to pay for high-resolution regional aeromagnetic and electromagnetic surveys of northern, central, and eastern Namibia.

### GOVERNMENT POLICIES AND PROGRAMS

In December 1992, the National Assembly approved the new Minerals (Mining and Exploration) Act, No. 33 of 1992. The Minerals Act replaces South African colonial legislation covering the mining sector and provides for a standard licensing regime with special provisions to promote investment by foreign and domestic enterprises in minerals exploration and extraction. An accompanying Mining (Taxation) Act sets out revised fiscal provisions for the industry. The main innovation is a provision for royalty payments by producers to the Government. The act provides that (1) the old Diamond Export Duty of 10% be changed to a royalty at the same rate; (2) a royalty of 5% of market value be levied on all dimension stone and semiprecious stones exported in unbeneficiated form; and (3) a maximum royalty of 5% of market value be levied on all other minerals that can be beneficiated locally. The new legislation, which is expected to come into force in July 1993, has not stipulated compulsory state participation in mining ventures, although the Government may seek a minority equity interest in new projects.

With regard to mining activities, excluding petroleum and diamond mines, the 1992 act allows that all exploration expenditure incurred before the startup be written off in the first year of production and subsequent exploration expenditure in the year in which they are incurred. In addition, the definition of exploration expenditure with regard to a specific mining company is now construed in a way that it includes any area in Namibia. The Government hopes that this will inspire mining companies to step up their exploration activities. In the case of development expenditure, however, the new act stipulates that only one-third can be written off in the year in which it is incurred and one-third in each of the 2 ensuing years. The new progressive tax rates applicable to nondiamond and nonpetroleum mining companies vary from 25% to 55%, with most companies' rates falling in the range of 25% to 40%.

The system of taxation on diamond mining consists of three separate taxes, namely income tax, diamond profits tax, and diamond export duty. The latter is now replaced by a royalty at the rate of 10%. Income tax on diamond mining companies is levied at the rate of 50% of taxable profits, plus a surcharge of 10%. A diamond profits tax is levied at the rate of 15% of the taxable profits as specified in the Diamond Taxation Proclamation, No. 16 of 1941, as amended. The Income Tax Act provides that the amount paid as diamond profits tax be credited against the income tax payable by diamond mines.

The fiscal regime for oil exploration companies consists of three principal elements, namely an income tax and an Additional Profits Tax (APT), both levied in terms of the Petroleum (Taxation) Act,



No. 3 of 1991, and thirdly, a royalty, levied in terms of the Petroleum (Exploration and Production) Act, No. 2 of 1991. In regard to income tax, the applicable tax rate is 42% of taxable income. The APT is a tax on profits above a level necessary to earn a reasonable rate of return on investment. A three-tier incremental APT scheme is provided for in the new legislation. The first-tier APT rate is at 25% when the net rate of return reaches 15%. The second- and third-tier incremental APT rates are negotiated between the Government and the oil company. As in the case of the petroleum income tax, the APT is applied on a license or contract area basis, which means that expenditures incurred on different oilfields within the same license area are not ring-fenced. The Petroleum (Exploration and Production) Act, No. 2 of 1991, provides that the holder of a production license for petroleum shall pay, to the State Revenue Fund, a royalty of 12.5% of the market value of petroleum produced. However, the act provides that the Minister of Mines and Energy may, in concurrence with the Minister of Finance, remit wholly or partly any royalty payable, or defer payment of any such royalty with the intention to assist any marginal oilfield development.

The Foreign Investment Act of 1990 offers prospective investors a fairly attractive package of incentives such as repatriation of profits, security of title and tenure, availability of foreign exchange, international arbitration, and fair compensation in case of expropriation.

The Ministry of Mines and Energy had responsibility for making and enforcing policies related to minerals and energy. Within the ministry and attached to the Permanent Secretary were the Diamond Board, the Mining Advisory Board, and the National Energy Council, all of which had both Government and private-sector representation. The Namibia Petroleum Co. and the Namibia Electricity Development Co. are also part of the ministry. Four main directorates in the ministry were the Geological Survey, Mining, Energy, and Administration and

Finance. The Ministry of Mines and Energy issued 303 new prospecting licenses in 1992 for all types of mining compared with 200 in 1991.

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## PRODUCTION

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The diamond sector of the mining industry was, by far, the best performer, setting a new record production of 1.55 million carats, an increase of 30% from that of 1991 and more than double the 1990 production. The reason for the increase was higher production from two new sites and expansion of existing production centers by CDM (Pty.) Ltd., a subsidiary of De Beers Centenary AG.

Output of the minerals sector was negatively affected by further cutbacks at the Rössing uranium mine. Total uranium oxide production was 1,986 tons, less than one-half of the 1988 production. Lead and silver production declined but copper, gold, and zinc production increased. Cadmium production was down by 50%.

Exploration for, and the exploitation of, dimension stone enjoyed a relatively good year, and a final feasibility study on a graphite ore body near Otjiwarongo was being carried out by Rössing Uranium Ltd. (See table 1.)

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## TRADE

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Namibia's total exports amounted to about \$1.2 billion in 1992, with diamond, manufactures (including processed fish and meat), and uranium as the main export products. Total mineral exports were estimated at about \$750 million and included diamond, \$460 million; base metals, \$135 million; gold, \$30 million; and others, including uranium, \$125 million. Imports were valued at about \$1.2 billion with food and beverages, machinery and electrical goods, vehicles and transport equipment, and mineral fuels and lubricant as the main imports. Namibia's main trading partners, in order of importance, were the Republic of South Africa, Germany, Switzerland, the United Kingdom, Japan, the United States, and Belgium. As a member of Southern African Customs Union

(SACU), Namibia's products have duty-free access to the markets of Botswana, Lesotho, the Republic of South Africa, and Swaziland. Namibia's products also have duty-free and quota-free access to the EC under the Lome Convention. On September 15, 1992, Namibia became the 105th contracting party of GATT.

Namibia's exports to the United States increased from \$35.4 million in 1991 to \$38.6 million during 1992. Crude petroleum and unleaded gasoline accounted for about \$29 million, and copper anodes for electrolytic refining made up about \$8 million of Namibia's exports to the United States. Namibia's total imports from the United States were \$32.6 million in 1991 and \$24.2 million during the first 9 months of 1992.

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## STRUCTURE OF THE MINERAL INDUSTRY

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Ownership of mining companies operating in Namibia was primarily private. Government participation remained limited to only a few entities, and it has generally functioned in a regulatory fashion.

Two Namibian mining companies can be considered significant by world standards, CDM and Rössing Uranium Ltd. Together these account for about 75% of the production value of the mining sector. CDM ranks sixth in terms of production volume of near-gem and gem diamond worldwide. Rössing ranks fifth in Western World uranium production with a share of about 9%.

The five other largest Namibian operations are all metal mines, of which four are base metal properties. The five are Tsumeb Mine, Kombat Mine, Otjihase Mine, Rosh Pinah Mine, and the Navachab gold mine. They may be joined by the Okanjande graphite deposit, which is currently at final feasibility and pilot plant state. There are three medium-sized mines with a labor force of more than 100 persons. These are the Rubicon Mine of SWA Lithium Mines; the base metal property Namib Lead and Zinc of Lead Namibia Ltd.; and the Okurusu fluorspar mine. The small-scale category comprises

about 35 properties, each employing a work force of between 5 and 75 persons on a regular schedule. With the exception of a copper and a gold-silver mine, the small mines extract nonmetallic minerals. (See table 2.)

Namibia has very little investment in smelters, refineries, or processing plants. Tsumeb has a copper and a lead smelter with blister copper and refined lead being produced. All other concentrate leaves the country for treatment and processing either in the Republic of South Africa or overseas.

The Chamber of Mines of Namibia reported that the total number of employees at its 34 member mines, as of December 31, 1992, was 11,441, down from 12,265 in 1990, and about 58% of its 1980 level. Mine wages are on par with those in the Republic of South Africa but are higher than those in other African countries. This has led to rationalization and more capital intensive mining practices.

The Mineworkers Union of Namibia (MUN), a member of the ruling party-affiliated National Union of Namibian Workers (NUNW), has concluded recognition agreements with all of the major mining houses. MUN led the country's first legal strike against CDM in September 1992, although little was achieved by the walkout.

Two institutions of higher education provide mineral sector-related training in Namibia. The Namibian Institute of Mining and Technology, financed by Rössing, is providing technician level training in geology, mining, mineral processing, metallurgy, surveying, and chemistry. The new University of Namibia (UNAM), which came into existence in early 1993, will have seven colleges. Two of these—Natural Sciences, and Social and Economic Sciences—are to cover mineral sector-related disciplines at undergraduate and graduate levels, although at this stage no mining courses are proposed. In addition, UNAM is establishing a Multidisciplinary Research Center (MRC) and will coordinate with other universities in Africa and overseas to provide research and training opportunities in mineral-related areas for

Namibian students.

## COMMODITY REVIEW

### Metals

**Copper.**—Revere Resources Ltd. of the Republic of South Africa failed to raise about \$2.5 million in share capital needed to finance the Haib copper project, 7 km north of the Orange River in southern Namibia. It sold its 80% ownership in the Haib Copper Mining and Investment Co. to Mega Holdings Ltd. for about \$175,000. Mega holdings planned to move forward with the first phase of Revere's development plan, investing up to about \$1.4 million to produce 1,200 mt/a of copper using in-pit crushing and the latest heap-leaching plus solvent extraction-electrowinning processes. Estimated recovery costs are less than \$0.55/lb. Proposals to invest \$100 million to turn Haib into a 50,000-mt/a operation have been shelved. The Haib area contains a resource base of 600 Mmt grading 0.32% copper, with a further 900 Mmt averaging 0.1%. As the main Tsumeb Mine's production declined, development work continued at Tsumeb Corp.'s Tschudi Mine, 32 km west of Tsumeb. Tschudi Mine was scheduled to come on-stream in 1993. The copper ore is of relatively low grade. The mine will have a life of 15 years. The Tschudi Mine will be a successor to the main Tsumeb Mine scheduled to be all but depleted within 2 years.

**Gold.**—Namibia's primary gold mine, Navachab, operated at a significant profit in 1992, resulting from an increase in production from 1,857 kg to 2,009 kg, an increase in the gold price in rand terms, and cost savings. The possibility of extending the operation underground in the longer term is being explored.

**Uranium.**—With the spot price recovering slightly, 1992 saw a slight improvement in the world uranium market. Despite this market improvement, production at Namibia's only uranium mine, owned and operated

by Rössing Uranium Ltd., declined to 1,986 tons of uranium oxide, or slightly less than one-half of production capacity. Production in 1993 is expected to be at a similar level. With new long-term contracts due to come into effect starting in 1995, Rössing expects to increase production later in the decade.

**Zinc.**—As a result of spending about \$10 million to develop new ore deposits at the Rosh Pinah lead-zinc mine, 70 km northeast of Oranjemund, Imcor Zinc (Pty.) Ltd. has blocked out proven and probable in situ reserves sufficient for a further 17 years of output at the current production rate. However, the low prices for zinc and lead have caused the company to suspend further exploration and development below 250 m except in the western ore body. Namibia's zinc production, in terms of metal content in concentrate, increased from 33,150 tons in 1991 to an estimated 36,000 tons in 1992.

### Industrial Minerals

**Diamond.**—Diamond is Namibia's most important mineral, accounting for more than one-half of the value of mineral exports. Total production was about 1.55 million carats compared with 1.19 million carats in 1991 and 0.76 million carats in 1990. This was a result of higher production levels in the main onshore mining area, combined with the first full year of production from CDM's Elizabeth Bay near Lüderitz, and further progress with the offshore marine operations. However, production in 1993 is expected to decline as the Central Selling Organization (CSO), De Beers' marketing arm, reduced contract deliveries from all producers, including CDM, by 25% from September 1992. CDM decided it is not in a position to stockpile diamond and has cut production from the beginning of 1993 in line with the reduction in sales to the CSO.

Over the longer term, CDM claims that its main onshore mining operations can continue for only one more decade at current production rates. Although two

new onshore mines have recently been brought on-stream, Elizabeth Bay near Lüderitz and Auchas Mine, 50 km northeast of Oranjemund on the northern bank of Orange River, increasing attention is being paid to the offshore diamond potential of the Namibian coast. In 1992, only 17% of diamond production of Namibia came from this source. However, with the declining production of the onshore mines, the offshore potential needs to be further developed if the Namibian mining industry is to maintain its economic importance.

**Graphite.**—Namibia will become a significant graphite exporter if a decision is taken to proceed with commercial mining at the Okanjande flake graphite deposit near Otjiwarongo. This is one of several known areas of graphite mineralization and has excellent potential due to large reserves of high-grade ore that could support a potential mine life in excess of 30 years. The deposit was identified during an exploration program for non-uranium minerals by Rössing. A final decision on whether to proceed to a 500,000-mt/a operation is due to be made in 1993.

### Mineral Fuels

Namibia produced neither crude oil nor natural gas and had no crude oil refining capacity. It had no proven crude oil reserves and only limited gas reserves, at the Kudu Gasfield, 200 km west of Oranjemund off Namibia's southern coast, generally estimated at between 150 to 500 billion m<sup>3</sup>.

In 1992, the Government awarded five offshore oil and gas exploration licenses to major international oil companies, including Chevron of the United States. Other licensees included a consortium of three Norwegian companies—Norsk Hydro, Saga Petroleum, and the state-owned Satoil. The area to be explored is about 11,000 km<sup>2</sup> on the northern coast and is believed to be geologically related to the Angolan shelf where there are several large oilfields. In June 1992, a consortium of Ranger Oil Ltd. of Canada

and Hardy Oil Ltd. of the United Kingdom was granted an oil exploration license covering more than 5,000 km<sup>2</sup> off Namibia's continental shelf, about 30 km northwest of Walvis Bay. The consortium has identified a number of structures with sediments the same age as those producing oil further north of the West African coast. In September 1992, the Government awarded a \$10 million oil exploration license to Sasol Mining Ltd. of the Republic of South Africa. The license covers an area of 11,000 km<sup>2</sup> known as Block 2012, situated on the southwest of Terrace Bay on the northern Namibian coast.

Energy Korea Ltd. (Enerkor), a British-registered company with South African and Republic of Korea connections, announced plans in 1991 to build a 15,000-bbl/d refinery at Usakos, 200 km northeast of Walvis Bay. In 1992, controversy continued over the economic viability of the project. Plant construction has not yet started.

### Reserves

Reserve data reported by the Chamber of Mines and operating companies in Namibia indicated reserves of about 1 billion carats of diamond, about 3 Mmt of contained copper, 100,000 tons of contained uranium oxide, 20 tons of gold, 36 Mmt of graphite ore grading 4.3% carbon, 70 Mmt of ore grading 0.135% tin, 6 Mmt of trona-rich and sulfate-rich salts, 2.9 Mmt of fluorspar ore grading 61% CaF<sub>2</sub>, and 29,000 tons of wollastonite.

### INFRASTRUCTURE

Namibia has two principal ports, Walvis bay (currently jointly administered by Namibia and the Republic of South Africa) and Lüderitz. Walvis bay has container and bulk mineral handling facilities, and oil storage tanks. More than 1 Mmt/a of freight is handled at Walvis Bay, compared with 50,000 mt/a at Lüderitz.

Namibia has a well-developed and maintained road transport system, with a railway network that links the principal

centers of population to the coast and to the Republic of South Africa. The country has about 40,000 km of roads, of which about 4,500 km is surfaced. There is a principal north-south axial road linking southern Angola with the Republic of South Africa, and east-west routes connect the coastal ports of Walvis Bay/Swakopmund and Lüderitz with the Republic of South Africa and Botswana, respectively. The Botswana route will assume even greater importance once the Trans-Kalahari Highway is completed, reducing the journey between Windhoek and Johannesburg by more than 400 km. In the northeast, work is under way on upgrading the road through the Caprivi Strip to link Namibia with southeast Angola, Zambia, Zimbabwe, and Botswana.

The 2,400-km-long rail network is operated by TransNamib. The rail fleet consists of 100 diesel-electric locomotives and 2,400 wagons. Namibia's railways carry about 2 Mmt/a of freight and 480,000 passengers per year, approximately 10 times the traffic transported annually on scheduled road services.

Electricity throughout the country is provided by SWAWEK, the national power utility. Principal power stations include the 120-MW Van Eck coal burning plant in Windhoek and the 240-MW Ruacana hydro-electric station on the Kunene River. The SWAWEK network interconnects with the Republic of South Africa's grid. Planning is currently under way for a second hydro station to be built on the Kunene River. The proposed Epupa plant would have an installed capacity of 450 MW.

### OUTLOOK

The health of the industry will remain important to the country's overall economy because mineral exports are the main source of foreign exchange earnings. The new mining and investment legislations approved by the National Assembly in 1992 are expected to provide incentive and guarantees to foreign participation in the Namibian mining sector. In its recent publication,

"Strategy for African Mining," the World Bank ranked Namibia as one of three African countries in their top category, namely countries in which in excess of \$100 million should be spent on exploration during the next 5 years.

Onshore diamond mining is expected to end in 10 years. Unless a replacement is found, Namibia will suffer a substantial decline in export earnings and employment in the mining sector. CDM has begun to develop offshore diamond mining. However, because of political uncertainties during the past 10 years, there has been little prospecting for other minerals in Namibia, with the result that few new mines have been developed. Given the long lead time between the prospecting and development stage of a mine, even with an increase in exploration, there is likely to be a gap in revenue from mining as the old mines close before the new ones come on-stream.

The mining companies will likely concentrate their exploration activities around areas that already have a well-developed infrastructure. Because of the high cost of exploration and mine development, large international mining companies are likely to remain dominant in Namibia's mining industry. However, there is potential to develop small mines using a minimum amount of capital.

The future of Namibia's mineral sector may lie in applying new cost-effective mining and extraction techniques to the country's wide variety of low-grade mineral deposits. Considering the country's general political stability, Namibia is a viable market for technology transfer, mining equipment, and investment for U.S. mining firms.

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<sup>1</sup>Where necessary, values have been converted from rand (R) to U.S. dollars at the rate of R2.85=US\$1.00 for 1992 and R2.76=US\$1.00 for 1991.

## OTHER SOURCES OF INFORMATION

### Agencies

Association of Prospectors and Miners of Namibia

P.O. Box 5059

Windhoek, Namibia

Telephone: (264) 61 34978

Fax: (264) 61 32809

The Chamber of Mines of Namibia

P.O. Box 2895

Windhoek, Namibia

Telephone: (264) 61 37925

Fax: (264) 61 222638

First National Development Corp.

Private Bag 13252

Windhoek, Namibia

Telephone: (264) 61 306911

Fax: (264) 61 33943

Geological Survey

Private Bag 2168

Windhoek, Namibia

Telephone: (264) 61 37240

Fax: (264) 61 228324

Ministry of Mines and Energy

Private Bag 13297

Windhoek, Namibia

Telephone: (264) 61 226571

Fax: (264) 61 38643

Ministry of Trade and Industry

Private Bag 13340

Windhoek, Namibia

Telephone: (264) 61 2989111

Fax: (264) 61 220148

Namibia National Small Miners Association

P.O. Box 7289

Windhoek, Namibia

Telephone: (264) 61 31088

Fax: (264) 61 31188

### Publications

Chamber of Mines of Namibia, 14th Annual Report, 1992.

Mineral Investment in Namibia, Mining Journal Research services in cooperation with the Ministry of Mines and Energy, Namibia, March 1993, 107 pp.

TABLE 1  
NAMIBIA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1988	1989	1990	1991	1992
<b>METALS</b>					
<b>Antimony, sodium antimonate (47% Sb):</b>					
Gross weight	156	73	5	21	13
Sb content	73	34	2	10	6
Arsenic, white, 99% arsenic trioxide	2,983	2,399	1,636	1,804	2,456
Beryl concentrate	—	—	25	6	10
Cadmium metal, refined	106	88	69	67	33
Cesium, pollucite, gross weight	—	—	3	5	5
<b>Columbium and tantalum:</b>					
<b>Tantalite concentrate:</b>					
Gross weight	6,905	5,730	3,678	200	200
Cb content*	900	630	550	30	30
Ta content*	900	630	550	30	30
<b>Copper:</b>					
<b>Mine output, concentrate (29% to 30% Cu):</b>					
Gross weight	142,989	109,305	108,331	116,842	115,178
Cu content	40,892	32,800	32,500	33,884	34,553
Metal, blister <sup>2</sup>	42,163	37,978	33,190	32,929	34,451
Gold	240	336	1,605	1,857	2,009
<b>Lead:</b>					
<b>Mine output, concentrate (30% Cu):</b>					
Gross weight	81,487	79,854	61,758	50,585	51,000
Pb content*	25,000	23,710	18,000	15,000	15,000
Metal, refined, primary <sup>2</sup>	44,447	44,183	35,129	33,367	31,655
Silver, mine output, Ag content of concentrate	108,000	108,247	92,072	91,293	72,000
<b>Tin:</b>					
<b>Mine output, concentrate (67% Sn):</b>					
Gross weight	1,772	1,683	1,390	17	15
Sn content	1,182	1,120	900	11	1
Uranium, U <sub>3</sub> O <sub>8</sub> content of concentrate	4,263	3,809	3,719	2,889	1,986
<b>Zinc:</b>					
<b>Mine output, concentrate (49% to 52% Zn):</b>					
Gross weight	71,655	79,805	72,480	68,098	71,897
Zn content	36,694	41,675	37,719	33,150	36,053
<b>INDUSTRIAL MINERALS</b>					
Aragonite	15	—	—	19	20
<b>Diamond:</b>					
Gem*	925	910	750	1,170	1,500
Industrial*	50	20	15	20	50
Total <sup>4</sup>	975	927	763	1,187	1,549
Fluorspar, concentrate, acid grade (98% CaF <sub>2</sub> )	38,533	25,679	27,107	34,565	40,408
Graphite*	—	—	—	200	200
<b>Lithium minerals:</b>					
Amblygonite	147	131	54	20	20
Lepidolite	18	41	80	33	30
Petalite	1,477	1,226	1,134	1,139	1,150
Total <sup>4</sup>	1,642	1,398	1,268	1,192	1,200
Quartz	—	—	107	100	100

See footnotes at end of table.

TABLE 1—Continued  
**NAMIBIA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

Commodity	1988	1989	1990	1991	1992
<b>INDUSTRIAL MINERALS—Continued</b>					
Salt	'149,317	142,102	'157,224	'141,368	*115,000
<b>Semiprecious stones:</b>					
Agate	99	93	72	53	*100
Amethyst	'116	'161	'110	'110	*120
Beryl kilograms	—	—	'3,000	'6	*10
Chrysocolla do.	'6,000	8,000	'900	'5,382	*6,000
Diopase do.	'130	190	'109	'52	*100
Quartz, crystal	48	7	20	11	*50
Rose quartz	'909	'302	605	'314	*600
Sodalite*	'100	'50	50	50	100
Tourmaline kilograms	'42	'968	'1,117	'1,216	*1,300
<b>Stone, sand, and gravel:</b>					
Granite	'3,322	'9,154	'5,437	'7,890	6,702
Marble	'8,050	'12,573	'12,882	'10,031	12,791
<b>Sulfur:</b>					
<b>Pyrite concentrate:</b>					
Gross weight (50% S)	226,682	196,531	'138,925	'127,119	164,191
S content <sup>2</sup>	115,200	100,000	70,000	65,000	82,000
Wollastonite	396	—	—	'305	300

\*Estimated. †Revised.

<sup>1</sup>Table includes data available through Apr. 30, 1993.

<sup>2</sup>Products of imported concentrate included.

<sup>3</sup>Reported figure.

<sup>4</sup>Data may not add to totals shown because of independent rounding.

TABLE 2  
**NAMIBIA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992**

(Metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Copper	Tsumeb Corp. Ltd. (Gold Fields Namibia Ltd., 100%)	Tsumeb	15,500 Cu in concentrate, 58,000 blister copper.
Do.	do.	Kombat, 50 kilometers south of Tsumeb	12,000 Cu in concentrate.
Do.	Otjihase Mine (Tsumeb Corp. Ltd., 70%; Johannesburg Consolidated Investment Co. Ltd., 30%)	Otjihase, near Tsumeb	16,500 Cu in concentrate.
Diamond	million carats CDM (Pty.) Ltd. (De Beers Centenary AG, 100%)	Mines near Oranjemund, Elizabeth Bay Mine, 25 kilometers south of Luderitz, and marine operations	1.6.
Fluorspar	Okorusu Fluorspar (Pty.) Ltd. (Iskor Ltd., 26%; Okorusu Holdings)	Okorusu, 100 kilometers north of Otjiwarongo	50,000, 98% calcium fluoride.
Gold	Navachab Gold Mine Co. (Erongo Mining and Exploration Co. Ltd., 70%; Metall Mining Corp., 20%; Rand Mines Ltd., 10%)	Navachab near Karibib	2 Au.
Lithium	SWA Lithium Mines (Pty.) Ltd. (Klockner; Matramco)	30 kilometers south of Karibib	1,500 concentrate.
Marble	cubic meters Karibib Mining and Construction Co. (Namibia) Ltd. (Private, 100%)	Karibib	2,500 marble, 600 granite.
Salt	Salt Company (Pty.) Ltd. (private, 100%)	Swakopmund	150,000.
Uranium	Rossing Uranium Ltd. (Government, 50.2%; RTZ Corp. plc, 26.5%; Urangesellschaft mbH, 5%; Gencor Ltd., 2.3%)	Rossing, 30 kilometers east of Swakopmund	4,800 uranium oxide.
Zinc	Imcor Zinc (Pty.) Ltd. (Iskor Ltd., 51%; Moly Copper Mining and Exploration Co.)	Rosh Pinah Mine, 80 kilometers northeast of Oranjemund	40,000.

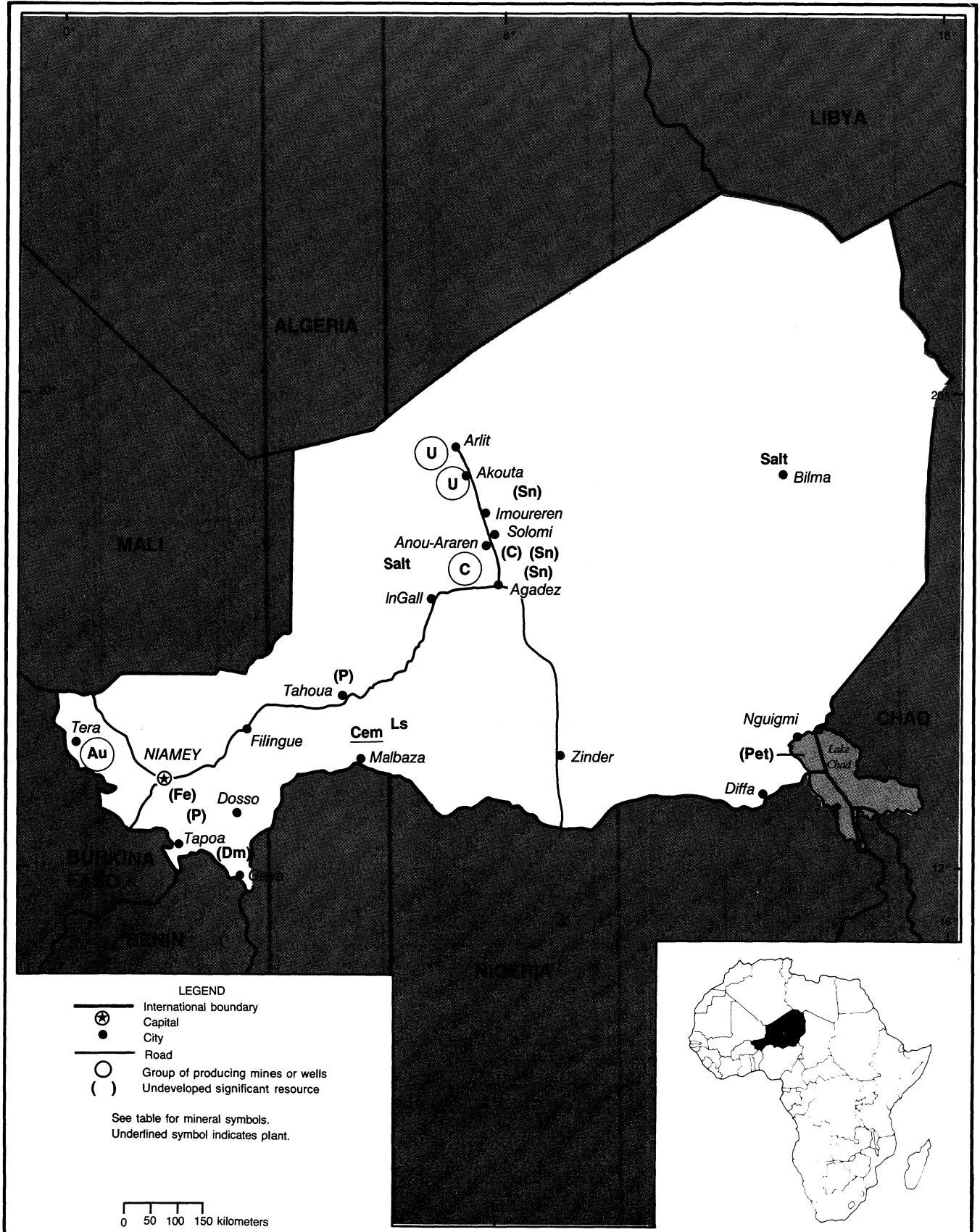




# NIGER

AREA 1,267,000 km<sup>2</sup>

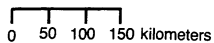
POPULATION 8.2 million



**LEGEND**

- International boundary
- Capital
- City
- Road
- Group of producing mines or wells
- Undeveloped significant resource

See table for mineral symbols.  
Underlined symbol indicates plant.



## THE MINERAL INDUSTRY OF

# NIGER

By David Izon

Niger remained the fourth largest exporter of uranium in the world and had the fifth largest uranium reserves in the world, while being the seventh largest producer in 1992. The minerals sector accounted for about 14% of the GDP of \$2.4 billion in 1992. Uranium sales accounted for 75% of total export earnings and about 8% of Government revenue in 1992. Subsidized buying of uranium by *Compagnie General des Matieres Nucleaires (COGEMA)* and Japan's Overseas Uranium Resource Development (OURD). COGEMA and OURD continued in 1992 but is expected to end in 1993. The country has commercially exploitable coal, gold, phosphates, salt, and tin. Exploration activities for oil were under way by Niger Hunt Oil Co. in the northeastern part of Niger. New regulations in place favor foreign and domestic private investment in all aspects of the country's economy.

Under the new laws investors had exclusive rights to search for hydrocarbons and drill exploration wells. The length of initial contract terms was extended to 4 years. A 15-year concession life was allowed for discoveries of commercial quantity, which could be extended for 15 additional years. The new tax laws reduced income tax to 45% for petroleum ventures with a depletion allowance of 12.5%.

Uranium continued to dominate mineral production and export in 1992. Production continued to be hindered by insurrections of the Tuaregs. Coal production was totally for domestic consumption. (See table 1.)

Niger's main export products for 1992 remained uranium, agricultural products, and tin. Uranium exports in 1992 were valued at \$212 million. Imports from the United States were oil industry

exploration equipment and technology, other industrial equipments, and manufactured goods. Niger's major trading partners were France, Japan, and Nigeria.

The Government participated in equity sharing arrangements with several companies through its ministry of mines, Office National des Ressources Miniere (ONAREM). Production of uranium concentrates was by two companies, the *Societe des Mines de l'Air (SOMAIR)* and *Compagnie Miniere d'Akouta (COMINAK)*. A large portion of other minerals produced was by artisanal miners, particularly gold. Major operating companies in the country were *Societe Nigerienne de Charbon (SONICHAR)* for coal and *Societe Miniere du Niger (SMDN)* for tin.

The 1992-93 prospecting program focused on a 135-km<sup>2</sup> area considered strategic and unexplored. The Governments of Canada, the Republic of Korea, and Kuwait signed agreements to exploit 10 new sites in Tera having gold concentrations ranging from 15 g/mt to 200 g/mt. Bids were invited for the development of these sites. Most gold operations were by small-scale artisanal miners in the Koma Bangou gold field. Other deposits exist along the Niger-Burkina Faso border.

Small quantities of tin ore were mined from El Mecki, Tarouadji, Timie, Agahak, and Cuissat in the Air Mountains by private individual operators. An annual output of about 250 tons was coordinated and marketed by SMDN.

Contracted buying prices for Niger's U<sub>3</sub>O<sub>8</sub> remained at \$28/lb. SOMAIR and COMINAK operated all mines that produced mainly from two concessions, one near the town of Arlit, 250 km northwest of Agadez, and the other at Akouta. The insurrection of the Tuaregs

disturbed production slightly. Joint-venture operations of mines was composed of the Government and several French, German, Japanese, and Spanish firms.

The transportation system in Niger was still inadequate, despite considerable road development. There was 39,970 km of roads in 1992. The total distance of paved roads was 13,500 km, of which 3,170 km was bituminous. The paved roads included a 902-km all-weather road between Niamey and Zinder and a 651-km "uranium road" from Arlit to Tahoua. Gravel and laterite roads covered a distance of 3,470 km to 10,330 km. Niger has no railways. The inland waterway of the Niger River was navigable for 300 km from Niamey to Gaya on the Benin border from mid-December to March.

Uranium remains the most important mineral commodity produced in Niger. It should continue as the largest foreign exchange earner for the immediate future. Long-term development goals were gradual development of other minerals such as gold, iron ore, petroleum, and phosphates.

<sup>1</sup>Where necessary, values for Niger have been converted from Communauté Financière Africaine francs (CFA) to U.S. dollars at the rate of CFA282=US\$1.00 in 1992.

TABLE 1  
NIGER: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992
Cement, hydraulic	26,400	27,000	<sup>1</sup> 19,478	20,109	29,288
Coal, bituminous	<sup>1</sup> 160,000	171,434	<sup>1</sup> 153,913	156,542	133,525
Gypsum <sup>3</sup>	3,000	3,000	<sup>1</sup> 950	<sup>3</sup> 1,000	<sup>3</sup> 1,750
Molybdenum concentrate, Mo content <sup>4</sup>	15	13	10	10	10
Salt	<sup>2</sup> 2,902	<sup>2</sup> 2,824	<sup>2</sup> 2,740	<sup>3</sup> 3,000	<sup>3</sup> 3,000
Tin, mine output, Sn content	119	71	<sup>3</sup> 38	20	<sup>2</sup> 20
Uranium, content of concentrate	3,482	3,013	<sup>3</sup> 3,161	3,330	2,970

<sup>1</sup>Estimated. <sup>2</sup>Revised.

<sup>3</sup>Includes data available through July 14, 1993.

<sup>4</sup>In addition to the commodities listed, Niger clay and sand and gravel for local construction purposes; however, available information is inadequate to make reliable estimates of output levels.

<sup>5</sup>Reported figure.

TABLE 2  
NIGER: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

(Thousand metric tons unless otherwise specified)

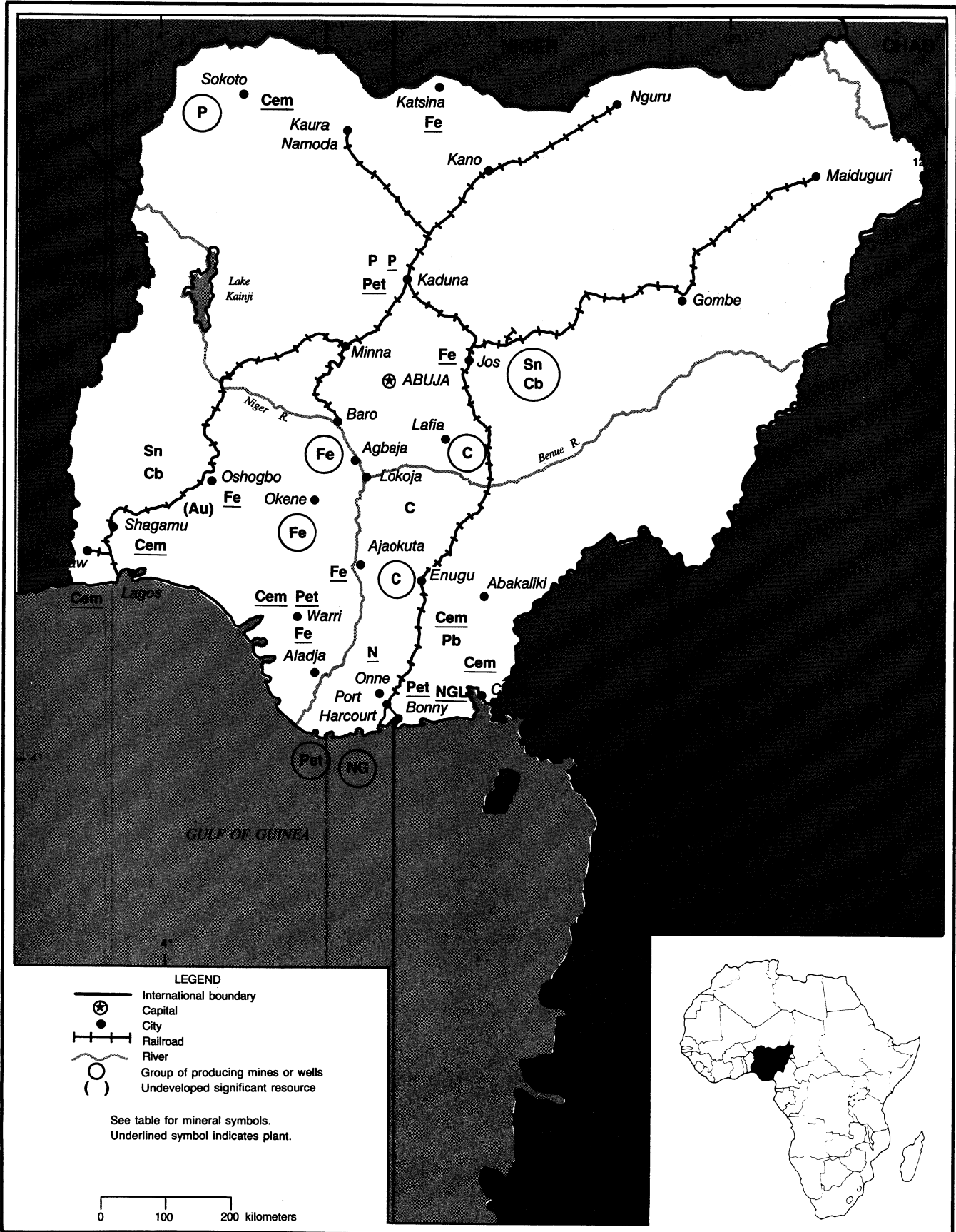
Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Cement	Societe Nigerienne De Cimenterie (Government, 100%)	Malbaza	37.
Coal	Societe Nigerienne De Charbon d'Anou Araren (Government, 100%)	Anou-Araren	150.
Tin	Societe Miniere du Niger (Government, 100%)	El Meki	0.1.
Uranium	Societe Des Mines De L'Air (Government, 33%; Cogema-France, 27%; France's Coompagnie de Mokta, 19%; and Sogerem, 19%; Fed. Republic of Germany's Urangesellschaft, 6.5%; and Italy's Agip Uranio, 6.5%)	Arlit and Taza	3.5 combined.
	Compagnie Miniere d'Akouta (Cogema-France, 34%; Government, 31%; Ourd-Japan, 25%; Enusa-Spain, 10%)	Akouta	2.



# NIGERIA

AREA 923,770 km<sup>2</sup>

POPULATION 88.5 million



## THE MINERAL INDUSTRY OF

# NIGERIA

By David Izon

Nigeria was the world's 10th largest producer of crude oil and the largest in Africa. Though there had been some diversification in the oil and gas industries, the nation's economy still reflected the dominance of a single product, crude petroleum. The petroleum sector provided about 96% of Nigeria's export and foreign exchange revenue. This accounted for more than 35% of a GDP of \$30 billion<sup>1</sup> in 1992. The oil sector accounted for 78% of total Government revenues in 1992. The oil industry has almost accomplished its goal of raising the country's oil reserves to 20 billion bbl by 1995.

The country's nonfuel mineral resources base of barite, gold, iron ore, lead, and zinc could help diversify the economy. To this end, the Raw Materials Research and Development Council (RMRDC) started a rigorous campaign to attract investors to explore and develop the known resources. The country has adequate work force and resources to build a stable minerals industry. It has about 110 universities and colleges, of which 10 have mining-related engineering programs. The most prominent among these were the University of Ibadan, the University of Lagos, the University of Benin, the University of Port Harcourt, the Amadu Bello University, and the Obafemi Awolowo University. There were several colleges of technologies that were tailored toward specific disciplines such as the Federal Institute of Petroleum Technology in Warri and the Federal School of Mines in Jos.

The mining laws and investment codes were under revision in 1992. Upon completion of the new investment code, the country expects to attract foreign investors for its mineral industry.

### GOVERNMENT POLICIES AND PROGRAMS

Policies and programs inherited under the Structural Adjustment Program (SAP) continued to be implemented in 1992. Government policies were revised as part of SAP to encourage direct foreign investment.

In 1992, the Government reduced the amount of royalties payable on solid minerals. Royalties on controlled minerals such as barite, bentonite, coal, gold, iron ore, lead and zinc, tin, and gemstones were reduced from 15% to 10% and other solid minerals were reduced from 12.5% to 7.5%. The royalty on limestone for cement manufacture declined from about \$0.2 per ton to about \$0.07 per ton. The Ministry of Petroleum and Mineral Resources proposed in July 1992 to fund solid mineral production with revenues from the oil sector. Particular attention was to be paid to revitalization of existing companies that produce barite, kaolin, gold, marble, and tin. The Ministry also announced an intention to permit 100% private ownership of some downstream oil sector ventures such as refineries and petrochemical plants. This may also include foreign ownerships.

In the oil sector, the Government continued its programs to complete the Eleme Petrochemicals plant, which is scheduled to start exporting polyethylene and polypropylene in early 1994. Other projects included the NAFCON 2, a second fertilizer plant to be completed in 1994, the LNG project to be completed in 1997, and the gas-gathering venture with Chevron of the United States to produce LPG at Escarvos in Rivers State. The Government is determined to attract enough foreign investors and oil companies to develop new fields both

onshore and offshore, start the LNG project, introduce sustainable domestic fuel prices, and privatize the distribution of fuel and gas in Nigeria. Efforts to review the Minerals Act of 1969 and the country's mineral laws received assistance from the U.S. Government. The country's Raw Materials Research and Development Council continued to establish and expedite industrial development through the maximum use of local materials. The Government maintained policies on tariffs, business, and expatriate structures established earlier to attract foreign investors.

### PRODUCTION

Production of ammonia for fertilizers exceeded design capacity in 1992. Oil and gas continued to experience growth in that crude oil reserves increased, and pilot projects to produce industrial minerals were started. Coal output increased, and the Raw Materials Research Development Council advertised for investors to explore and develop several mineral deposits where such mineral deposits were believed to be found in commercial quantities. (See table 1.)

### TRADE

Nigeria's oil revenues for 1992 were about \$9 billion, accounting for about 96% of foreign exchange and about 78% of total Government revenues of about \$11.5 billion. The total Government revenues from crude oil alone amounted to about \$8.3 billion. Major mineral exports included coal, crude oil, steel billets, tin, some industrial minerals, and agricultural produce.

The United States continued to be the

largest importer of Nigerian crudes, accounting for about 57% of the country's oil exports. Other major consumers of Nigerian crude were the Netherlands, 10%; Spain, about 10%; and the west African Economic Community of West African States (ECOWAS) member countries, 5%. The United States was Nigeria's major export market, accounting for about 41% of total exports in 1992. Germany and Spain were the second and third most important export markets, respectively.

Nigerian imports consisted mainly of manufactured goods. Machinery and transport equipment accounted for the largest share of total imports, followed by chemicals and other manufactured products. Germany and the United Kingdom were the most important sources of imports, each accounting for about 14% of total imports, followed by the United States with about 12%. Others include France with 9% and Southeast Asian countries as a group with about 15%.

Major factors affecting the trade imbalance in Nigeria were inflation, shortage of raw materials for manufacture of goods, low credit markets due to large Government fiscal deficits, and an external debt of about \$29 billion.

## STRUCTURE OF THE MINERAL INDUSTRY

The Nigerian mineral industry in 1992 was dominated by the oil and gas industry in terms of contributions to the country's GDP, employment, and export earnings. The Government had a 51% to 60% controlling interest in all foreign mineral companies operating in the country. In an effort to privatize its parastatal companies, Nigeria restructured its largest corporation, Nigerian National Petroleum Corp. (NNPC), into 10 subsidiary companies. They were to be run on a profit-and-loss basis without Government intervention. Other principal mineral agencies of the country included the Nigerian Mining Corp., Nigerian Coal Corp., and the Nigerian Steel Development Authority. All important

minerals such as coal, columbite, and tin were mined by Government-owned companies or agencies. (See table 2).

## COMMODITY REVIEW

### Metals

Exploration for bauxite at the Adamawa-Mambilla Plateau deposit continued in 1992. The 180,000-ton aluminum plant being built at Ikot Abasi in Cross Rivers State, southeastern Nigeria, was reported to be progressing slowly. The initial production capacity of 45,000 tons was planned to come on-stream in 1995. Information on gold has not been made public. However, the gold deposit at Ilesha was known to be operational in 1992. Other reported metallic minerals with reserves of commercial quantity were iron ore, lead, and zinc. The RMRDC made efforts to attract investors for the development of these deposits. Official production figures for gold mined at Ilesha were not available.

**Iron and Steel.**—Activity continued to center on the Ajaokuta Steel Complex, the Delta Steel plants, the National Iron Ore Mining Co. at Itakpe, and several rolling mills. There were a total of 14 rolling mills, 8 electric arc furnaces, and 1 blast furnace (at Ajaokuta) in the country. The Government-owned mills are at Jos, Katsina, and Oshogbo. Total billets production capacity of the industry was 2.69 Mmt/a and rolled products capacity was 3.5 Mmt/a.

Construction work on phase 1 of the Ajaokuta complex was 95% completed as of December 1991, but continued to have funding problems in 1992. The startup date for Ajaokuta was postponed indefinitely. The Ajaokuta complex comprised 1.3 Mmt/a of light sections, bars, and rods; a central workshop; and a thermal powerplant. The complex's total combined capacity of billets and rolled products was 2 Mmt/a.

Production at Delta Steel Co. at Aladja continued at its 1991 level. Production of billets accounted for about 80% of output while the remaining was in the form of

rolled products. The plant operated well below capacity in 1992.

The National Iron Ore Mining Co. (NIOMC) continued to stockpile iron ore that is required to serve the Ajaokuta steel plant and the Delta Steel Co. The same reasons of inadequate maintenance of mining equipment, frequent theft, and inefficient management accounted for the continued poor performance. The progress report on work on the beneficiation plant was good as was the rail link between Itakpe and Ajaokuta.

**Tin.**—Production of tin in 1992 was almost at the same level as that in the previous year. The tin industry continued to experience a shortage of spare parts, mine flooding, low prices and, above all, increasingly difficult conditions at the mines. Production was estimated at 200 mt/a compared with a world production of about 176,000 tons. Major reasons for the weak domestic tin industry were the depletion of minable reserves and a world decrease in demand for tin. Also, tin ore found at depths of 70 m was too expensive to mine with the limited resources available.

Other factors that contributed to the weak industry included production and exports from China and the former U.S.S.R.

### Industrial Minerals

The RMRDC has enumerated a number of mineral commodities that have proven reserves or adequate resources for industrial development. Among minerals identified in commercial quantities for investor consideration were asbestos, barite, bentonite, clay, kaolin, fire clay, diatomite, dolomite, feldspar, fluorspar, graphite, gypsum, ilmenite, kyanite, limestone, phosphate, salt, soda ash, sulfur, and talc. Other industrial minerals that occur in commercial quantities were gemstones, which include amethyst, aquamarine, sapphire, topaz, and tourmaline.

There was no official production of these minerals, but illegal mining of barite, gemstones, and gypsum was reported to have increased in 1992. The

RMRDC set up pilot plants for the production of minerals such as kaolin and phosphate rock at Katsina and soda ash and talc at Maiduguri in 1992. The projects were scheduled to begin in late 1992 with these annual output levels: kaolin, 20,000 mt/a; phosphate rock, 15,000 mt/a; soda ash, 3,000 mt/a; and talc, 3,000 mt/a. Two companies that were formed in 1991 to exploit and export barite and bentonite in the country as joint-venture partners of the Government continued site development work in 1992.

The National Fertilizer Co. of Nigeria (NAFCON) continued as the sole ammonia- and urea-producing company in the country. It uses a natural gas feedstock to produce nitrogen-base fertilizers.

NAFCON II, Nigeria's second fertilizer plant scheduled to be built next to the existing plant at Onne, was stalled for lack of funding. However, authorities in the NNPC are optimistic that the project could be revived in early to late 1993.

#### Mineral Fuels

**Coal.**—Coal output, which increased in 1991, continued the same trend in 1992. Export levels exceeded 1991 levels slightly as production fluctuated owing to infrastructural and transportation problems. The Government continued to pursue its efforts to divest by inviting private investors to participate in development of the coal industry. The Government formed joint-venture partnerships with Bulgarian and British firms. Bulnig Mining Co., a joint-venture partnership between Nigerian Coal Corp. and Bulgaria's EC Minstroy and its local affiliate Bienventures, was to mine the Okaba and Onwukpa Mines.

Production from the Onyeama Mine continued at about 100,000 mt/a, but is expected to top 220,000 tons in the mid-1990's. Output is expected to increase to between 440,000 tons and 500,000 tons starting in 1995. Reserves at the Onyeama Mines were reported at 254 Mmt. The Government continued in its exploration programs to establish proven

reserves and develop an open pit mine at Okaba to supply local and regional markets. Exploration work was completed at the Ogboyega deposit in Enugu, and work continued at other deposits. Proven reserves were 250 Mmt, while estimated resources remain at 2.7 billion tons.

Eagle Mining Co. Ltd., a joint venture between Carbomin Ltd. of the United Kingdom and Nigerian Coal Corp., continued to mine the Onyeama Mines and planned to expand its operations to other parts of Nigeria.

**Natural Gas.**—With reserves of more than 2.6 trillion m<sup>3</sup>, Nigeria ranks 12th in the world in natural gas reserves. Most of the natural gas produced was associated gas and before December 1992, about 79% was flared. Nigeria also has probable reserves of about 1.8 trillion m<sup>3</sup>.

In December 1992, the \$900 million Oso I Condensate project came on-stream. The development of the Oso project became feasible because OPEC excluded condensate from its quota system. Thus it became very economically attractive for Nigeria to export as much gas as it wanted. The first 600,000 bbl of condensate in the form of natural gas liquids was delivered to Mobil Oil Co.'s refinery in Texas in December 1992. Condensate traded for about the same price as North Sea crude oil and could be refined into jet fuel, kerosene, and naphtha feedstock for petrochemicals. In early 1993, production remained at 50,000 bbl/d, but designed capacity was for 100,000 bbl/d. Mobil started engineering work on Oso II, an \$800 million project to extract natural gas liquids from neighboring gasfields.

Controversy over the awarding of the contract to build the liquefied natural gas (LNG) plant has stalled the LNG project. The contract was expected to be awarded in December 1992, but the Nigerian LNG board was dissolved before an announcement of the winners could be made. The \$4.6 billion two-train LNG plant was a joint-venture between Nigerian LNG Ltd., a subsidiary of NNPC (60%), Shell Oil Co. of the United States (20%), AGIP oil of Italy (10%), and Elf Aquitaine Oil Co. of

France (10%). Failure to implement this project could be detrimental to the future of sales and purchase agreements already concluded on the project.

**Petroleum.**—Production of crude oil was from small fields and many wells. About 65% of all oil produced in Nigeria in 1992 was light, sweet crude with a 35° API gravity or higher. Also, about 65% of output was onshore in the Niger Delta areas, with nearly all the rest produced from offshore wells in the shallow continental shelf. In 1992, deepwater concessions were opened for companies to bid on, with the successful party becoming an equity partner with NNPC. Production of crude petroleum in 1992 averaged 1.9 Mbbbl/d, of which about 1.65 Mbbbl/d was exported. The balance of production was used locally for manufacture of petroleum products. Exploration activities continued throughout the year in a determined effort by the Government to increase the country's oil reserves.

#### Reserves

Nigeria's proven oil reserves at yearend 1992 were about 20 billion bbl. Known natural gas reserves were about 2.6 trillion m<sup>3</sup>, ranking Nigeria fifth in the world in natural gas reserves. Nearly 70% of the oil and gas reserves are onshore, and all were in the Niger River Delta. Nigeria's oil reserves have high gas-to-oil ratios, and most of the new gas discoveries occurred during oil exploration. The total in situ reserves of Nigerian coal were reported at 1.5 billion tons. A lignite belt exists across the southern portion of the country. Reserves of the lignite deposits were not accurately known but were believed to be as much as 250 Mmt. Total iron ore resources were estimated at about 2.5 billion tons with an iron content averaging about 37%. About 2 billion tons of the total iron ore reserves is at Agbaja with an average iron content of 45% to 47%. See table 3 for reported reserve figures of other minerals. (See table 3.)



## INFRASTRUCTURE

The Nigerian railway system, the fifth largest in Africa, consists of 3,510 km of 1.067-m-gauge track. The two main north-south lines, from Lagos to Kano, 1,126 km, and from Port Harcourt to Maiduguri, 1,443 km, are connected by a 179-km east-west line from Kaduna to Kaura Namoda. There are also four branch lines with railheads at Nguru, Jos, Idawaw, and Baro. The Ajaokuta-Port Harcourt line was still under construction in 1990. Roads totaled about 120,000 km, of which 35,000 km was paved. Inland waterways of about 9,000 km consisted mainly of the Niger and Benue Rivers, their tributaries, and the navigable routes to Kainji Lake. The Kainji dam and powerplant, with a capacity of about 11,500 MW, was the major source of hydroelectric power for the country. Major ports included Lagos, Port Harcourt, and Koko near Warri. Major airports were in Lagos, Kano, Port Harcourt, and most recently at Abuja, the new capital of the country.

## OUTLOOK

The Government's fiscal and financial incentive programs designed to attract local and foreign investors into new investments and developments in the mineral industry is expected to continue through the mid-1990's. Petroleum and natural gas are anticipated to continue dominating the economy for the foreseeable future. Because there have been no major changes in policy and programs, industrial development in Nigeria would depend mostly on the successful completion and operation of the iron and steel complexes. These developments in the steel industry could generate the development of the heavy equipment and metalworking industries and could provide jobs for the available large labor force.

Revitalization of the coal industry could add to reserves and provide an additional source of foreign exchange when exploited. Joint-venture agreements signed with foreign investors could

increase production of coal and reduce importation of coal. Coking coal required for the beneficiation plant at Itakpe would continue to be imported.

The mineral industry as a whole should continue to enjoy considerable growth because of increasing activity in the mineral fuels sector. The planned output of 2.5 Mbbl/d of crude oil by 1995 is achievable. The abundance of natural gas could provide a new energy source and feedstock for the chemical and petrochemical industries.

Development of other nonfuel minerals could stabilize the economy and would increase the revenue base of the country, particularly with favorable mining and investment codes, which are under review.

<sup>1</sup>Where necessary, values have been converted from Nigerian naira (N) to U.S. dollars at N30.00=US\$1.00 in 1992.

## OTHER SOURCES OF INFORMATION

Federal Ministry of Mines and Power  
Six Storey Building  
Lagos, Nigeria

Nigerian National Petroleum Corp.  
NNPC Building Falomo  
Lagos, Nigeria

TABLE 1  
NIGERIA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1988	1989	1990	1991	1992 <sup>*</sup>	
<b>METALS</b>						
<b>Columbium and tantalum concentrates:</b>						
Gross weight	50	46	44	36	40	
Columbium content <sup>*</sup>	20	20	19	15	17	
<b>Iron and steel:</b>						
Iron ore, gross weight	thousand tons	304	<sup>*</sup> 300	374	398	400
Steel, crude	do.	192	<sup>*</sup> 213	133	137	140
<b>Lead:</b>						
Mine output, Pb content <sup>*</sup>		85	<sup>2</sup> —	106	<sup>*</sup> 100	100
Metal, refined secondary		<sup>3</sup> —	<sup>3</sup> —	<sup>3</sup> —	—	—
<b>Tin:</b>						
<b>Mine output, cassiterite concentrate:</b>						
Gross weight		432	350	310	350	300
Sn content		300	<sup>*</sup> 254	<sup>*</sup> 165	182	200
Metal, smelter		566	258	227	246	220
Zinc ore and concentrate, Zn content		<sup>(3)</sup>	<sup>2</sup> —	<sup>2</sup> —	—	—
<b>INDUSTRIAL MINERALS</b>						
Cement, hydraulic <sup>*</sup>	thousand tons	3,500	3,500	3,500	3,500	3,500
<b>Clays:</b>						
Kaolin		105	500	1,356	<sup>*</sup> 1,300	1,300
Unspecified		15,000	13,341	60,113	<sup>*</sup> 60,100	60,100
Feldspar		190	945	714	<sup>*</sup> 700	700
<b>Nitrogen:</b>						
N content of ammonia	thousand tons	300	364	<sup>*</sup> 360	367	360
N content of urea	do.	260	522	<sup>*</sup> 550	372	370
<b>Stone:</b>						
Limestone	do.	1,712	1,315	1,136	1,436	1,400
Marble		5,445	1,377	1,605	1,600	1,600
Shale	thousand tons	86	38	67	<sup>*</sup> 70	70
Coal, bituminous	do.	150	28	78	138	140
<b>Gas, natural:</b>						
Gross	million cubic meters	20,740	24,831	<sup>*</sup> 27,593	31,286	31,300
Dry	do.	3,193	3,833	<sup>*</sup> 3,233	2,568	2,600
<b>Petroleum:</b>						
Crude	thousand 42-gallon barrels	569,400	626,489	<sup>*</sup> 660,462	689,800	695,700
<b>Refinery products:</b>						
Gasoline	do.	21,000	23,337	30,706	30,818	30,800
Jet fuel	do.	500	<sup>*</sup> 510	<sup>*</sup> 700	920	900
Kerosene	do.	10,600	11,873	14,521	14,760	14,700
Distillate fuel oil	do.	15,000	17,591	17,366	26,464	26,400
Residual fuel oil	do.	13,600	19,254	23,935	13,468	13,400
Unspecified	do.	5,000	2,274	3,806	1,615	1,600
Total	do.	65,700	74,839	91,034	88,045	87,800

<sup>\*</sup>Estimated. <sup>2</sup>Revised.

<sup>1</sup>Includes data available through Feb. 19, 1993.

<sup>2</sup>Reported figure.

<sup>3</sup>Less than 1/2 unit.

TABLE 2  
NIGERIA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

(Million metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Coal	thousand metric tons	Nigerian Coal Corp. (Government, 100%)	Enugu	144.
Iron ore	do.	National Iron Ore Mining Co. (Government, 100%)	Itakpe, near Okene	*325.
Iron and steel		Ajaokuta Steel Co. Ltd. (Government, 100%)	Ajaokuta City	1.3, .7 rolled steel.
Do.		Delta Steel Co. Ltd. (Government, 100%)	Aladja	1.00 liquid steel, .32 rolled steel.
Do.		Jos Steel Rolling Co. Ltd. (Government, 100%)	Jos	.21.
Do.		Katsina Steel Rolling Co. Ltd. (Government, 100%)	Katsina	.21.
Do.		Oshogbo Steel Rolling Co. Ltd. (Government, 100%)	Oshogbo	.21.
Nitrogen	thousand metric tons	National Fertilizer Co. of Nigeria (Government, 63%; M.W. Kellog, 37%)	Onne	548 N content of ammonia, 360 N content of urea.
Petroleum, crude	million barrels	Nigerian National Petroleum Corp. (Government, 60%; private, 40%)	Lagos	695.
Petroleum refinery products				
	thousand barrels	Kaduna refinery (Government, 100%)	Kaduna	40.
Do.	do.	Warri refinery (Government, 100%)	Warri	46.
Do.	do.	New Port Harcourt refinery (Government, 100%)	Port Harcourt	55.
Do.	do.	Old Port Harcourt refinery (Government, 100%)	do.	22.
Tin	thousand metric tons	Makeri Smelting Co. Ltd. (Government, 100%)	Jos	1.

TABLE 3  
NIGERIA: RESERVES OF MAJOR  
MINERAL COMMODITIES FOR  
1992

(Million metric tons unless otherwise specified)

Commodity	Reserves
Asbestos	0.4
Barite	700
Columbite	.14
Coal	5,000
Diatomite	10
Iron ore	2,300
Lead and zinc	.711
Natural gas	
trillion cubic meters	2.6
Petroleum, crude	
million barrels	20,000
Tin	.17

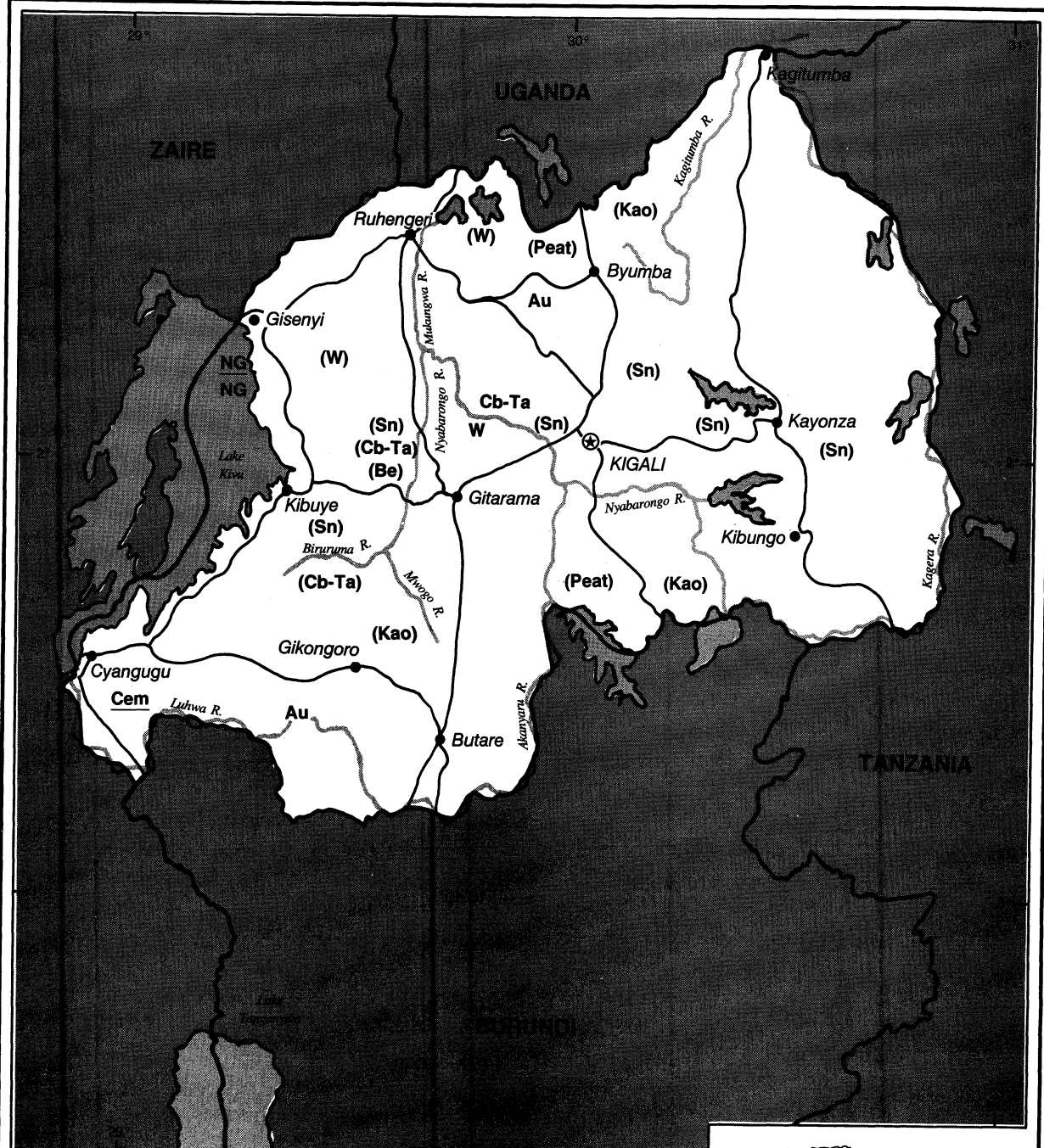
Source: Ministry of Petroleum and Natural Resources of Nigeria.



# RWANDA

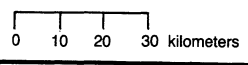
AREA 26,340 km<sup>2</sup>

POPULATION 8.2 million



- LEGEND**
- International boundary
  - Capital
  - City
  - Road
  - River
  - Undeveloped significant resource

See table for mineral symbols.  
Underlined symbol indicates plant.



## THE MINERAL INDUSTRY OF

# RWANDA

By Lloyd E. Antonides

No significant changes in Rwanda's small mineral industry were reported during 1992. The sector contributed little to the country's economy although many occurrences of potentially valuable minerals had been recorded for some years. Small cooperatives and individual artisans continued to produce concentrates of tin, tungsten and columbium-tantalum ores, and also some gold bullion. A small cement plant in the southwest utilized local limestone, and a brewery used natural gas from a pilot plant exploiting resources beneath Lake Kivu.

The economy had been contracting for several years but was expected to have leveled-off in 1992. In 1991, the GDP in current francs was \$1.67 billion,<sup>1</sup> according to International Monetary Fund data available in March 1993. A significant drain on the economy was the cost of military operations in the north against an invasion of former exiles. A cease-fire was reported negotiated in

April 1993. In 1992, the minerals industry probably made up less than 2% of GDP, although mineral exports likely approached 10% of total exports in value. Coffee remained the major foreign exchange earner despite low prices. Mineral-related imports were significant, probably about 25% of total imports in value, because they included petroleum refinery products and metal construction materials.

The Government remained committed to promoting investment in mineral commodity production. Foreign funds were sought and training and financial assistance to small domestic mine operators were offered.

The internal road system was considered satisfactory; hydroelectric power was ample; and communications, internal and external, were good. International air transportation was also good but ground routes involved long distances to ocean ports.

No substantial change in the status of the mineral industry could be expected in the near term, especially not until political stability could be restored.

<sup>1</sup>Where necessary, values have been converted from Rwanda francs (RF) to U.S. dollars at the official annual average rate of RF133.35=US\$1.00 for 1992 values and RF125.14=US\$1.00 for 1991 values. The official 1992 yearend rate was RF146.27=US\$1.00.

### OTHER SOURCES OF INFORMATION

#### Agency

Ministry of Industry and Handicrafts  
Republic of Rwanda  
P.O. Box 73, Kigali, Rwanda  
Telephone: 250-75417  
Facsimile: 250-75465

#### Publication

Map of Mineral Deposits of Rwanda, Ministry of Natural Resources, Republic of Rwanda, 1982.

TABLE 1  
RWANDA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>		1988	1989	1990	1991*	1992*
Cement		58,073	67,706	60,339	60,000	60,000
Columbite-tantalite, ore and concentrate, gross weight	kilograms	<sup>r</sup> 37,000	<sup>3</sup> 64,100	<sup>r3</sup> 109,900	<sup>1</sup> 100,000	100,000
Cb content*	do.	2,000	19,000	<sup>3</sup> 33,000	<sup>3</sup> 30,000	30,000
Ta content*	do.	2,000	14,000	<sup>2</sup> 24,000	<sup>2</sup> 22,000	22,000
Gold, mine output, Au content	do.	<sup>4</sup> 15	<sup>4</sup> 745	<sup>2</sup> 2,163	<sup>1</sup> 1,000	1,000
Natural gas, gross	thousand cubic meters	903	132	973	970	970
Tin: Mine output, Sn content		<sup>r</sup> <sup>5</sup> 118	<sup>5</sup> 762	<sup>5</sup> 734	730	730
Tungsten, mine output, W content		<sup>6</sup> 22	<sup>6</sup> 105	<sup>6</sup> 156	175	175

\*Estimated <sup>r</sup>Revised.

<sup>1</sup>Includes data available through Apr. 15, 1993.

<sup>2</sup>In addition to commodities listed, the following are produced, but information is inadequate to reliably estimate output: some gemstones (sapphire and tourmaline); limestone for cement and possibly agriculture; shale and/or clay for cement; and presumably crude construction materials (e.g., clays for brick and tile, sand and gravel, stone) from small local operations. Beryllium (beryllium concentrate, estimated 10% BeO) production was last reported in 1985 at 27 tons. Tin smelter production was last reported in 1985 at 800 tons metal when the smelter was reported shut down.

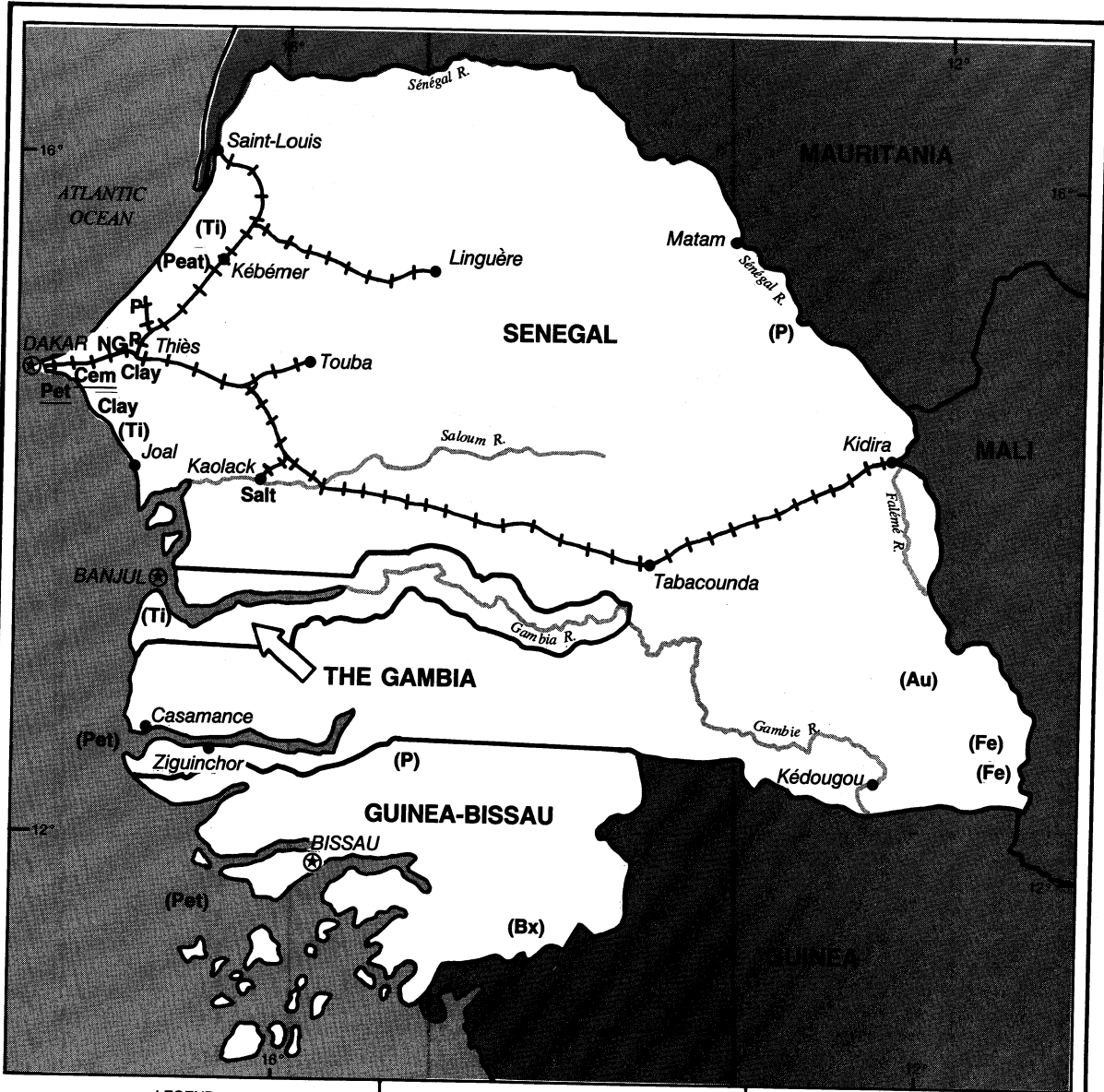
<sup>3</sup>Reported figure. Estimated to contain 22% Ta plus 30% Cb (content last reported in 1985 at 27% Ta<sub>2</sub>O<sub>5</sub>).

<sup>4</sup>Gross weight reported, estimated to contain 92% Au.

<sup>5</sup>Gross weight ("cassiterite") reported, estimated to contain 70% Sn.

<sup>6</sup>Gross weight ("wolfram") reported, estimated to contain 54% W (68% WO<sub>3</sub>).

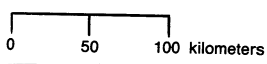
# SENEGAL, THE GAMBIA, GUINEA-BISSAU



**LEGEND**

- International boundary
- Capital
- City
- Railroad
- River
- Undeveloped significant resource

See table for mineral symbols.  
Underlined symbol indicates plant.



**SENEGAL**  
 AREA 196,190 km<sup>2</sup>  
 POPULATION 8.0 million

**THE GAMBIA**  
 AREA 11,300 km<sup>2</sup>  
 POPULATION 875,000

**GUINEA-BISSAU**  
 AREA 36,120 km<sup>2</sup>  
 POPULATION 1.0 million



# SENEGAL, THE GAMBIA, AND GUINEA-BISSAU

By Hendrik G. van Oss and David Izon

## SENEGAL

The mineral industry of Senegal was the dominant force in the country's industrial sector in 1992. Total domestic plus export sales of mineral commodities, including cement and manufactured fertilizers but excluding refined petroleum products, amounted to almost \$237 million in 1992. Primary mineral sales amounted to about \$90 million of this, of which calcium phosphates accounted for 83%. Among value-added commodities, cement sales amounted to almost \$43 million, and manufactured phosphate fertilizers and phosphoric acid sales amounted to about \$104 million. Sales data for petroleum products refined in Senegal were unavailable, but based on 1992 production data and 1990 trade data, it can be estimated that these sales in 1992 amounted to at least \$275 million. Overall, mineral sales revenues were similar to those in 1991. Senegal's GDP in 1992 has been estimated at \$6.5 billion, up 11% from that in 1991, but largely reflecting a strengthening of the French franc and hence the local currency<sup>1</sup> rather than an overall growth of the economy.

Senegal's total exports in 1992 are estimated at about \$900 million. Primary mineral exports amounted to almost \$67 million, and phosphate fertilizer and phosphoric acid exports amounted to almost \$104 million. Exports of petroleum products were worth an estimated \$25 to \$30 million. Total imports in 1992 were estimated at about \$1.3 billion. Complete mineral commodity import data were unavailable for 1992, but the imports are estimated at

about \$350 million, largely crude and refined petroleum, semifinished steel products, and sulfur. Probably \$120 million of the total mineral imports (largely refined petroleum products) represented material for reexport.

Geologically, most of Senegal is made up of Mesozoic and Tertiary sedimentary rocks of the Senegal Basin. The country's important phosphate rock and clay deposits are found in Lower Tertiary rocks. Senegal is prospective for oil. Major exploration targets are salt diapirs, sourced from Jurassic salt beds, that have formed stratigraphic traps for oil derived from Cretaceous source rocks. Other hydrocarbon traps are associated with folds that appear to have been formed by normal faulting related to the opening of the Atlantic Ocean. Senegal's coastline contains a large resource of titaniferous sands, derived from Precambrian granites outside of Senegal and deposited in Senegal by longshore currents. Lower Proterozoic granites and associated Birimian Series volcano-sedimentary rocks are found in southeast Senegal. These host a number of gold deposits, generally associated with quartz veins and/or iron sulfides, and commonly within northeast-trending shear zones. Large iron deposits are also found in this terrane, as are scattered occurrences of base metals, tantalum, and columbium mineralization.

### Government Policies and Programs

Although the Government, as part of a privatization program, had been seeking a buyer for the country's cement plant, no such sale was announced during the

year. The Government remained a major participant in the rest of the country's mining sector. Recent policies to encourage development of mineral resources other than phosphate have largely concentrated on gold, iron ore, titaniferous sands, and petroleum. Iron ore has attracted little interest owing to depressed world prices, but exploration for the other commodities was under way in 1992.

In 1986, a new petroleum code was adopted to replace the Petroleum Code of 1960. The new petroleum legislation was followed by the adoption of a new investment code, law No. 87-25 of July 30, 1987. Apart from detailing certain licensing and tax exemptions for new investments, the new investment code identifies mining as a high-priority sector of the economy. A new mining code, law No. 88-06, was adopted August 26, 1988.

### Production

Mineral output in Senegal continued to be mixed in 1992 (see table 1). Output of calcium phosphate, Senegal's best known mining product, increased significantly, although stagnant world prices and reduced demand offset the production gains. The related production of phosphoric acid and phosphate fertilizers declined. Output of crude and calcined aluminum phosphate declined for the third year in a row. Cement and salt output showed significant increases. Total oil refinery output increased slightly; the reported significant shift in product mix was unexplained.

Artisanal miners in Senegal produce a modest but undocumented quantity of



gold each year. A pilot plant was in operation toward yearend 1991 on a long-explored gold deposit in southeast Senegal, but no production data were available for 1992. Although firm data were unavailable, Senegal's small production of natural gas in 1992 was probably at about the same level as in 1991, based on a similar output of oil (as gas condensate).

## Trade

Senegal's exports are estimated to have totaled about \$900 million in 1992. The value of overall mineral commodity exports was believed to be about the same as in 1991, or about \$200 million. As in 1991, the main mineral commodities exported were calcium phosphate rock and derived phosphoric acid and manufactured fertilizers, refined petroleum products, and salt.

Exports of calcium phosphate rock in 1992 declined 14% to 1.17 Mmt, largely because of modest world demand and competition from other major world producers. The exports were worth \$51.37 million, down 13%. The major customer in 1992 continued to be Iran, which took almost 470,000 tons, a 24% increase. Other major customers were India, the Philippines, and Greece, although exports to these countries fell significantly. Total sales of calcium phosphate to the EC, once the major customer, continued to decline owing to environmental concerns over the high levels of cadmium in Senegalese phosphate rock. Sales to the EC in 1992 were only about 163,000 tons, 2% less than in 1991 and 56% less than in 1990. Sales of aluminum phosphate rock were down also—there were no customers in 1992 for the crude material. Exports of the calcined product called clinker, directly usable as a fertilizer, fell 12% to about 48,000 tons. The exports, worth \$1.8 million, were all to the EC.

Exports of phosphoric acid continued to be all to India, a joint owner of the producing company. Exports in 1992 increased 2% to 258,729 tons, but were worth only \$67.5 million, a 14% decline. Exports of manufactured fertilizers

increased 11% to 144,137 tons, worth \$32.2 million. Fertilizer exports were mainly to west African countries. West African countries were also the main customers for Senegalese refined petroleum products exports and salt, worth about \$25 million and \$7.5 million, respectively. Attapulgitite exports were virtually all to the EC and were worth about \$5.3 million.

Senegal's total imports in 1992 amounted to an estimated \$1.3 billion, of which mineral commodity imports amounted to almost 30%. Crude oil and refined petroleum products imports amounted to an estimated \$220 million, about 55% of which (all as refined products) was destined to be reexported. Crude oil imports in 1992 were from Nigeria (68%), Gabon, and Angola. Refined products import sources were varied and included various countries in Africa, the EC, and the Caribbean.

Complete sulfur import data were unavailable for 1992 but, based on 1990 trade data (total imports were 237,204 tons) and fertilizer/phosphoric acid production for 1990-92, sulfur imports in 1992 are estimated to have amounted to about 270,000 tons, worth about \$28 million. Based upon incomplete data, Canada was probably the largest supplier of sulfur to Senegal in 1992 at an estimated 150,000 tons. The United States supplied 104,299 tons in 1992. Other major suppliers in recent years have been France and Saudi Arabia. Imports of steel are estimated to have been unchanged significantly from 1990 levels, about \$65 million.

## Structure of the Mineral Industry

In 1992, the mining industry of Senegal continued to be dominated by the production of phosphates and derived phosphoric acid and manufactured fertilizers, and cement (*see table 2*). The Government had major equity stakes in most of the companies.

Although current data were unavailable, an estimated 4,500 persons worked in the mining and related industries, of which about 2,400 were employed in phosphate mining and about

1,000 in the fertilizer industry. In addition, the majority of the country's approximately 2,000 railroad employees and many of Dakar's port workers owed their livelihood to the transportation of mineral commodities. An undocumented number of artisanal gold miners were at work in southeast Senegal, if only on a part-time basis.

## Commodity Review

**Metals.**—Paget Mining Ltd. of Australia reportedly signed an option during the year to earn a 51% stake in Société Minière de Sabodala, a joint-venture controlling several gold properties in southeast Senegal north of Kédougou. Paget was to do a prefeasibility study that, if favorable, would commit the company to an exploration program to prove reserves. Exploration work was to start in 1993. A German company was reported to be exploring for gold near Tambacounda.

**Industrial Minerals.**—Senegal's mining industry is dominated by the mining of calcium and, to a lesser extent, aluminum phosphate rock. A major secondary industry in the country is the processing of some of this material to make phosphoric acid and fertilizers. Of the two companies mining phosphates, Compagnie Sénégalaise des Phosphates de Taïba (CSPT) is by far the larger. For many years, CSPT produced its phosphate rock from the Keur Mor Fall deposit, but ever increasing stripping ratios led the company, in 1991, to shift the bulk of its mining to the nearby Tobène deposit. This caused a 6-month disruption in production in 1991 and output was only 1.546 Mmt. In contrast, production in 1992 was back to normal levels, at 2.101 Mmt. Exports, however, fell 13% to 1.044 Mmt, largely owing to reduced demand by India and the Philippines, which significantly offset a large increase in demand by Iran, the largest customer. These countries together accounted for 85% of the total exports, a shift from a few years before when a large share of the production went to the EC. Sales to the EC have suffered in

recent years and continued to decline in 1992 because of environmental concerns over the high cadmium content of the ore. Domestic sales of ore were to the Industries Chimiques du Sénégal (ICS) for the manufacture of phosphoric acid and phosphate fertilizers and fell 5% to 802,000 tons. Output by ICS declined significantly during the year because of increased export competition. The company has partially completed a program to expand sulfuric acid and phosphoric acid production capacity.

Société Sénégalaise des Phosphates de Thiès (SSPT) had a poor performance year. Output of aluminum phosphate, for which this company was reportedly the sole world source, continued to fall. Production of crude ore declined about 16% and production of the calcined ore, called clinker, fell 18%. The clinker, when ground, can be used directly as a fertilizer. Traditionally, part of the crude ore was processed in Senegal and the rest was exported (mostly to France) for processing. There were no exports of crude ore in 1992, and clinker exports fell 12% to 48,433 tons, mostly to France and Belgium. In contrast to several years of declining demand for aluminum phosphate, demand for SSPT's calcium phosphate has been strong, and output of this material was increased for several years. In 1992, however, demand weakened and production declined 7% to 182,500 tons. Exports, largely to Greece, France, and China, actually increased 7% to 128,799 tons, but local sales during the year fell 20% to 50,625 tons.

**Mineral Fuels.**—Union Oil Co. of California reportedly commenced drilling in 1992 on its concession covering the Dôme Flore area, 60 km offshore of Casamance. The 3-year concession, received toward yearend 1991, covers 6,500 km<sup>2</sup>. Coastal Oil and Gas of the United States had a 5,382-km<sup>2</sup> offshore concession near the border with Guinea-Bissau.

**Reserves.**—Exploration for phosphates has been ongoing in Senegal for about 50 years. The first commercial deposit was that of aluminum phosphate near Thiès,

which has been in production by SSPT since 1949. The large calcium phosphate deposits at Taïba have been in production by CSPT since 1960, and the calcium phosphates near Thiès have been in production by SSPT since 1974. Several other phosphate deposits are known,<sup>2</sup> but few appear to be potentially economic. SSPT's reserves of aluminum phosphate near Thiès amount to about 100 Mmt grading 27.5% P<sub>2</sub>O<sub>5</sub>, within which inventory are reserves of about 50 Mmt grading 28.5% P<sub>2</sub>O<sub>5</sub>. Original reserves of calcium phosphate on SSPT's concessions totaled about 4 Mmt grading about 29.5% P<sub>2</sub>O<sub>5</sub>, concentratable to 34% P<sub>2</sub>O<sub>5</sub>. Approximately one-third of this inventory had been mined by yearend 1992. The remaining inventory of calcium phosphate at CSPT's Keur Mor Fall deposit amounts to about 30 Mmt grading about 29% P<sub>2</sub>O<sub>5</sub>, concentratable to 37.5% P<sub>2</sub>O<sub>5</sub>. The stripping ratio at the mine is high and it is not clear how much of the inventory can be classified as reserves given the increased mining costs, low world phosphate prices, and the material's high cadmium content. The adjoining Tobène deposit has reserves, according to the company, of about 50 Mmt, capable of being concentrated to 36.2% P<sub>2</sub>O<sub>5</sub>. A number of phosphate occurrences are known just south of the Mauritania border in the Senegal River valley. The largest resource is in two deposits near Semmé, 60 km southeast of Matam. The total resource at Semmé is 40.5 Mmt (36.5 Mmt recoverable) grading 28.7% P<sub>2</sub>O<sub>5</sub>. Development of the Semmé phosphates, except on a very small scale for local consumption, would require the construction of railing and port facilities, the cost of which has been estimated to be in excess of \$100 million. Given the large remaining reserves in the Taïba-Thiès area, the Semmé deposits are not likely to become economic for many years.

Senegal has had past small-scale mining of titaniferous sand deposits. Numerous studies have been done to determine reserves of heavy minerals, most recently by Dupont Senegal, which has announced an inventory on its concession north of Dakar of 8 to 10

Mmt; no grade has been announced, but the deposit is believed to require improved market conditions to be economic.

Numerous gold occurrences are known in the Precambrian terrane of southeast Senegal. The Sabodala deposit is the best documented of these occurrences. According to the Government, a feasibility study completed in 1982 concluded that reserves amounted to 240,000 tons of oxide ore grading 7.42 g/mt of gold, plus 2.42 Mmt of sulfide ore grading 4.92 g/mt of gold. A 1983 study concluded that the oxide reserves were 235,260 tons grading 6.5 g/mt of gold. A consortium of foreign companies was exploring the Sabodala and nearby deposits in 1991 and 1992. It was reported that they were conducting a prefeasibility study on Sabodala based on a resource of about 600,000 tons grading 4.28 g/mt gold.

Probably the most significant undeveloped mineral resources in Senegal are the iron occurrences of southeast Senegal, generally called the Falémé deposits. A 1990 audit of past feasibility studies on the Falémé deposits put the reserves of the largest deposit (Koudékourou) at approximately 300 Mmt grading 60% iron. Exploitation of the deposit would require the construction of extensive railing and port shipping infrastructure, and the expected cost of this makes the project economically questionable. Four other iron ore deposits are known in the region; these alone could not justify the cost of the required ore transportation infrastructure but could potentially be viable once Koudékourou was developed. Two of these other deposits are hematitic; the Karakaène deposit has a resource of 60 Mmt, and the Kouroudiako deposit contains 51 Mmt. Both grade about 56% iron and occur 50 to 60 km north of the Koudékourou deposit. About 35 km north of the Koudékourou deposit are two magnetite iron ore deposits; these contain a total resource of about 190 Mmt grading 41% to 45% iron.

Senegal's oil and gas reserves are not well known. Despite sporadic exploration for almost 40 years, including the drilling

of approximately 150 wells, commercial discoveries have been limited to small gasfields east of Dakar. The most significant of these is the Diam Niadio Field, currently in small-scale production. According to the Government, reserves in this field total about 50 Mm<sup>3</sup>. The offshore Dôme Flore Field has been explored intermittently since 1958. According to the Government, known reserves in this field are approximately 640 Mbbl of very heavy-weight crude oil ( $\pm 10^\circ$  API) and perhaps 14 Mbbl of light crude.

Senegal has extensive peat deposits along the coast between Dakar and Saint-Louis. The largest deposits are in the so-called Central Zone, a 1- to 3-km-wide belt extending 30 to 70 km northeast of Dakar. This zone contains an extractable resource estimated to be almost 23 Mm<sup>3</sup>, sufficient for 20 years of feed for a 30-MW electrical plant. Smaller deposits within this zone and in zones to the northeast and southwest contain an additional resource of 6 Mm<sup>3</sup> that is not suitable for large-scale mining but could be used for domestic heating purposes. In this regard, the peat is said to have a heat output equivalent to 58% of that of charcoal. In addition, there is a resource of approximately 15 Mm<sup>3</sup> of peat that is too sandy for burning but that could be used as mulch for agricultural purposes.

### Infrastructure

Senegal's railroad infrastructure is relatively well developed only in the northwest part of the country. The railroad network in 1992 consisted of 1,034 km of 1-m-gauge track, all single track except for 70 km of double-track line from Dakar to Thiès. The line from Dakar to the Mali border (and thence to Bamako) was completed in 1923, and trade along this route led to Dakar's early development as a significant regional port. More than 95% of the total rail tonnage in Senegal in recent years has been related to the transport of mineral commodities, including fertilizers. Most freight and passenger railings are handled by the parastatal Régie des Chemins de fer du Sénégal. However, traffic related

to ICS is handled by that company's own railroad company, Société d'Exploitation Ferroviaire des Industries Chimiques du Sénégal. Although adequate for current mining output, the railroad infrastructure would not allow the exploitation of the Falémé iron ore deposits in southeast Senegal; such would require the construction of additional infrastructure.

Dakar is the only significant mineral port in Senegal, although some of the country's salt production is shiploaded at Kaolack. Dakar had facilities adequate for offloading approximately 1.5 Mmt/a of crude oil and petroleum products, 300,000 mt/a of sulfur, and about 30,000 mt/a of ammonia. Shiploading and storage capacity for minerals was adequate to handle about 2 Mmt/a. The exploitation of Senegal's iron ore deposits will require the construction of an ore port at Bargny, 30 km east of Dakar.

Senegal had an electrical generating capacity of 231 MW in 1990, the latest year for which data were available. All of this installed capacity was in thermal plants. Production of electricity in 1991 was 760 GW·h. Except for the burning of the country's modest natural gas output, all of the country's electricity generation used imported fuel. Senegal is involved in a joint project with Mali and Mauritania to harness the Senegal River and its tributaries for hydroelectric and irrigation purposes. The project involves two dams, although only the Manantali Dam, on the Bafing tributary to the Senegal River in Mali, will have a hydroelectric plant. Installation of the turbines at Manantali continued to be held up in 1992 because of a dispute with Mauritania over the routing of the power transmission lines from the dam to Dakar. Senegal will receive approximately two-thirds of the expected 800-GW·h/a output.

### Outlook

It appears inevitable that Senegal's mineral economy will continue to be dominated by phosphates and related fertilizers. Environmental concerns over the high level of cadmium in Senegalese phosphates has hurt sales to certain

markets, although sales could improve if ongoing research to remove the contaminant through processing is successful. Senegal has reserves of phosphate adequate for any foreseeable growth in demand. It appears likely that Senegal will become a gold producer in the near future although resources, by west African standards, appear modest. Senegal's resources of titaniferous sands require an improvement in world prices to justify development, but if developed would require a lead time of only about 2 years. The economics of exploiting the Falémé iron ore deposits remain very uncertain given the high cost of constructing the necessary railing and port infrastructure and current world market conditions for iron ore. There appears to be some modest potential for the discovery of commercial petroleum deposits. The production of natural gas, from known onshore fields, is likely to remain small but may well increase above current levels. Installation of hydroelectric capacity at the Manantali Dam in Mali will greatly reduce Senegal's need to import fuel for electricity generation and would reduce the incentive to exploit the country's large deposits of peat.

## THE GAMBIA

Mining continued to be a negligible component of the Gambian economy, which has for many years been dominated by agriculture, tourism, and the largely unregistered transshipment of goods into Senegal. Production of mineral commodities in 1992 was limited to brick clay, laterite, sand and gravel, and cockle shells, for local construction purposes. Deposits of these materials are believed to be significant and could support a greater level of exploitation. Fewer than 200 persons were believed to be employed full time in mining.

The geology of The Gambia is similar to that of the adjoining parts of Senegal and, accordingly, there may be potential for the discovery of oil. Several thousand kilometers of seismic surveys have been run over the past 30 years and a few exploration wells, all unsuccessful,

drilled. The Government was trying to attract petroleum exploration investment in the country.

The Gambia has significant glass sand deposits; these have yet to be exploited. Like Senegal, The Gambia has resources of titaniferous sands; these were mined in the 1950's. Remaining resources, according to the Government, amount to 20 Mmt grading 4.9% heavy minerals, dominantly ilmenite.

## GUINEA-BISSAU

The economy of Guinea-Bissau is dominated by agriculture and has mineral production limited to small but undocumented quantities of construction

materials. Mining revenues in 1992 were reported to have been only \$8 million. Bauxite deposits exist in the Boé region along the border with Guinea, but are of low grade. Phosphate deposits are found near Farim in the north-central part of the country. These grade about 30% P<sub>2</sub>O<sub>5</sub>; the economics of exploiting this resource were uncertain, given the large, higher grade deposits in Senegal and the lack of infrastructure in Guinea-Bissau. Guinea-Bissau's current mining and investment code was formulated in 1990 by the UN Department for Technical Co-operation and Development (UN/DTCD). Ongoing mineral-related activities by the UN/DTCD in 1992 included a regional exploration program for gold and diamonds.

Oil exploration was under way in the Anetibené region.

<sup>1</sup>Where necessary, values have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF264.69=US\$1.00.

<sup>2</sup>Direction des Mines et de la Géologie, 1984, Plan Minéral de la République du Sénégal.

## OTHER SOURCES OF INFORMATION

Direction des Mines et de la Géologie  
B.P. 1238  
Dakar, Senegal  
The Ministry of Economic Planning and Industrial Development Central Bank Building  
Banjul, The Gambia

TABLE 1  
SENEGAL: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

Commodity <sup>2</sup>		1988	1989	1990	1991	1992
Cement, hydraulic	metric tons	390,956	379,793	469,537	503,317	601,071
Clays: Fuller's earth (attapulgit)	do.	118,725	98,882	114,610	129,403	112,336
Petroleum:						
Crude	thousand 42-gallon barrels	20	13	8	4	4
Refinery products:						
Gasoline	do.	951	*2,261	*2,520	*2,124	787
Kerosene and jet fuel	do.	799	652	682	644	710
Distillate fuel oil	do.	1,564	*2,000	2,057	1,374	3,002
Residual fuel oil	do.	1,815	1,493	*1,500	*1,300	*1,000
Other	do.	*44	*57	*32	55	52
Refinery fuel and losses	do.	227	*185	209	193	217
Total*	do.	5,400	6,648	7,000	5,690	5,768
Phosphate rock and related products:						
Crude:						
Aluminum phosphate	thousand metric tons	119	*140	*127	*92	*75
Calcium phosphate	do.	2,326	2,273	2,147	1,741	2,284
Manufactured:						
Aluminum phosphate, dehydrated <sup>3</sup>	do.	61	100	91	66	54
Phosphoric acid	do.	189	189	228	302	288
Calcium phosphate-based fertilizers	do.	120	117	173	171	169
Other <sup>6</sup>	do.	2	2	1	1	1
Salt	metric tons	75,000	*97,000	*92,000	102,000	110,000

\*Estimated.

<sup>1</sup>Includes data available through July 21, 1993.

<sup>2</sup>In addition to the commodities listed, Senegal produced clay, sand and gravel, and stone for local construction purposes, limestone for cement, minor artisanal gold, and natural gas for electricity generation. Information is inadequate to make reliable estimates of output levels, although, in 1992, gas production was reportedly in the range of 2,800 to 4,000 cubic meters per day.

<sup>3</sup>Includes gasohol, reported as 66% of total production in 1989, 68% in 1990, and 61% in 1991.

<sup>4</sup>Output was reported as nil. Estimate based on required usable crude output for reported clinker (dehydrated aluminum phosphate) production.

<sup>5</sup>Reported as "clinker"; material is derived from crude product output.

<sup>6</sup>Products marketed under the trade names "Balifos" and "Phospal."

TABLE 2  
SENEGAL: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

(Metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Attapulгите	Compagnie des Produits Chimiques et Matériaux (Carbonisation et Charbon Actifs, France, 100%)	Open pit mining of 4 deposits at Nianing, 80 kilometers southeast of Dakar	25,000 attapulгите.*
Do.	Société Sénégalaise des Phosphates de Thiès (SSPT) (Rhône Poulenc Group France, 50%; Government, 50%)	Open pit mine 15 kilometers southwest of Thiès	120,000 attapulгите.*
Cement	Société Ouest-Africaine des Ciments (Government, 100%)	Limestone quarry and cement plant at Rufisque, 20 kilometers east of Dakar	700,000 kiln output.
<b>Mineral fuels:</b>			
Crude oil and natural gas	Tullow Oil Plc. of Ireland and Société des Petroles du Sénégal	Diam Niadio gasfield, 40 kilometers northeast of Dakar	NA.
Petroleum products thousand barrels	Société Africaine de Raffinage (Société Nationale Elf Aquitaine, France, 30.0%, Royal Dutch/Shell, 23.6%; British Petroleum, 11.8%; Total, France, 11.8%; Mobil Corp., 11.8%; Government, 10.0%; Exxon Corp., 1.0%)	Oil refinery near Dakar	8,800 crude input.
<b>Phosphates:</b>			
Aluminum phosphate	SSPT	Open pit mine 17 kilometers	500,000 aluminum phosphate ore, 350,000 clinker.*
Calcium phosphate	Compagnie Sénégalaise des Phosphates de Taïba (CSPT) (Government, 50%; Compagnie Française des Mines, 14.64%; Nouvelle Compagnie Financière pour l'Outre Mer, France, 13.65%; International Minerals and Chemical Corp., United States, 10.42%; others, 11.29%)	Open pit phosphate mines at Taïba, 38 kilometers north-northeast of Thiès	2,300,000 calcium phosphate ore.
Do.	SSPT	Open pit mine near Thiès	200,000 calcium phosphate ore.*
Calcium phosphate fertilizers	Industries Chimiques du Sénégal (Governments of Senegal, 28%; India, 20%; Côte d'Ivoire, 10%, Nigeria, 10%; Cameroun, 10%; private companies, 22%)	Phosphoric acid plant near Taïba and fertilizer plant near Dakar	400,000 phosphoric acid, 250,000 manufactured fertilizers.
Salt	Société Nouvelle des Salins de Siné-Saloum (Government, Compagnie des Salins du	Marine salt recovery ponds west of Kaolack	150,000 salt.*

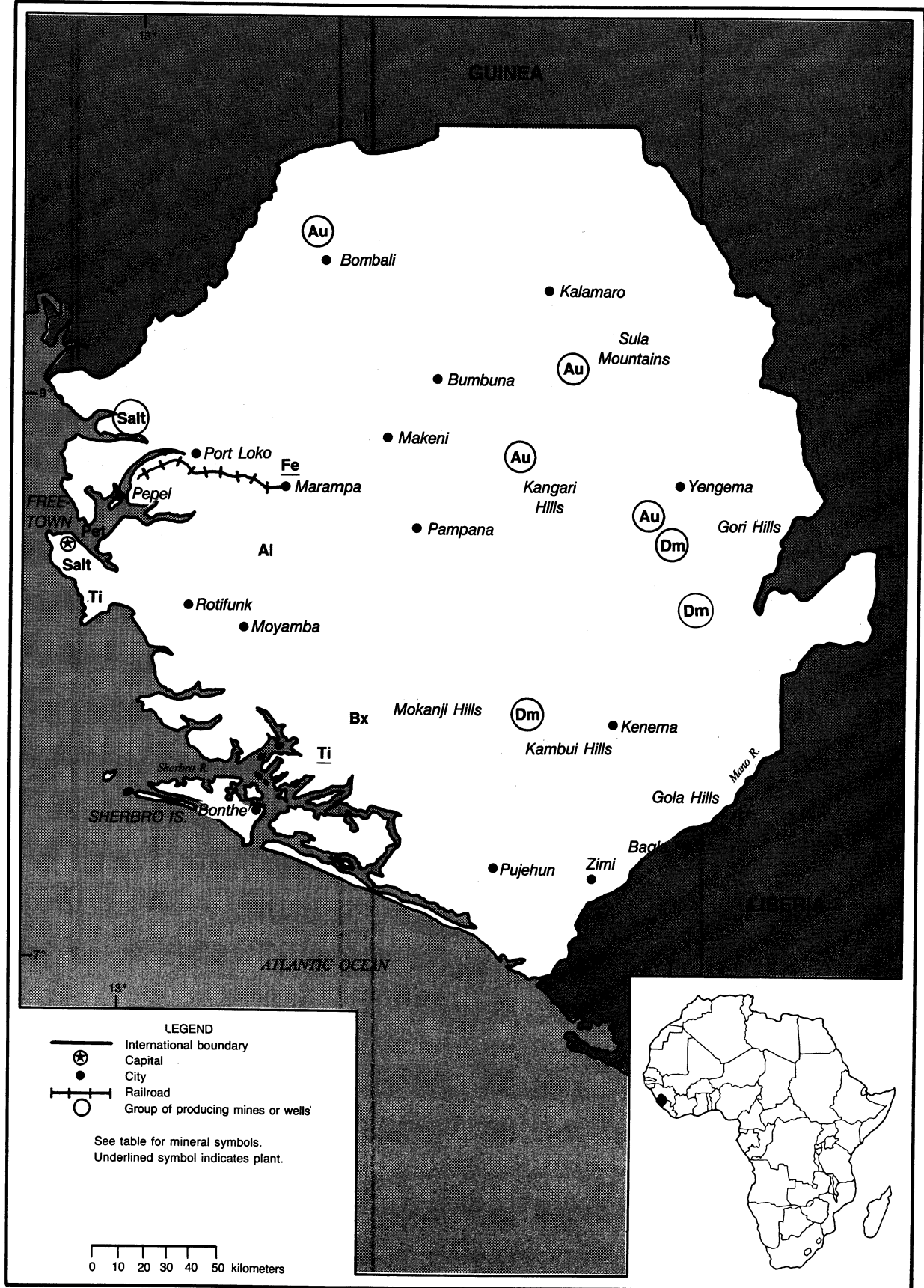
\*Estimated. NA Not available.



# SIERRA LEONE

AREA 71,740 km<sup>2</sup>

POPULATION 4.5 million



# THE MINERAL INDUSTRY OF SIERRA LEONE

By Bernadette Michalski

The nation's mineral industry is centered on the production and export of rutile and ilmenite, bauxite, diamonds, and gold, listed by order of value. In recent years, heavy revenue losses attributed to illegal trading in diamonds and gold contributed to the country's serious trade deficits and faltering economy. Diamond and gold mining and trading regulations continued to be revised in an effort to reverse this situation. A cement plant and a petroleum refinery, entirely dependent upon imported crude oil, were in operation.

An economic, scientific, and technical co-operation agreement including mining, energy, and power was signed between Nigeria and Sierra Leone in 1992. With the disruption of supplies from the iron ore mines in Liberia, the Nigerians have expressed keen interest in resuscitating Sierra Leone's Marampa mines to ensure continuity of supply for the Nigerian steel industry. If brought to fruition, the resumption of iron ore operations could earn much needed revenue for the country.

## GOVERNMENT POLICIES AND PROGRAMS

A military coup was effected in April 1992. The established Government was replaced by the National Provisional Ruling Council. The Council confirmed its commitment to the economic recovery program agreed to between the previous Government and the IMF. A credit agreement with the World Bank also was honored by the new Government. Following these assurances, the World Bank announced the disbursement of \$43 million for essential commodity imports such as spare parts for main powerplants in Freetown and petroleum products.

## PRODUCTION

Mineral output was relatively stable; however, titanium minerals production experienced a slight decline because of the 1-month delay in transferring mining operations from the lowergrade Pejebu deposit to the more favorable Lanti deposit. Diamond and gold production registered increases with the implementation of more stringent anti-smuggling programs. The production of iron ore remained suspended since 1985, but the reactivation of the Marampa iron ore mine was near realization. (See table 1.)

## TRADE

The value of Sierra Leone's mineral exports was estimated at \$140 million in 1992, equal to approximately 90% of total exports for the year. Titanium minerals continued to be the nation's principal export, valued at nearly \$70 million, with shipments destined for Western Europe and the United States. Bauxite exports earned approximately \$37 million in 1992. Although illicit trading of diamonds and gold continued, official diamond exports were valued at approximately \$32 million.

Nigeria has become the largest supplier of crude oil to Sierra Leone in partnership with Panaf. Petroleum product imports exceeded 1.22 Mbbbl. Of this total, gasohol and leaded gasoline combined accounted for 946,600 bbl; fuel oil, 102,400 bbl; kerosene, 93,665 bbl; aviation fuel, 76,068 bbl; and the remainder was composed of minor quantities of butane, lubricants, greases, and asphalt.

## STRUCTURE OF THE MINERAL INDUSTRY

Early in 1992, the Government in power announced the pending privatization of two parastatals: the Sierra Leone Petroleum Refining Co. and the Seracem cement factory. No confirmation of this proposal has been announced by the ruling Council. The Council, however, has expressed its intention to restore the National Diamond Mining Co. to full Government ownership. The mining of bauxite, rutile, and ilmenite remained open to foreign investment. (See table 2.)

## COMMODITY REVIEW

### Metals

**Bauxite.**—The Sierra Leone Ore and Metal Co. (SIEROMCO), the nation's sole bauxite producer, operated the Mokanji Mine. A second bauxite operation and an alumina plant were under development at Port Loko.

**Gold.**—The National Diamond Mining Co. holds exclusive licenses for gold prospecting in three areas of the country, including Pampana North and Gori Hills. Although 49% ownership of the company has been sold to the private sector, the Council now in power is considering a buy-back proposal.

**Iron and Steel.**—African Metals Ltd., a subsidiary of FERROMET, has signed a \$40 million contract with the Sierra Leone Government to collect and process ferrous and nonferrous scrap. An estimated 200,000 tons of mostly ferrous scrap is found in industrial sites. African Metals will collect and compress the scrap for export through FERROMET.



**Titanium.**—Sierra Rutile, Ltd. commenced dredging activities from the Lanti deposit in April 1992. The move from the exhausted Pejebu deposit covered a distance of nearly 4 km and included a vertical drop of 18 m. It was accomplished with a production downtime of only 29 days. The Lanti deposit and its associated Gbeni deposit are reportedly the richest known deposits of commercially minable rutile. These deposits are expected to be worked through the year 2006.

Sierra Rutile, Ltd. has launched an expansion and rehabilitation program at an estimated cost of \$48 million. The program includes a new powerhouse, updated mining equipment, improvement in recovery plant operations, infrastructure development, rehabilitation of mined areas, and village relocation activities. The village relocation program, as in previous Sierra Rutile, Ltd. operations, should result in the development of planned villages containing improved housing, sanitation, water supply, and communal facilities. A portion of the financing was made available through a \$13 million loan from the Commonwealth Development Corp. of the United Kingdom. The International Finance Corp., a part of the World Bank Group that finances private-sector projects in developing countries, has signed an agreement to provide a \$15 million loan to Sierra Rutile, Ltd. Other financing is to be provided by the Overseas Private Investment Corp. of the United States and the German Finance Co. for Investments in Developing Countries.

Intercontinental Gold and Minerals NL and MC Mining NL of Australia have entered into agreement with the Government to develop the titanium dioxide-bearing mineral deposits near Rotifunk, about 60 km southeast of Freetown. Mining operations were expected to yield 56,000 tons of rutile and 83,000 tons of ilmenite annually for a projected production life of 12 years.

## Industrial Minerals

**Diamonds.**—Precious Stones Sierra Leone Corp., a wholly owned subsidiary of Harry Winston Corp. of the United States, reported a completion of a 350-meter-long exploration adit on its 10-square-km prospecting license in central Sierra Leone. The company was preparing a feasibility study to be presented to the Government in support of a mining lease application.

An important new source of Government revenue became available when the Sunshine Mining Co. of Dallas, Texas, began to extract and market diamonds from the Koidu area. A total of 2.4 million carats of mostly gem-quality diamonds is anticipated over a 15-year period. Production commenced in late 1992.

The National Provisional Ruling Council announced its intention to buy back 49% of the National Diamond Mining Co. (NDMC), which was sold to the private sector by the previous Government.

## Mineral Fuels

The Sierra Leone Petroleum Refining Co. of Freetown operated a 10,000-bbl/d-capacity refinery based on imported crude. However, overdue obligations had jeopardized Sierra Leone's credit position and consequently the ability to purchase crude oil. The situation improved as Unipetrol of Nigeria agreed to supply Sierra Leone with 260,000 bbl/month of crude oil. Under a joint-venture agreement, the refined oil is marketed in Sierra Leone by Unipetrol Sierra Leone, a company with 60% equity held by the Panaf Group of Sierra Leone and 40% held by Unipetrol Nigeria.

## Reserves

Proven reserves totaled 370 Mmt of ore containing 5.7 Mmt of recoverable rutile in 1992. Nearly 1 Mmt of recoverable rutile was added to proven

reserves as a result of exploration and ore definition work in the southern Gbangbama area and in the northern area near Sembehun.

## INFRASTRUCTURE

The nation's network of classified roads was about 11,330 km consisting of 1,260 km of paved roads, 5,820 km of gravel roads, and about 4,250 km of rural feeder roads consisting of gravel and earth tracks. A 43-km road link between Waterloo and Masiaka was under construction at a cost of \$13.9 million. Financing was obtained by a grant from the European Development Fund.

A \$48 million loan was secured from the African Development Bank to construct the Bumbuna Hydroelectric Dam on the Seli River, which will provide 50 megawatts (MW) of power to Freetown, Makeni, Magburaka, Port Loko, and Lunsar. The second construction phase will extend capacity to more than 100 MW, and the third phase will incorporate an upriver dam to produce an additional 210 MW. Before the closure of the Marampa Mine, the 1.067-m narrow-gauge railroad delivered iron ore to the port at Pepel, 84 km away. The line remained operable but in limited use.

The Port of Freetown permits a draft of almost 10 m. The port has six berths with a total quay length of 1,100 m. Freetown services most of the country's general cargo and all of its petroleum import traffic. The Ports of Niti and Pepel are operated by private mining firms and handle bulk exports of bauxite, rutile, and, when in production, iron ore.

## OUTLOOK

Sierra Leone is endowed with significant mineral potential, ample cultivatable land, and exploitable fisheries. However, the inadequate development and mismanagement of resources has impoverished the country. Government institutions have deteriorated with only limited capability of delivering the most basic services. Although improving, a significant proportion of diamond and gold mining and trading

activity continues to bypass Government revenue collection channels. There are, however, indications that the diamond and gold markets are responding to policy changes. Nonetheless, the country continues to experience grave economic difficulties, exacerbated by a small stagnant production base, high import bills, a heavy debt service burden, declining Government revenues, and inflation that is officially placed at more than 120% annually. The resumption of international lending for projects in Sierra Leone offers some promise. A commitment of \$48 million in combined loans to Sierra Rutile was obtained from the International Finance Corp., the Overseas Private Investment Agency, the Commonwealth Development Corp., and the German Finance Co. for Investments in Developing Countries.

The mining of titanium-bearing sands has been the most successful mineral project in the nation. Sierra Leone's rutile is of high grade with notably low radioactivity. These aspects should continue to make it highly marketable. Worldwide economic conditions in 1992 continued to exert downward pressure on the price for rutile. Sierra Rutile was protected to some extent by its long-term sales contracts and high-quality ore, but revenue per ton declined. Demand for TiO<sub>2</sub> pigment is expected to increase an average of 3.5% to 4% annually between 1992 and 1996. Recovering economies in developed countries should be favorable to industries requiring large quantities of paint, paper, and plastic. This in turn should stimulate the demand for rutile.

#### **OTHER SOURCES OF INFORMATION**

Ministry of Mines  
Freetown, Sierra Leone  
Bank of Sierra Leone  
Freetown, Sierra Leone  
Nord Resources Corp.  
8150 Washington Village Drive  
Dayton, Ohio 45458  
Telephone: (513) 433-6307  
Fax: (513) 435-7285

TABLE 1  
SIERRA LEONE: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1988	1989	1990	1991	1992 <sup>*</sup>
Aluminum: Bauxite, gross weight	1,379	1,562	1,430	1,288	<sup>2</sup> 1,246
Diamond:					
Gem <sup>*</sup>	12	90	66	160	200
Industrial <sup>*</sup>	6	39	12	83	96
Total	18	129	78	243	<sup>2</sup> 296
Gold	44	226	32	26	<sup>2</sup> 92
Gypsum <sup>*</sup>	4,000	4,000	4,000	4,000	4,000
Petroleum refinery products:					
Liquefied petroleum gas	8	7	6	4	6
Gasoline	225	190	180	125	200
Jet fuel	125	100	100	100	125
Kerosene	45	35	30	25	30
Distillate fuel oil	425	375	375	300	350
Residual fuel oil	350	300	300	250	300
Other	1	1	1	1	1
Total	1,179	1,008	992	805	1,012
Salt <sup>*</sup>	200	200	200	200	200
Titanium:					
Rutile ore and concentrate 96% TiO <sub>2</sub> , gross weight	126,332	128,198	144,284	154,800	<sup>2</sup> 148,990
Ilmenite ore and concentrate 60% TiO <sub>2</sub> , gross weight	42,118	62,310	54,639	60,371	<sup>2</sup> 60,331
Zircon	—	—	—	1,119	<sup>2</sup> 1,329

<sup>\*</sup>Estimated.

<sup>1</sup>Table includes data available through July 15, 1993.

<sup>2</sup>Reported figure.

TABLE 2  
SIERRA LEONE: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Bauxite	Sierra Leone Ore and Mineral Co. (subsidiary of Alusuisse, 100%)	Mokanji Hills near Moyamba	1,600
Cement	Sierra Leone Cement Co. (Seracem) (Government, 100%)	Freetown	120
Diamond	National Diamond Mining Co., Ltd. (Government, 51%; British Petroleum Minerals International, 49%)	Yengema region	NA
Gold	do.	do.	NA
Petroleum products	Sierra Leone Petroleum Refining Co. (Government, 100%)	Refinery at Freetown	3,500
Titanium minerals	Sierra Rutile, Ltd. (Nord Resources Corp., 100%) <sup>1</sup>	Lanti	210
Do.	Rotifunk Rutile Co. (Intercontinental Gold & Minerals NL, 50%; MC Mining NL, 50%)	Rotifunk, 60 kilometers southeast of Freetown	140

NA Not available.

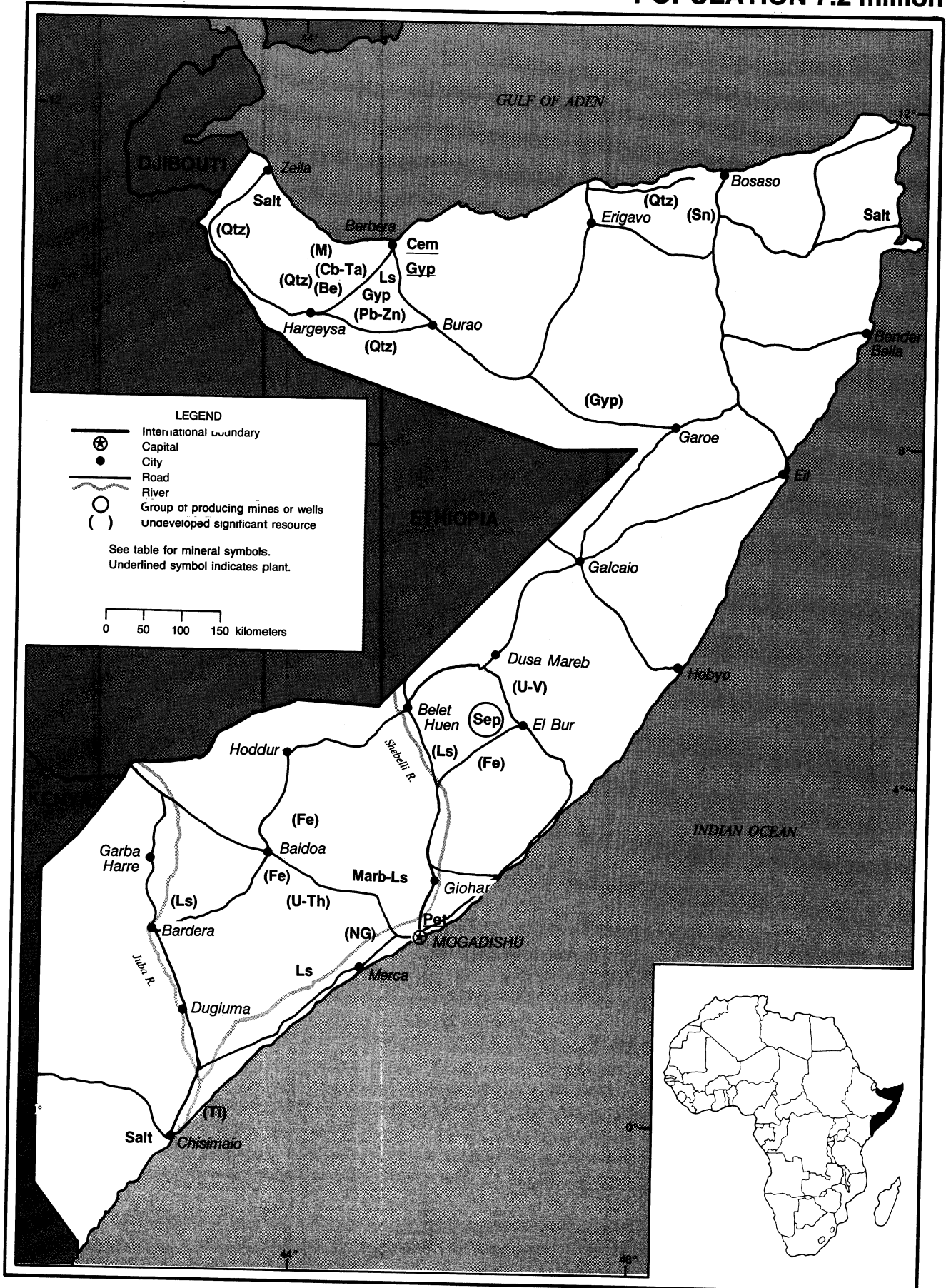
<sup>1</sup>Consolidated Rutile Ltd. of Australia obtained 50% interest in Sierra Rutile, Ltd., on June 28, 1993.



# SOMALIA

AREA 637,660 km<sup>2</sup>

POPULATION 7.2 million



## THE MINERAL INDUSTRY OF

# SOMALIA

By Lloyd E. Antonides

Historically, the mineral industry was an insignificant part of the primarily pastoral economy of mostly semidesert, Texas-sized Somalia. In the recent past, the industrial sector, including the minerals industry, accounted for well under 10% of a GDP approaching \$2 billion. Agriculture, mostly livestock raising, comprised almost 60%. Such a GDP and a population of about 7 million, one-half of which was nomadic or seminomadic dependent on raising livestock, defined one of the world's poorest countries. Large deficit trade balances and Government budgets, mostly to maintain the military, resulted in high foreign debt and price inflation, as well as an economy dependent on foreign aid.

During 1992 Somalia was in political and economic chaos. In response to the humanitarian crisis, international military forces led by the United States landed in Mogadishu in December to secure food supplies. In May 1993 a UN force began taking control in the south. The more stable north continued to declare independence, as Somaliland.

Mineral commodities produced in recent years consisted of cement and its components—limestone and gypsum—as well as gypsum plaster and crude minerals for construction, plus meerschaum, sea salt, and refined petroleum products from imported crude. Meerschaum was the only noteworthy mineral export.

However, mineral possibilities, including oil and gas, were an important concern of the country. Over several decades a number of investigators supported by international aid agencies and various individual countries reported many potentially valuable solid mineral occurrences. These appear to be concentrated in three main areas as follows, in order of importance: the northern

highlands along the Gulf of Aden; the southern highlands centered a few hundred kilometers northwest of Mogadishu, and a central area centered a few hundred kilometers north of Mogadishu. From the late 1940's through 1990, many international oil companies explored the oil and gas potential over much of the country with only limited success. The most attractive possibilities appeared to be onshore in the north and offshore along the Indian Ocean Coast on the east.

Parastatal organizations were operators of the two major mineral commodity ventures in Somalia: the 10,000-bbl/d crude petroleum refinery at Mogadishu and the 200,000-mt/a cement plant near Berbera. But the small sea salt, meerschaum, and crude mineral construction material producers were believed to be privately owned and operated, as presumably was a 1,500-mt/a plaster (calcined gypsum) production facility reported near Berbera.

TABLE 1  
SOMALIA: ESTIMATED PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992
Cement, hydraulic	50,000	50,000	40,000	10,000	25,000
Gypsum	3,500	3,500	2,500	1,000	2,000
Limestone <sup>3</sup>	85,000	85,000	65,000	17,000	40,000
Petroleum refinery products:					
Gasoline <sup>4</sup> thousand 42-gallon barrels	*740	750	*740	150	150
Jet fuel do.	160	*160	*120	30	30
Kerosene do.	*80	80	60	20	20
Distillate fuel oil do.	*600	*610	*620	120	120
Residual fuel oil do.	100	100	*110	20	20
Other <sup>5</sup> do.	*210	*90	*100	*20	20
Total do.	*1,890	*1,790	*1,750	*360	360
Salt, marine	2,000	2,000	1,500	500	1,000
Sepiolite, (meerschaum)	20	20	10	4	2

\*Revised.

<sup>1</sup>Includes data available through May 1, 1993.

<sup>2</sup>In addition to the commodities listed, various crude construction materials (e.g., clays, sand and gravel, crushed and dimension stone) and limestone for lime manufacture and/or agriculture are presumably produced; also clay and/or shale are normally produced for cement manufacture, but available information is inadequate to make reliable estimates of output. Nitrogen production (as ammonia) ceased in 1987 when the plant closed.

<sup>3</sup>Estimated for cement manufacture only.

<sup>4</sup>Includes aviation and motor gasoline.

<sup>5</sup>Includes nonenergy products (lubricants, bitumen, and miscellaneous other) and refinery fuel and losses. Liquid petroleum gas apparently was not produced. Refinery fuel and losses were estimated as follows, in thousand barrels: 1988—160; 1989—40; 1990—60; 1991—10; and 1992—10.

It was doubtful that mineral production would develop into an important factor in Somalia's economy for some time.

#### **OTHER SOURCES OF INFORMATION**

Ministry of Mineral and Water Resources  
P.O. Box 744  
Mogadishu, Somalia

United Nations  
Department of Technical Cooperation for  
Development  
Natural Resources & Energy Division  
1 UN Plaza  
New York, NY 10017

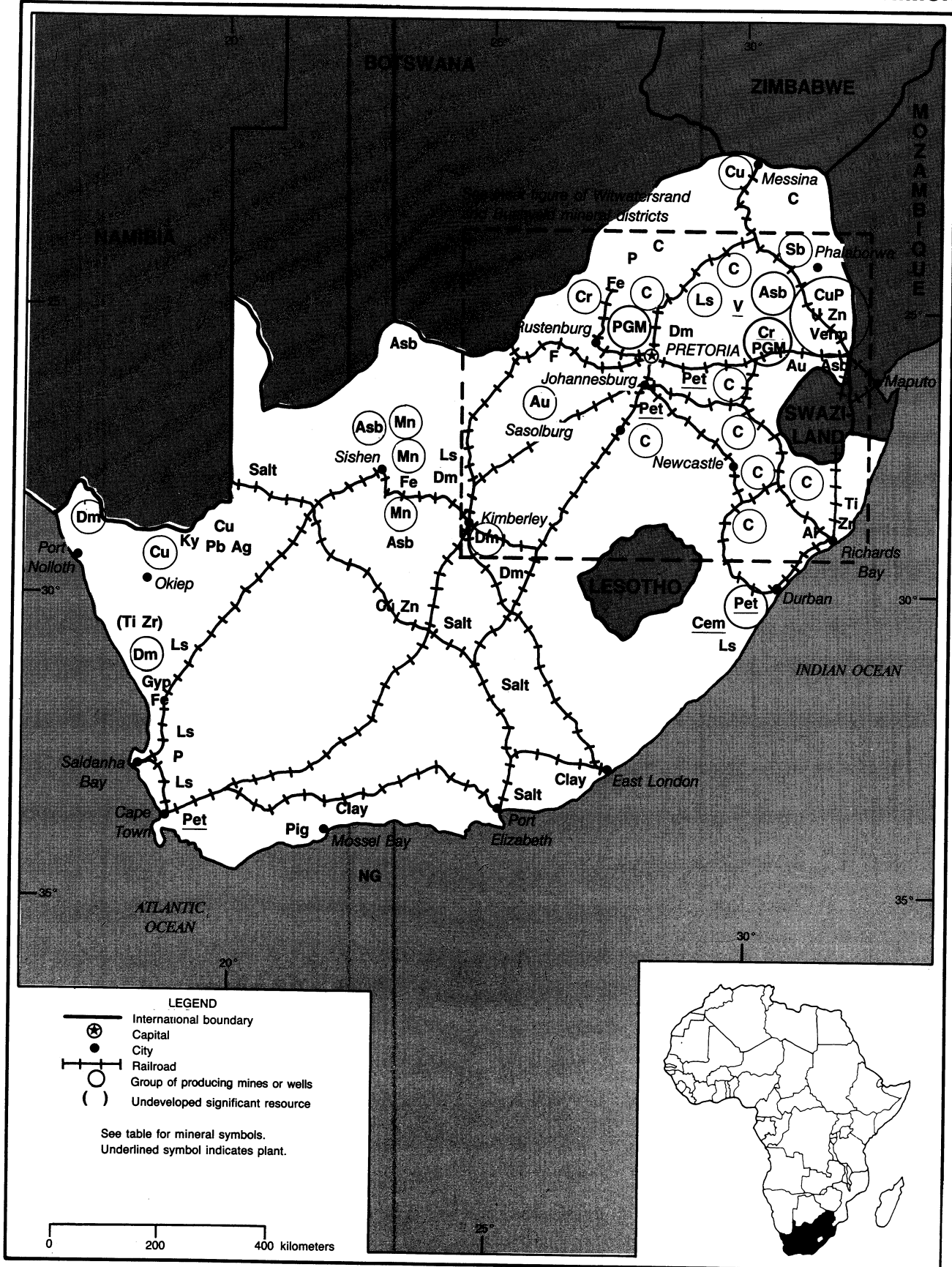




# REPUBLIC OF SOUTH AFRICA

AREA 1,221,040 km<sup>2</sup>

POPULATION 41.7 million



# THE REPUBLIC OF SOUTH AFRICA

By Michael M. Heydari

The Republic of South Africa<sup>1</sup> remained one of the most important producing and exporting nations for primary and processed mineral products in 1992. The mining and quarrying industry accounted for 9.6%, down from 10.4% in 1991, of the country's GDP, which, in turn, dropped by 2.1% in real terms in 1992. Manufacturing production dropped by 3%, but gold production increased by 2%. The long-term decline in the contribution of mining and quarrying to the GDP was attributed to rising operating costs, low commodity prices, and expansion of the country's manufacturing sector. Total crude mineral sales in 1992 were about \$15 billion.<sup>2</sup> Gold was once again the most important revenue earner with \$6.4 billion, followed by coal at \$3.1 billion. Total local sales of crude minerals were about \$3 billion, of which coal was \$1.67 billion; quarry products, \$162 million; limestone and dolomite, \$162 million; and copper, \$138 million. Local sales of andalusite, asbestos, salt, and titanium recorded increased earnings. Primary mineral exports totaled about \$12 billion and accounted for about 51% of total export earnings. However, if the value of processed mineral products such as refined base metals, ferroalloys, iron and steel, and refinery products produced from coal is included, about two-thirds of the Republic of South Africa's 1992 export revenue would come from mineral-based products.

Gold production continued to rise despite the closure of marginal mines and sections, as producers mined more selectively to combat rising costs and falling revenue. Production in 1992 increased by 13 tons to 614 tons. This was mainly due to an increase in the average grade to 5.4 g/mt from 5.2 g/mt

in 1991.

Mining directly accounted for 12%, and indirectly for about one-third, of the country's work force. An average of 560,000 workers was employed in the mining and quarrying industry in 1992, compared with 618,000 in 1991. Gold mines employed 377,000 people, coal mines 70,000, and other mines 113,000. The gold mining industry has lost more than 150,000 jobs from peak employment in 1986. Total mining salaries, wages, and allowances exceeded \$4 billion, including \$2.8 billion for the gold and coal industries. The Employment Bureau of Africa (Teba) continued to recruit unskilled and semiskilled workers throughout southern Africa for members of the Chamber of Mines. Teba is believed to be the largest single employment agency in the world, engaging more than 345,000 semiskilled and unskilled workers at 60 gold, coal, and platinum mines in 1992. As much as 60% of the total income earned by mineworkers in South Africa is remitted to neighboring countries. In 1992, about \$95 million was remitted to Lesotho and \$54 million to Mozambique on behalf of workers from those countries. In addition, more than \$8 million was repatriated to Botswana and \$7 million to Swaziland.

In early 1993, General Mining, Metals and Minerals Ltd. (Gencor), the second largest mining concern in the Republic of South Africa, announced its intentions to eliminate the pyramid structure of its holdings and to break itself into smaller units—a move termed as unbundling. Gencor is to sell all of its nonmining interests and acquire the international mining interests of Billiton Ltd., a subsidiary of Shell/Royal Dutch Petroleum Co., thus establishing itself as

a major international mining company and rivaling Anglo American Corp. of South Africa Ltd. (AAC) and its international affiliate Minorco Ltd. Barlow Rand Ltd., one of the largest industrial groups in the Republic of South Africa, also has announced that it will split itself into three separate entities. However, AAC, the country's largest company, has stated its opposition to the concept of unbundling as a means of reducing its size and influence in the local economy.

## GOVERNMENT POLICIES AND PROGRAMS

During 1992, the Department of Mineral and Energy Affairs (DMEA) was the primary Government entity with responsibility for oversight of the country's mineral industry. Within DMEA were the Minerals Bureau, the Geological Survey, the Government Mining Engineer's office, and the Energy Branch.

The Minerals Bureau had responsibility for collecting, classifying, and analyzing mineral data to assist the Government in formulating policies on mineral development. It also provided mineral information to the industry. During the first quarter of 1993, the Minerals Bureau was downgraded from a Chief Directorate to a Directorate within the DMEA, and the five overseas Counsellor for Energy and Minerals positions were eliminated.

The Geological Survey of the Republic of South Africa had responsibility for geological mapping and basic studies relevant to the identification, nature, extent, and genesis of ore deposits in South Africa as well as other parts of Africa.

The Energy Branch was responsible for a variety of research programs related

to energy consumption and supply, including solar thermal energy. Its activities were of a regulatory, planning, and advisory nature, including the coordination of energy-related activities in the Government sector and various other institutions concerned with energy.

The Council for Mineral Technology (Mintek), formerly a Government agency, had the responsibility of promoting technology in the mineral field. It conducted research into the properties, composition, recovery, extraction, processing, and utilization of minerals and mineral products.

The Council for Scientific and Industrial Research (CSIR) had the responsibility of undertaking research related to specific minerals, mineral exploration, air quality, water pollution and purification, as well as mining and mineral processing problems. The Chamber of Mines Research Organization was merged with CSIR in March 1993 and is now known as the CSIR's mining technology division. Mineral and mining research also is undertaken by most of South Africa's universities and technical schools that are responsible for training people for the mining industry.

Mining in the Republic of South Africa currently is governed by a number of mining acts. These include the Liquid Fuels and Oil Act, 1947; Mining Titles Registration Act, 1967; Mining Rights Act, 1967; Central Energy Fund Act, 1977; Petroleum Products Act, 1977; Nuclear Energy Act, 1982; Diamonds Act, 1986; Electricity Act, 1987; Mineral Technology Act, 1989; and Minerals Act, 1991. The latter, Act No. 58 of 1991, came into effect on January 1, 1992. It repealed nine principal statutes, including virtually all sections of the Mines and Works Act of 1956. It also eliminated the state's exclusive right to mine precious metals, changed some of the safety and health provisions, and created a new Government mining organization. Under the new law, the Republic of South Africa is divided into nine mining regions, each headed by a regional director. Each director has almost complete authority for the enforcement of mining laws within the region. The new

organizational structure represents a substantial decentralization of authority. Before January 1, 1992, the state reserved the right to mine for and dispose of all precious metals, precious stones, and crude oil. The owner of the mineral rights needed to obtain a mining lease from the state to mine these commodities. An element of the lease was the payment of a "lease consideration" or royalty to the state. Under the new Minerals Act, the state does not claim the right to mine precious metals and stones. The mining lease and the payment of royalty have been eliminated. Instead, there is a requirement to obtain a prospecting permit or mining authorization from the state. The Minerals Act requires that by January 1994 all mines will have to reapply for mining permits.

The Minerals Act of 1991 introduced strict environmental laws requiring the preparation of reclamation plans and environmental impact statements. In early 1993, legislation was introduced in Parliament to increase the responsibility of mine owners to rehabilitate environmental damage. It would no longer be possible to complete closure of a mining operation until a certificate had been furnished attesting that adequate provision had been made for rehabilitation. The Minerals Amendment Bill, which will amend the Minerals Act of 1991, also lays down regulations that will increase the environmental planning requirements of new mines.

In early 1993, the Government appointed an independent three-man commission of inquiry into mine safety, health, and compensation following a number of deaths in accidents at the Middelbult coal mine and the Buffelsfontein and Vaal Reefs gold mines. The commission is to study existing regulations on safety and health in the mining industry, including compensation paid for injury, illness, and death.

The Income Tax Act of 1962 has been amended to promote investment in industries that add value to locally produced minerals. Special tax deductions facilitate accelerated depreciation of machinery, plants, and buildings used in

the beneficiation of local minerals. Incentives also allow for tax deductions against preproduction, interest costs incurred in financing machinery, and plants and buildings for beneficiation projects. The incentives are subject to certain conditions. To benefit from tax deductions and incentives, the beneficiation process must add at least 35% to value, be internationally competitive, and more than 60% of output must be exported. The income tax amendment has been welcomed by the South African mining industry. It also has been suggested that, in the longer term, the Republic of South Africa could become a beneficiation center for minerals produced elsewhere in Africa. Other changes in the mining tax laws included the full implementation of the gold mining tax formula, recommended by the 1988 Marais Technical Committee. The formula is expressed as  $y=61-(305/x)$ , where  $x$  is the percentage of total income from gold mining that is taxable. The tax rate for nongold mines also was amended in 1991. The effective tax rate became 50.88% compared with the previous rate of 54.5%. In addition, provision was made for a drop in the rate of tax on nonmining income, from 50% to 48%, and it was expected to continue to drop in the next few years to an ultimate target of 40%.

The energy crises of the 1970's and the effect of international sanctions on the Republic of South Africa's supply of imported crude oil have resulted in the Government being involved in most aspects of the oil and gas industry, particularly in an effort to achieve a degree of energy self-sufficiency. Prices of fuels and some petroleum products are controlled. The Government, through the Industrial Development Corp. of South Africa Ltd. (IDC), provided the capital to build the Sasol and Moss gas synthetic fuels plants. Deregulation of the industry is being considered by the Government. However, the problem of what to do with the expensive synfuels produced by Sasol and Moss gas may well limit the scope of any deregulation.

## PRODUCTION

The Republic of South Africa continued to be one of the world's major producers and exporters of mineral commodities in terms of both quantity and diversity. Metals for which the Republic of South Africa was among the world's leading producers included antimony, chromite, gold, manganese, platinum-group metals (PGM), titanium, uranium, vanadium, and zirconium. Industrial minerals of significance were andalusite, asbestos, diamond, fluor spar, pyrophyllite, and vermiculite.

The mining industry, which recorded growth of 0.9%, was the only primary industry in the Republic of South Africa to show any growth in 1992. Production of gold increased by 2% despite the closure of some marginal mines, while production of other precious metals also increased—diamond by 20% and PGM by 7%. In contrast, production of chrome ore and manganese ore declined dramatically by 34% and 22%, respectively, and chromium ferroalloy production dropped by 40%. Coal production decreased by 2%. The only nonmetallic commodities that had higher production in 1992 were andalusite, calcite, salt, sillimanite, sulfur, and talc. (See table 1.)

## TRADE

As in previous years, the bulk of the Republic of South Africa's mineral production was exported. Increasing amounts of chromite, crude steel, diamond, dimension stone, gold, and manganese were being upgraded or consumed in higher value-added products locally and then were exported.

International demand for most of the mineral commodities produced in the Republic of South Africa remained weak in 1992 owing to the continued slowdown in world economic growth. However, lower export volumes were largely offset by improved domestic sales and the further depreciation of the rand against the U.S. dollar. The value of crude mineral exports in 1992 was about \$12

billion, down from \$12.5 billion in 1991, and more than one-half of the Republic of South Africa's total exports of \$23.5 billion. The value of exported processed mineral products such as refined base metals, ferroalloys, iron and steel, and refinery products produced from coal was estimated at \$3.5 billion. As a result, about two-thirds of the Republic of South Africa's 1992 export revenue came from mineral-based products. Gold was once again the country's highest foreign currency earner at \$6.4 billion, down from \$7 billion in 1991. The Republic of South Africa was the third largest coal exporter in the world with coal exports of 49 Mmt valued at about \$1.4 billion. The next highest revenue earners were PGM, iron ore, and copper. In line with the softening of the world steel market, exports of chrome ore, manganese ore, and ferroalloys fell.

In 1992, the United States had imports from the Republic of South Africa totaling \$1.72 billion, slightly less than those in 1991. Of these imports, more than 90% was minerals and metals, mainly PGM and ferroalloys. Although the U.S. Federal restrictions on trade with the Republic of South Africa were repealed in July 1991, as of the end of 1992 more than 160 State and local governments in the United States still restricted business with the Republic of South Africa.

The Republic of South Africa's total imports amounted to \$18.5 billion in 1992. The country remained the largest export market for U.S. products and services in sub-Saharan Africa. U.S. exports to the Republic of South Africa in 1992 were \$2.43 billion, compared with \$2.1 billion in 1991. The United States was the country's third largest supplier, behind Germany and the United Kingdom. Principal U.S. exports to the Republic of South Africa were mining equipment, chemicals, aircraft and parts, electronic data processing and related equipment, and office machinery. (See tables 2 and 3.)

## STRUCTURE OF THE MINERAL INDUSTRY

The South African mining industry continued to be dominated by six major mining investment groups: AAC; Anglovaal Ltd.; Gencor; Gold Fields of South Africa Ltd. (GFSA); Johannesburg Consolidated Investment Co. Ltd. (JCI); and Rand Mines Ltd., a subsidiary of Barlow Rand Ltd. (See table 4.) The groups, often referred to as mining houses, interact through the Chamber of Mines of South Africa, a private organization having the primary objective of promoting and protecting the interests of its members. The members include the majority of gold and coal mines and a number of producers of other mineral commodities, notably PGM. The Chamber of Mines is responsible for a variety of advisory and service functions, as well as technical research, which is handled on a co-operative basis. One of the main activities of the chamber is the annual wage negotiations between member mines and the National Union of Mineworkers. The chamber also controls the Rand Refinery, the largest gold refinery in the world.

According to an analysis released in 1993,<sup>3</sup> in 1991 AAC was the Western World's largest mining company, controlling 8.3% of the total value of the entire Western World's nonfuel minerals production, nearly double the 4.6% share of its nearest rival, Rio Tinto Zinc Ltd. (RTZ) of the United Kingdom. AAC had major ownership interests in the giant diamond-producing and diamond marketing group De Beers Consolidated Mines Ltd./De Beers Centenary AG. The above ranking process counts De Beers as an integral part of the AAC group. Gencor, with 1.2% of the Western World's value of all nonfuel mining commodities produced, was placed 12th in the world, according to the aforementioned source, while Rand Mines was 25th and Anglovaal was 27th.

The mineral industry was dynamic, with numerous changes in corporate ownership and joint ventures and active trading on the Johannesburg Stock

Exchange. The six major domestic mining investment groups had highly diversified investments during 1992. In addition to controlling a large number of South Africa's gold and coal mines, AAC had significant holdings in many of South Africa's other mining operations such as its 75% holding in Consolidated Murchison Ltd., the country's only producer of antimony; 45% of Samancor, Gencor's chrome, manganese, and ferroalloy producer; 42% of Palabora Mining Co. Ltd., the largest copper producer in the Republic of South Africa; and full control of Rustenberg Platinum Mines Ltd. and Highveld Steel and Vanadium Corp. Ltd. However, in 1992 the group's gold interests fell from 23% to 21% of the total value of its investments. The value of AAC's industrial and commercial interests was unchanged at 23%, but their contribution to investment earnings fell from 25% to 22%. Contribution by value of investments in financial services and property increased to 19% from 16%. The group's profitable diamond business dropped by value to 12% from 13% in 1991, but its contribution to earnings increased to 19% from 18%. The value of AAC's investments in platinum, base metals, and other mining interests fell from 20% to 18% and the share of earnings fell from 20% to 17% as a result of prevailing low metal prices. AAC's coal sector's contribution increased to 7% from 5% in 1991.

Anglovaal Ltd. had 22% of its investments in packaging and rubber; 21% in base metals and minerals; 14% in fishing and frozen food; 13% in consumer goods; 11% in gold mining; 9% in engineering and textile; 7% in construction and electronics; and 3% in finance. Gencor had increased its interests in energy from 22% to 24% of its net asset value; investments and financial services, 18%; forest products, 14%; ferroalloys, 12%; gold dropped from 14% to 9%; manufacturing and marketing, 7%; PGM, 6%; other mining products except coal, 5%; coal, 2%; and international and other, 3%. GFSA's group net asset value, by sector, was as follows: gold, 54%; financial, 13%;

PGM, 11%; mining finance, 8%; cash, including dividends receivable and payable, 6%; energy, 5%; base minerals, 2%; and industrial and property, 1%. JCI's net asset value, by sector, was as follows: industrial and financial, 41%; PGM, 37%; diamond, 8%; gold, 5%; coal, 5%; ferrochrome, 2%; property, 1%; and mining finance, 1%. Barlow Rand Ltd.'s net assets by sector were as follows: food and pharmaceutical, 32%; industry, 17%; packaging and textile, 14%; coal, 14%; international, 11%; cement, lime, and other nongold mining, 6%; financial services, 3%; property, 2%; and other, 1%.

Apart from the six major mining houses, two other South African concerns, Iscor Ltd. and Sasol Ltd., were world-class mineral producers in 1992. Iscor is a fully integrated steel producer and operates several large coal, iron, and dolomite mines in the Transvaal, Natal, and northeastern Cape Provinces. Sasol, a world leader in the conversion of coal to oil and gas, is a major coal producer with operations near Secunda, 100 km southeast of Johannesburg.

The largest foreign-owned mining group operating in the Republic of South Africa was RTZ. RTZ is the co-owner, with AAC, of Palabora copper mine in northeastern Transvaal, one of the largest copper mines in the world. RTZ is also a 50% shareholder in Richards Bay Minerals Ltd. (RBM), a major world producer of mineral sands, with operations in the coastal areas of Natal Province. In addition, several smaller groups and numerous independent operators carry out other mining and beneficiation activities. Not only do they contribute substantially toward the creation of employment opportunities, but they also exploit smaller mineral deposits that might not be economically attractive to the larger groups. Some of the small operators are also members of the Chamber of Mines.

The Government had an important interest in certain mining and mineral processing enterprises. Participation was pronounced in the synthetic fuels sector, which was based on domestic coal resources. Sasol III remains partly

Government owned through IDC. The Government also was funding and overseeing the development of natural gas reserves offshore Mossel Bay.

Rock bursts and ground falls were the major cause of injuries and deaths from mining accidents. Total number of injuries dropped from 9,103 to 8,801 while the injury rate rose from 14.74 to 16.19 per 1,000 employees. Although the number of deaths for all South African mines dropped from 604 in 1991 to 552 in 1992, the death rate climbed from 0.98 to 1.02 per 1,000 employees. Accidents occurring in gold mines accounted for about 70% of the total mining accidents and resulted in 407 deaths. Gold mining was declared by the Government Mining Engineer as the most hazardous occupation in the Republic of South Africa. Platinum mines reported 455 accidents, claiming 43 lives and leaving 428 miners injured. Coal mining accounted for 393 accidents and 43 fatalities. Diamond mining had 143 accidents, causing 29 fatalities.

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## COMMODITY REVIEW

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### Metals

**Aluminum.**—Primary production in 1992 at the Richards Bay-based Aluminum South Africa (Pty.) Ltd. (Alusaf), the only South African primary aluminum producer, was about 173,000 tons, higher than the rated full base capacity of 169,000 tons. Although all the bauxite used by Alusaf is imported, the company is a major potential consumer of alumina produced from Phosphate Development Corp.'s (Foskor) \$21.66 million pilot phlogopite plant at Phalaborwa. The first phase of this project is to be operational in 1993, and the commissioning of the full demonstration plant is scheduled for early 1995. If given the green light, a \$1.4 billion commercial plant is to be built to supply 30% of Alusaf's requirements. The quality of the alumina to be produced is expected to be of superior quality to the normal cell-grade alumina available on world markets. Initial feasibility studies have shown that the plant will be

able to produce alumina at a cost competitive with alumina from imported bauxite.

Alusaf's exports of ingots in 1992 amounted to 89,700 tons while exports of rolled, mainly flat, products totaled 16,000 tons. Of the approximately 700,000 mt/a of primary aluminum to be produced by Alusaf by 1997, all but about 250,000 mt/a has already been earmarked for 15-year contracts. Alusaf continued to supply the bulk of the Republic of South Africa's primary aluminum requirements amounting to 100,000 tons in 1992. This included 33,000 tons of rolled ingots and 10,000 tons of milled ingots. About 4,000 tons of aluminum, consisting of volume alloys and forms that are not economical to produce locally because of limited demand, was imported.

The cost of Alusaf's Hillside smelter expansion project is now expected to be somewhat lower than the forecasted capital cost of \$2.4 billion. The expansion project, combined with a 40,000-mt/a upgrading of the existing smelter, will boost the country's production by about 465,000 mt/a to 636,000 mt/a by 1996. At full production in 1997, Alusaf's output is expected to reach 700,000 mt/a.

There are five secondary aluminum manufacturers in the Republic of South Africa, of which Hulett Aluminum Ltd. and Anso Ltd. account for 40% each of the total output. Exports of aluminum semimanufactures remained at the same level as in 1991, about 25,000 mt/a.

Domestic sales of primary aluminum are set to increase substantially in 1997 when the Highveld Steel and Vanadium Corp. Ltd.'s subsidiary, Rheem South Africa (Pty.) Ltd., is to commission its \$50 million aluminum can plant that will manufacture 500 million all-aluminum, 340 ml, two-piece beverage cans. Rheem hopes to capture about 20% of the \$267 million beverage can market, which is growing at a rate of 17% per year. Rheem initially will import about 7,000 mt/a of primary aluminum from Australia. However, the large-scale expansions at Hulett and Alusaf will allow Rheem to source its raw material

locally after 1997.

**Antimony.**—Consolidated Murchison Ltd., the world's largest single antimony producer and the Republic of South Africa's sole producer of antimony sulfide concentrate, was in the unenviable position of mining a commodity for which there was an oversupply, poor demand, and weak prices. To increase revenues, emphasis was placed on mining areas of the ore body where byproduct gold grades were higher. Gold production rose by 40.7% to 1,016 kg in 1992. Ore milled increased by 8.5% to 435,000 tons from the previous year's level, but the antimony head grade fell to 1.07% from the previous year's average of 1.28%. This, combined with a lower rate of recovery in the flotation plant, adversely affected concentrate production, which dropped by 14.2% to 6,465 tons for the year ending June 30, 1992. Sales of antimony concentrate fell 16.3% to 5,950 tons, and revenues earned from antimony sales dropped 12.1%. The company reported that operating costs rose in 1992. As with most producers, the South African antimony industry continued to be adversely affected by oversupply and price discounting by Chinese producers of antimony in all forms. For the second consecutive year, no surface geological exploration was undertaken by Consolidated Murchison. The company has excluded reserves at the Alpha shaft from total ore reserves as the area contains very little gold, which is now the company's major source of income. This has resulted in a reduction in life-of-mine reserves to about 6 years at the current mining rate.

**Chromite.**—The Republic of South Africa's production of chromite fell dramatically from 5.11 Mmt in 1991 to 3.63 Mmt in 1992 owing to depressed chrome ore and ferrochrome prices worldwide. While local sales to ferroalloy producers dropped by 45% to 1.87 Mmt, exports increased by 18% to 1.09 Mmt in spite of the depressed international stainless steel market.

The Republic of South Africa's largest

chromite producer remained Samancor, a Gencor subsidiary, with a production capacity of approximately 3.6 Mmt/a. The company controls about 80% of the Republic of South Africa's chromite reserves, which are the largest in the world. In 1992, some sections of Samancor's mines were closed due to low demand. Although the company exports considerable volumes of beneficiated ore, the bulk of its output is smelted at its own plants to produce high-, medium- and low-carbon ferrochrome that in turn is sold on both local and export markets.

In spite of the completion of a feasibility study on the development of a chromium mine by Consolidated Metallurgical Industries (CMI) and two Japanese companies, Nippon Steel Corp. and Mitsui and Co., the development of the mine depends on the recovery of depressed chrome ore and ferrochrome prices worldwide as well as political stability in the Republic of South Africa. If given the go-ahead, the mine probably will produce more chrome ore than CMI will require for ferrochrome production, and the excess will be exported. CMI, the country's second largest chromite producer, presently buys chrome ore fines requirements for its Lydenburg ferrochrome plant from Samancor's Winterveld Mine.

Because of the gloomy outlook in the chrome and ferrochrome markets, Associated Ore and Metal Ltd. put its Zeerust and Rustenburg chrome mines on care and maintenance. The company will not reopen these mines until market conditions improve, which is unlikely to be before the end of 1993.

**Copper.**—Palabora Mining Co., the Republic of South Africa's major copper producer, reported that the total ore and waste material loaded and hauled during 1992 amounted to 37.8 Mmt compared with 37.3 Mmt in 1991 and 49.1 Mmt in 1990. The average mining rate of 127,500 mt/d was up from 126,500 mt/d in 1991, although mill throughput was adversely affected by the increasing proportion of poor grinding ore types. Palabora's copper recovery for 1992 was 83.8%, slightly below that of 1991. It was

decided to embark on a \$21.3 million upgrade of the aging smelter to bring its capacity into line with mining, concentration, and refining stages of the production. As a result of this upgrading project, smelting continued to be disrupted throughout 1992. Although refining capacity at Palabora is estimated at more than 137,000 mt/a, current production of refined copper has been reduced to about 120,000 mt/a because of the smelter bottleneck. The smelter upgrade project, which will result in lower emissions of sulfur dioxide as well as increased capacity, should be complete by mid-1993. However, the new higher capacity will still be well below refinery capacity. It is therefore Palabora's intention to further increase smelter throughput, and new technology is being examined for either a further expansion by up to 20% or the construction of a new smelter. The latter decision would be linked to the go-ahead of the underground mine. In 1992, Palabora cut its total work force by 3.5% to 3,245.

O'Okiep Copper Co. Ltd.'s new Nigramoep Mine started production in April 1992. However, the initial planned milling rate of 40,000 mt/month was delayed until the last 6 months of 1992. Production at Hoits Mine was increased from 102,680 tons to 200,050 tons to offset the loss of tonnage after closure of Spektakel Mine and during the buildup of Nigramoep Mine. At Carolusberg Deep Mine, the collapse of a backfill stop in November seriously affected production into 1993. Together with the problems at Nigramoep, this resulted in a decrease in O'Okiep's total production of copper in concentrate from 25,082 tons in 1991 to 23,290 tons in 1992. However, production of blister copper increased from 22,957 tons in 1991 to 24,668 tons in 1992. The Messina copper mine ceased production during January 1993.

**Gold.**—The Republic of South Africa remained the world's largest gold producer in 1992 with 28% of total world production and one-third of the Western World's output. In contrast to the widespread predictions of a fall in output, gold mine production increased by 2.2%

to 614,100 kg in 1992, the highest level since 1988, owing to the mining of higher grade ore, productivity improvements, and effective cost control. The average working costs decreased from \$294 to \$286 per ounce of gold but the total cost remained unchanged at about \$324 per ounce of gold. The industry was once again under pressure as the average spot price received by South African producers fell from \$334 per ounce to \$326 per ounce of gold in 1992. However, this was in part offset by hedging contracts, which pushed the price up to about \$342 per ounce of gold. With gold exports increasing by 2.5% to 620,941 kg in 1992, the gold industry contributed about 28% to South African exports and nearly 5% to GDP. Average grade of ore mined was about 5.4 g/mt in 1992, compared with 5.2 g/mt in 1991.

In 1992, 11 mines, with a total production of about 90 mt/a and employing in excess of 80,000 skilled, semiskilled, and unskilled workers, were in either a marginal or loss-making position. The South African gold mining industry lost 30,000 jobs in 1992 and a total of 117,000 jobs since 1990. Total gold mining employment, including contractors, fell from a peak of 534,000 in 1986 to 377,000 in December 1992.

In October 1992, the first blast took place at AAC's new Moab shaft, the 11th shaft to be sunk at the Vaal Reefs Complex. The new mine is to produce a total of 200 tons of gold at an estimated maximum rate of 13 mt/a. In contrast, Gencor is to focus on smaller projects that are more flexible, have shorter lead times, and are therefore less vulnerable to a fall in the gold price. Gencor is to proceed with three such projects. The multigold dump reclamation project at Buffelsfontein Mine, which will treat 330,000 mt/month of ore with an average grade of 0.56 g/mt, is scheduled to come on-stream in 1994. A \$26 million sub-vertical decline will be sunk at Beatrix Mine instead of the proposed \$150 million No. 3 vertical shaft. The extension of the two declines at Kinross Mine from depths of 1,850 m to 1,920 m at a cost of \$15.3 million proceeded on schedule.

Negotiations on the proposed merger between JCI's H.J. Joel Mine and Genmin's Beatrix Mine have been temporarily shelved. H.J. Joel Mine has massive debt problems, and the mine continues to be dogged by technical problems in its attempt to change from its original design of trackless mining to conventional methods. However, if the merger materializes, Beatrix's No. 3 shaft, which has been delayed for 5 years, would be ideally placed to provide access to ground held by Joel.

Although the legislation banning Sunday blasting was in effect, certain highly marginal gold mines were given permission to operate on Sundays. Among these is Rand Mines' Harmony Mine, which was granted approval in September 1992. As a result, the mine reported an after-tax profit of \$2.83 million in the last quarter of 1992 after posting heavy losses in previous quarters. The Lorraine gold mine was also granted permission to operate a 7-day working week. In 1992, Lorraine's total labor force fell to 6,000 from nearly 10,000 in 1989. It is anticipated that Lorraine will increase its work force in 1993. Both Harmony and Lorraine need to produce more gold to avoid closure. Other mines that have applied for permission to work a 7-day week include Gengold's St. Helena, JCI's H.J. Joel, and Anglovaal's Hartebeesfontein. St. Helena Mine plans to reduce costs from the current \$300 per ounce to \$228 per ounce of gold by improving recovery at production and milling stages. The mine is relying heavily on underground vacuuming of gold, a process that currently recovers 65 kg/month of gold. It plans to increase output from this method to 520 kg/month. The work force has been reduced to 3,000 from 12,000 in 1989.

Rand Mines' 100-year-old ERPM Mine is to receive a Government subsidy of \$2.81 million and a loan of \$3.43 million in 1993. The funds will be used for pumping out excess water and for the operation and maintenance of affected shafts. Depending on the gold price, the mining of a large reef deposit from the far east vertical shaft will continue into the 21st century. A pumping subsidy was

also approved for another Rand Mines' gold mine, Durban Roodepoort Deep.

Since being rescued from liquidation in May 1992, the Eersteling Mine, the Republic of South Africa's oldest operating gold mine, established in 1872, has returned to profitability and reported that it had sufficient ore reserves to provide at least for a 7-year life. The company has applied for its listing on the Johannesburg Stock Exchange to be reinstated and plans to raise \$2.6 million to finance the acquisition of additional mineral rights contiguous to its Zandrivier operation.

**Iron and Steel.**—The Republic of South Africa continued to be Africa's largest steel producer. Iscor and Highveld Steel remained the country's major producers with Iscor accounting for 75% of the Republic of South Africa's total steel production and supplying about 75% of the local market. Iscor produced 7.66 Mmt of steel in its financial year ending June 30, 1992, up 6% from the same period of 1991. This represents a new record, the previous highest being 1980's 7.4 Mmt before the rationalization of primary steel production in 1983. Running at only 75% of capacity, Highveld Steel produced a total of 760,738 tons of hot metal in 1992, down 19% from the previous year. This represents the lowest output since 1984's total of 656,469 tons.

In 1992, the Republic of South Africa's steel producers were adversely affected by declining world steel consumption combined with increased world production by the United States and China, which offset a drop in output by Western Europe, Japan, and the former Eastern bloc countries. In addition, the weak local economy and pressure to cut back stock levels in a number of industries resulted in a significant reduction in local steel sales.

In response to current and anticipated market conditions, Iscor cut capital expenditure to about \$200 million, of which about \$170 million is to be spent on replacement of assets to remain competitive. The IDC's investigation into the construction of a multimillion dollar

steel plant to be built at Sishen or Saldanha Bay continues. If approved, steel would be produced in a Corex plant similar to the one in use at Iscor's Pretoria steel plant. However, this project is unlikely to get off the ground until there is a significant upturn in overseas steel markets. Iscor formally accepted the international iron and steel declaration on the environment and has implemented a number of actions designed to improve the company's environmental and rehabilitation policies.

Highveld, an integrated steel affiliate of AAC, is the Republic of South Africa's second largest privately owned steel producer. Highveld's steelmaking process is unique because the titaniferous vanadiferous magnetite ore is converted to steel as well as vanadium-rich slag. The synergy of the process enables steel to be produced at very competitive prices as the slag spinel is sold to converters to produce vanadium pentoxide and ferrovanadium. The continued weak domestic economy, coupled with a substantial inventory correction by steel merchants, caused local sales to decline by a significant amount in 1992. To improve cost-effectiveness and competitiveness, Highveld is to spend about \$20 million on the installation of a new ladle furnace to upgrade the steel plant and slab caster and improve steel quality. Modifications are expected to be completed during 1994.

**Ferroalloys.**—With the breakup of the former U.S.S.R. and falling production of ferroalloys in Russia and Kazakhstan, the Republic of South Africa was the world's largest producer of ferroalloys in 1992, despite a 36% drop in its ferrochrome production. Ferroalloys exports, the third largest earner of foreign exchange after gold and coal, dropped from 1.36 Mmt in 1991 to 1.21 Mmt in 1992.

Samancor, South Africa's major producer of ferroalloys, encountered adverse trading conditions, particularly for ferrochrome, in 1992. Samancor's exports continued to fall in 1992 as a result of poor demand from specialty steel producers, a reluctance to reduce output

on the part of Western producers, the collapse of demand from Eastern Europe and former Soviet Republics, an increase in exports of scrap and ferrochrome from these countries, and an increase in cheap supplies from China. The reduced demand for ferrochrome triggered Samancor's decision to close all its ferrochrome furnaces, including the 120,000-mt/a-capacity direct-reduction plant taken over from Middelburg Steel and Alloy Ltd. (MS&A), for at least 3 months in 1992 for maintenance. Production cutbacks commenced in January 1992, and all of Samancor's furnaces were shut down by March 1992. Accordingly, Samancor also sharply reduced production at its chromite mines. Samancor held sufficient stocks of ferrochrome to meet its contractual obligations owing to stocks from MS&A, which it took over in October 1991.

CMI completed a feasibility study with Japan's Nippon Steel and trading house Mitsui Corp. to assess the viability of developing the Thorncliff chrome mine, 100 km from CMI's Lydenburg plant.

The proposed joint ventures between Samancor and CMI and Japanese steel producers are the culmination of 20-year-long ties between the Republic of South Africa, the world's largest producer of ferrochrome, and Japan, the world's largest ferrochrome consumer and steel producer. In 1992, the Republic of South Africa supplied nearly 55% of total Japanese ferrochrome imports of 450,608 tons. Japan accounted for about 38% of the Republic of South Africa's total ferrochrome exports of 663,749 tons.

The use of manganese sinter produced at Samancor's Mamatwan plant has significantly improved Samancor's competitiveness on overseas ferromanganese markets. The plant's entire production of sinter, currently 420,000 mt/a, is consumed at Samancor's Metalloys plant at Meyerton, about 40 km south of Johannesburg, which currently produces about 260,000 tons of high-carbon ferromanganese and 160,000 tons of silicomanganese. Metalloys produces a range of ferromanganese grades with a manganese content varying from 75% to 78%. Samancor varies its sales conditions



according to quantity, customer, and market conditions and sells on the basis of long-term contracts, quarterly prices and spot prices to more than 360 customers worldwide. Iscor is the company's major local customer.

Samancor has reached agreement with a French company, Société du Ferromanganese du Paris-Outreau (SFPO) to co-operate in the production of 40,000 to 80,000 mt/a of medium-carbon ferromanganese at Boulogne in France. Samancor will supply between 80,000 and 160,000 mt/a of its high-grade manganese ore to SFPO, who will convert it into low-phosphorous, high-carbon ferromanganese using its existing blast furnaces. The alloy will then be refined into medium-carbon ferromanganese. Although the agreement is still subject to approval by the French authorities, trials of the equipment required for the refining process are well advanced and small-scale production and sales were expected to start in late 1993. Output would be increased gradually in line with market requirements and is expected to reach 40,000 mt/a in 1994. Both SFPO and Samancor will individually market the product. The agreement will not affect alloy output from Samancor's Metalloys' plant in Meyerton. Samancor is to acquire a 5% shareholding in SFPO.

Ferralloys Ltd., wholly owned subsidiary of Associated Manganese Mines of South Africa Ltd., reported a \$7.22 million loss in 1992 as a result of depressed demand and prices for both its ore and ferroalloy production. Almost all the loss was derived from operations of the company's high-carbon ferrochrome plant in Machadodorp, 80 km east of Middelburg.

**Iron Ore.**—In 1992, the Republic of South Africa ranked eighth among world iron ore producers with a production of about 28.2 Mmt. About 14.9 Mmt or 53% of production was exported, compared with 15.5 Mmt in 1991. The 4% decrease in exports was attributed to reduced demand for steel.

Iscor's two iron mines, Sishen and Thabazimbi, produced 78% of the Republic of South Africa's total iron

production. These two mines supplied 100% of Iscor's iron ore requirements of 9 Mmt. A new section of the Thabazimbi operation, Kwaggashoek East Mine, was commissioned in October 1992. Kwaggashoek East has reserves of about 7 Mmt and will be mined by a combination of open pit and underground sublevel caving methods.

The Mapochs Mine near Roossenekal, 140 km northeast of Witbank in the Eastern Transvaal, produced about 1.4 Mmt of iron ore in 1992, 34% less than in 1991. Mapochs Mine's output is believed to have fallen sharply because of Highveld's reduced steel production in 1992. The mine has sufficient reserves for several decades. Titaniferous magnetite ore is crushed to under 25 mm and railed to Highveld's iron plant in Witbank for pig iron production and to its Vantra plant for vanadium recovery.

Iron ore was also produced as a byproduct by Associated Manganese's Beeshoek Mine, about 120 km south of Sishen. Titaniferous magnetite also was recovered at the Palabora and Foskor Mines, as a byproduct of copper and phosphate rock production, respectively. Tisand (Pty.) Ltd., a unit of RBM, mined titanium-bearing beach sands north of Richards Bay. Concentrates were supplied to Richards Bay Iron and Titanium Ltd., also a unit of RBM, to produce both low-manganese pig iron and titanium slag.

**Manganese.**—The bulk of the Republic of South Africa's production of manganese ore was of metallurgical-grade, with a manganese content of more than 48%. It was mined in the Kalahari Field north of Sishen mainly by two companies, Samancor and Associated Manganese Mines Ltd. A third company, National Manganese, was a small producer. Chemical-grade ore was produced near Zeerust in the western Transvaal by Klipveld and Metmin as well as by Samancor's Mamatwan Mine in the Kalahari Field.

In 1992, total South African manganese ore production dropped by 22% to 2.46 Mmt and ore exports fell by 19% to 1.40 Mmt, in a response to reduced world steel production. It was

expected that this situation would continue in 1993.

Samancor's Wessels Mine currently produces 70,000 mt/month of high-, medium-, and low-grade manganese ore with the capacity to produce 100,000 mt/month. Although the entire production of manganese sinter produced at Samancor's Mamatwan operation is consumed by its Metalloys ferromanganese plant at Meyerton, consideration is being given to increasing output and selling on exports market.

Kapstevell Manganese, a small independent producer 20 km north of Postmasburg in the northern Cape Province, has been sold to Union Mines Ltd., previously a tin producer. Manganese values on the property range from 36% Mn to more than 50% Mn with a generally low iron content giving a good manganese to iron ratio. No difficulties are foreseen in supplying 44% to 46% manganese ore for the export market. The open pit operation is expected to produce about 40,000 tons of manganese ore, increasing to 130,000 tons in 1994.

Samancor's manganese metal company's plants at Nelspruit and Krugersdorp continue to operate at full capacity, despite the worldwide economic recession. The Nelspruit plant is currently producing about 25,500 mt/a of electrolytic manganese metal while the Krugersdorp plant produces about 14,500 mt/a. Output of manganese metal consists of flake, powder, and briquette. Feedstock for both plants, amounting to about 120,000 mt/a of ore, is derived from Samancor's Mamatwan Mine.

**Nickel.**—All nickel output in the Republic of South Africa is produced as a byproduct of platinum production. Two factors will determine future nickel output: the level of platinum production and the proportion of platinum production derived from UG2 Reef, which has a nickel content as low as one-tenth that of Merensky Reef. Of the current South African platinum producers, only two, Rustenburg Platinum Mines Ltd. (RPM) and Impala Platinum Ltd., produce nickel in a form that can be used directly in

stainless steel production. RPM produces high-nickel cathodes with very low impurities, and Impala produces similar quality nickel in the form of briquettes and powder. In addition to the production of salable nickel metal by RPM and Impala, two other platinum producers sell the intermediate product, nickel sulfate containing 22% nickel. Western Platinum and Northam Platinum produce about 3,600 mt/a and 2,400 mt/a of contained nickel in the form of nickel sulfate. The nickel sulfate is sold on both the local and export markets, mainly for use in electroplating.

Local sales of nickel are expected to increase sharply as purchases by the Columbus stainless steel expansion project rise from about 7,500 mt/a to 28,000 mt/a.

Despite the need for an increase in local supplies of nickel, it is unlikely that new mine sources will be developed during the present decade because there is a large world oversupply of nickel, which is reflected in current low prices. The latter contributed to the suspension of the investigations into the viability of AAC's Uitkomst nickel-copper prospect near Badplaas in the eastern Transvaal. This deposit is comparatively low grade with limited reserves.

**Platinum-Group Metals.**—RPM, the world's largest producer of PGM, operated three major mines in the northwestern Transvaal: Rustenburg (east and west), Union section, and Amandelbult. The new \$41 million, 1,350-m-deep No. 2 vertical shaft at the Amandelbult section is progressing well and is expected to be completed by the end of 1996. This is the first vertical full-face shaft to be sunk at Amandelbult where previously the mine worked on incline and raisebored shafts. However, as current prices are lower than the cost of production at Boschfontein shaft, RPM has announced it will close the shaft—the first shaft closure in 12 years. As a result, RPM will be unable to meet its contractual obligations and will have to buy the shortfall on the market.

Impala Platinum Ltd., the world's second largest and the lowest cost

producer, reported a 22.5% drop in the cost of producing refined platinum compared with that of 1991. However, declines in the prices of both platinum and rhodium at the end of 1991 caused Impala to mothball its new Messina platinum project in January 1992.

JCI's Lebowa Platinum Mines Ltd. is currently meeting its target of 70,000 mt/month. In 1992, the company shelved plans to increase output to 100,000 mt/month after experiencing production problems underground.

GFSA's Northam platinum mine officially opened in December 1992. Northam's platinum output is expected to reach about 7,800 mt/a in 1994, a level at which it should stabilize. This will bring the Republic of South Africa's production to more than 93,000 mt/a. The total capital cost of bringing Northam to full production is estimated at about \$53 million.

Western Platinum Ltd. is expected to produce about 15,000 mt/a of platinum in 1993, and completion of the current expansion program will result in yearly production of about 17,000 mt/a of platinum and 2,000 mt/a of rhodium by 1995. Western Platinum's new \$50 million shaft will be used to replace existing production at the Merensky Reef that will be lost with the closure of the mine's No. 2 shaft. The shaft also will be used to exploit new rhodium-rich ore at the UG2 Reef. Mintek recently developed technology, under the sponsorship of Western Platinum, for producing platinum-gold and platinum-aluminum-copper alloys that are gold or coral-pink in color. It is expected that these products will increase the popularity of platinum for jewelry manufacture.

**Uranium.**—The Republic of South Africa's uranium production increased 9% after several years of decline. Uranium is mined as a byproduct of gold on the Witwatersrand and of copper from the Phalaborwa complex. The Vaal Reefs gold mine produced 1,261 tons of yellowcake in 1991, accounting for about 57% of the country's total output of 2,222 tons. Hartebeestfontein Mine produced 308 tons and Western Areas

Mine, 284 tons. Production of uranium oxide in calcine produced by the Palabora copper mine amounted to 117 tons in 1992. Production from Witwatersrand ores is processed and packed at a central plant owned and operated by the industry's uranium marketing arm, Nuclear Fuels Corp. of South Africa (Pty.) Ltd. (NUFCOR), a Chamber of Mines-controlled organization. Uranium output is sold by NUFCOR to nuclear power stations, including the Republic of South Africa's only nuclear power station, Koeberg near Cape Town.

**Vanadium.**—The three major South African vanadium producers were Highveld; Vanadium Technology (Vantech), a subsidiary of Chromecorp Technology; and Vametco, which belongs to the Strategic Metals Corp., a U.S. company. South African producers have the capacity to meet nearly all current world vanadium demand. Highveld, the world's largest individual vanadium pentoxide producer, has a total rated capacity of about 8,000 mt/a of contained vanadium, almost 50% of world capacity. However, it currently is operating at about 70% of capacity. Most of Highveld's production is in the form of slag produced as waste in the manufacture of steel and contains about 25% V<sub>2</sub>O<sub>5</sub>. The slag is sold to converters in Europe for production of V<sub>2</sub>O<sub>5</sub> in an intermediate product, which is subsequently converted to ferrovandium. It is also sold to the United States where it is used directly to produce a proprietary alloy known as Ferovan. Although Highveld has a slag production capacity of more than 18,000 mt/a, its 1992 production of slag amounted to about 14,000 tons. The balance of output is produced by Highveld's Vantra plant in the form of V<sub>2</sub>O<sub>5</sub> flakes directly from vanadiferous magnetite ore using the salt-roast, water-leach process.

Highveld is constructing the first locally produced rotary calcining reactor at a cost of about \$667,000 for the production of vanadium trioxide. Highveld hopes that this will enable the company to gain access to valuable export markets in Europe and the Far East.

To add to the already serious oversupply situation, Vantech recommissioned the mine and plant that it took over from Rand Mines' Vansa Vanadium in May 1992. Vantech is operating at 80% of its capacity of about 3,000 mt/a of vanadium pentoxide. At full production, Vantech's output could further depress prices.

Construction of Rhombus Vanadium (Pty.) Ltd.'s new vanadium oxide plant has commenced and is proceeding according to plan. The company will be the Republic of South Africa's fifth largest vanadium producer after Highveld, Vametco, Vantech, and Transvaal Alloys, which have a current total capacity of about 44,000 mt/a of vanadium pentoxide. Rated capacity of the Rhombus plant, which will beneficiate magnetite concentrates from the Ba-Mapoga Mine near Brits in the Transvaal, will be 6,500 mt/a. At this stage it is not known whether output from the new plant will be vanadium pentoxide or trioxide. According to Rhombus, the new plant, which is scheduled to come on-stream in 1995, will be one of the lowest cost vanadium producers in the world. However, this additional output could serve to lower prices even further.

**Zinc.**—AAC and GFSA are investigating the possibility of establishing a giant underground zinc mine in the northwestern Cape Province. The mine would be at Gamsberg, about 20 km from the existing Black Mountain lead-zinc-copper mine operated by GFSA. Exploration at the site has proven reserves of about 100 Mmt of ore with an average grade of 7% zinc and 0.5% lead down to a depth of 800 m. The ore at Gamsberg has a high manganese content, which precludes the use of normal electrolytic recovery processes. The decision to go ahead with the project will depend on the result of recovery tests being carried out by Mintek on behalf of GFSA. If the mine is developed, it will require either the massive expansion of GFSA's Zincor refinery near Springs or a new plant near the mine.

**Zirconium.**—The Republic of South Africa's major zircon producer is RBM in which Gencor recently increased its interest from 25% to 50%. The other 50% is held by RTZ. RBM consists of two separate Richards Bay-based operating companies, Tisand Ltd. and Richards Bay Iron and Titanium Ltd. (RBIT). Tisand is a producer of heavy metals—ilmenite, rutile, and zircon. Ilmenite concentrates are supplied to RBIT, a smelting and beneficiation operation producing 85% titanium dioxide slag and high-purity pig iron, mostly for export.

Although the controversy continues regarding the expansion of RBM's mineral sands project at St. Lucia in Natal, AAC was given the go-ahead to establish the \$340 million Namakwa sands project at Brand Se Baai, about 220 km north of Saldanha Bay, on the coast of Cape Province, an area that is not considered to be as ecologically sensitive as St. Lucia. The project will consist of three separate components: an open pit mine 80 km north of Veredendal, a separation plant at Koekenaap, and a smelter at Saldanha Bay. The \$200 million equity portion will be funded 80% by AAC and 20% by De Beers. The IDC will be lending the balance. More than 95% of the revenues will be generated by exports. The main product at Namakwa Sands will be ilmenite, which will be smelted to produce titanium slag and pig iron. Zircon and rutile will be recovered as byproducts. At full production, about the year 2000, it is estimated that production should be 140,000 mt/a of zircon, 38,000 mt/a of rutile, 195,000 mt/a of titanium slag, and 120,000 mt/a of pig iron. Production is expected to start in 1994 at an initial mining rate of 4 Mmt/a, rising to full capacity of 16 Mmt/a. Ore reserves are in excess of 500 Mmt.

The world's only significant source of primary zirconia is the Phalaborwa carbonatite in the northeastern Transvaal, where baddeleyite ( $ZrO_2$ ) is extracted as a byproduct of phosphate and copper production by Foskor. Several grades of baddeleyite, together with zirconium sulfate and purified zirconia powder, are

produced by means of flotation, gravity separation, and leaching. The world's third largest fused-zirconia plant has been commissioned by Foskor at Phalaborwa to supplement the supply of baddeleyite with zirconia products manufactured from zircon sand. Although details of production were not available, output is believed to be about 2,000 mt/a from sands supplied by RBM. Most of Foskor's production is exported.

### Industrial Minerals

**Andalusite.**—With more than 90% of total annual world supplies, the Republic dominates world production of andalusite. In 1992, production and export of andalusite increased by 9.2% and 26%, respectively. Local sales increased by 55%. Andalusite refractories are manufactured in the Republic of South Africa by Cullinan with a production of 25,000 to 40,000 mt/a.

The main andalusite producers in the Republic of South Africa are France's Damrec, Anglovaal, Verref, and Hoogenoeg. Damrec and Anglovaal are by far the largest producers. Damrec has three andalusite mines in the Republic of South Africa: Annesley, Andafax, and Krugerspost, which it purchased from Cullinan in 1992. Anglovaal has a 51% interest in Rhino Andalusite. Verref processes raw andalusite to produce bricks and monolithics for both the domestic market and export. Hoogenoeg is owned by a European company, Enro GmbH of Germany.

**Asbestos.**—The Republic of South Africa's production of asbestos decreased by 10%, as a result of lower world demand for amosite and crocidolite. The Griqualand Exploration and Finance Co. (GEFCO) operated the only crocidolite mine, Merencor/Cortesi, in the Kuruman district in the northern Cape Province. Although stock levels remain high, the mine is being run at the lowest economic rate of production. In contrast to GEFCO, Msauli Ltd., a subsidiary of Hanova Corp., benefited from the fact that demand for its high-quality chrysotile

fiber outstripped supply. Its Kangwane Mine in the eastern Transvaal operated at full capacity of about 110,000 mt/a in 1992.

**Cement.**—Cement is produced by three companies, Pretoria Portland Cement (PPC), Anglo Alpha Cement, and Blue Circle Cement. In 1992, production capacity utilization was about 68%; about 2 Mmt/a of capacity was idle. PPC's Dwaalboom plant, with a capacity of 600,000 mt/a of clinker, is on a care-and-maintenance program and is expected to remain so until significant demand materializes. Anglo Alpha is operating at about 60% of capacity. As a result the company's labor force has been cut to 3,450, its lowest level since 1986. In contrast to both PPC and Anglo Alpha, Blue Circle is spending \$25 million on upgrading its plants to ensure that it will be prepared when the South African economy takes off. The greatest potential for growth remains the provision of low-cost housing and its attendant infrastructure, which could provide a boost to the industry as early as 1994.

Although the Republic of South Africa has not imported cement for several years, a consortium of users in Natal is planning to import cement from Russia in an attempt to bypass higher coastal prices for local cement compared with inland prices and delays in delivery.

**Diamond.**—In 1992, the Republic of South Africa's diamond production increased by 20.5% to a total of just under 10.2 million carats, largely as a result of commissioning of De Beers' Venetia Mine. De Beers' operations accounted for about 95% of South African production. The balance was produced by several independent producers, primarily along the western coast of Namaqualand, between Saldanha Bay and Port Nolloth in the Cape Province. Prospecting continued offshore in the Namaqualand area, although it was at a much less advanced stage than that off the neighboring Namibian coast.

De Beers' mines were the Finsch, the Kimberley, the Koffiefontein, the

Namaqualand, Premier, and Venetia Mines. In 1992, Kimberley Mine produced 602,358 carats from 3,848,000 tons of ore against 672,398 carats from 3,928,000 tons in 1991. Dump-retreatment continued and contributed a significant proportion to the total tonnage treated.

The total tonnage treated at the Koffiefontein Mine increased by 22% to 3,296,000 tons yielding 244,290 carats in 1992, although the average grade decreased by 10% to 7.4 carats per 100 tons as a result of mining in lower grade ore areas. The plant feed treated included 324,000 tons of surface dump material.

At the Finsch Mine, only one-half the plant feed was derived from underground operations owing to difficulties with the ore passes. The shortfall was drawn from surface stockpiles. Total tonnage treated was 2% less than in 1991, and 3,446,275 carats was recovered. Average grade was 73 carats per 100 tons.

Total diamond production from the Namaqualand Mines, including tailings retreatment, surface-zone mining, and prospecting, was 1,001,828 carats at an average grade of 16.1 carats per 100 tons of ore. Production in 1991 amounted to 1,004,168 carats at an average grade of 15.3 carats per 100 tons.

De Beers' Premier Mine recovered 2,444,219 carats from 6,923,000 tons treated compared with 2,249,728 carats from 7,300,000 tons in 1991. Underground production of 3,748,739 tons was 577,726 tons less than in 1991 as a result of termination of mining in some of the blocks above the 75-m-thick barren gabro sill as well as unavailability of ore passes below the sill. Above-sill production will cease altogether in October 1993 when about 300 Mmt of rock will have been extracted from the pipe. The 90-year-old Premier Mine, De Beers' second largest diamond mine, is one of the highest cost producers because of the massive costs involved in reinforcing its block-caving operations below the sill.

At the new \$367 million Venetia diamond mine, 150 km north of Potgietersrus in the northern Transvaal, a total of 1,867,572 carats was recovered

from 1,576,000 tons of ore. At full production and operating 7 days per a week, Venetia should be capable of producing 5.9 million carats of diamond per year. This would make it the Republic of South Africa's largest diamond mine, comparing with Finsch's output of 3.4 million carats and Premier's 2.4 million carats. Average recovery grade at Venetia is 118.5 carats per 100 tons. The mine is expected to employ 750 people. Operating life is expected to be at least 20 years.

**Dimension Stone.**—The Republic of South Africa's exports of dimension stone, consisting mainly of "granite" (including true granite, gabbro, norite, syenite, diabase, and tonalite), amounted to 180,000 m<sup>3</sup> or about 500,000 tons. The country was one of the main suppliers of rough "granite" blocks to world markets and was the largest supplier of the much sought-after "black granite" (norite). Japan was a major buyer of this material. More than one-half of the Republic of South Africa's exports of raw granite was shipped to Italy. Because of the distance from quarries to the Italian customers, transport and handling costs account for nearly 70% of the total cost, with rail transportation from the producing areas near Rustenburg to the port of Durban amounting to nearly 30%. Much of the material was reexported from Italy after further processing.

Keely Granite (28% owned by Gencor), one of the world's largest producers, acquired Rand Mines' extensive mineral rights to Rustenburg gray and African red granite. Marlin Corp. Ltd. concluded an agreement for the sale of its investment in Marlin Granite's operation in Rustenburg to an Italian company that may become involved in beneficiation of the granite in the Republic of South Africa before export. Another Italian company, Techno Stone, started cutting and polishing granite slabs in the country in 1992. About 50% of these slabs is exported. Cutting and polishing reduces the weight of raw blocks by about 30%, thereby cutting transport costs. The other major

South African producers, Keely, and the recently merged Kudu Granite Holdings Ltd./Impala, also have started in-country downstream processing of their granite.

**Fluorspar.**—In the Republic of South Africa, metallurgical-grade fluorspar is produced in lumpy and briquetted form. Acid- and ceramic-grades are recovered as flotation concentrates. The country's most significant fluorspar deposits are in the Transvaal, with less important deposits found in Namaqualand, northwestern Cape Province, and Natal. During 1992, four mines were operative, of which the Buffalo and Vergenoeg Mines were in the Bushveld Complex, 100 km northeast of Pretoria, and the Witkop and Van den Heever Mines were in the dolomites, 160 km west of Johannesburg. As in 1991, the largest South African producer, Genmin's 41-year-old Buffalo fluorspar mine, cut production levels in 1992. The depressed market conditions, caused by the gradual phasing out of chlorinated fluorocarbons, the major users of fluorspar, as well as undercutting of prices by Chinese producers, are expected to continue through 1994. The Republic of South Africa's total production of fluorspar, which peaked at 522,700 tons in 1980, continued its gradual decline and amounted to 258,105 tons in 1992, down from 270,341 tons in 1991.

**Phosphate.**—Foskor, with production of about 2.8 Mmt/a of phosphate, accounted for 95% of the Republic of South Africa's production. Installation of a new maintenance program and condition monitoring system at its open pit operation in Phalaborwa enabled Foskor to save about \$334,000 in 1992. Foskor's beneficiation plant has the capacity to process about 30 Mmt/a of phosphate ore.

In 1992, Foskor was able to increase export sales of high-quality phosphate rock by 23%. It is expected that, in spite of a weak international market and substantially lower prices since 1991, Foskor's exports could increase in 1993 as a result of a concerted drive to secure

new overseas markets. The main reasons for Foskor's success on international markets are its phosphate's high grade and low level of impurities, which overcome the disadvantages of its distance from export markets.

Although the drought and the poor financial position of the agricultural sector caused sales of phosphate rock on the local market to decline by a further 14% to a level last experienced in 1969, sales to domestic converters for the manufacture of phosphate products for export increased by 42%. Foskor supplies the three major fertilizer suppliers in the Republic of South Africa—the FEDMIS plant at Phalaborwa, which is jointly owned by AECI's Kynoch and Sasol; Omnia; and Kynoch.

Foskor is on schedule with the first phase of its \$21.67 million pilot plant to extract magnesia, alumina, and potassium sulfate from phlogopite due for completion in 1993. Subsequent phases are expected to be completed by February and June 1994, respectively. The results, expected in mid-1995, will determine whether a proposed \$1.4 billion commercial plant will go ahead. Foskor produces phlogopite as a waste product of its existing operation at a rate of 2.5 Mmt/a. The proposed plant would produce 300,000 mt/a of magnesia together with 350,000 mt/a of alumina and 230,000 mt/a of potassium sulfate.

Indian Ocean Fertilizer (IOF), a major exporter of phosphate products, and a company in which Foskor has a 50% stake, exported 130,000 tons of dry fertilizer and 180,000 tons of phosphoric acid in 1992. Although IOF's major markets are Australia and the Far East, much of its output in 1992 went to countries in Africa. The company also is investigating markets in South America. In an effort to increase its export capacity, IOF has installed a \$400,000 conveyor belt system at its Richards Bay plant that will load bulk granular phosphate fertilizer directly into ships. Exports of diammonium phosphate, monoammonium phosphate, and triple super phosphate will be increased by about 70% to about 120,000 mt/a.

## Mineral Fuels

The Republic of South Africa produces no crude oil and has limited resources of gas. About 82% of the country's primary energy needs is supplied by coal. Most electricity is generated in coal-fired power stations, and coal is also the basic raw material for the Republic of South Africa's production of synthetic fuels.

The Southern Oil Exploration Co. (Soekor), the state-owned petroleum exploration company, controlled all offshore oil and gas prospects. It conducted all exploration efforts offshore, with the exception of test drilling in which private companies could participate. Soekor continued to explore the waters off the Republic of South Africa in 1992 without success. Soekor has been criticized for spending public money on what seems to be a futile search for oil. Other South African exploration companies shifted their activities up the west coast of Africa.

In its search for oil-bearing reservoirs, Soekor concentrated its exploration efforts in the Bredasdorp Basin, 90 km off the southwest coast. Total crude petroleum resources in the Bredasdorp Basin, excluding those earmarked for Mossgas, are estimated at 200 Mbbl of oil, less than Saudi Arabia's production for 1 month. The basin also contains 34 billion m<sup>3</sup> of gas spread over several fields, less than the North Sea's production for 3 months.

**Coal.**—The Republic of South Africa was the sixth largest coal-producing country in the world after China, the United States, the former U.S.S.R., India, and Australia. Bituminous coal accounted for more than 98% of South African coal production. Four companies, Anglo American Coal Corp. Ltd. (Amcoal), Trans-Natal Coal Corp. Ltd., Rand Mines, and Sasol Mining (Pty.) Ltd., accounted for more than 80% of the country's coal production. Other producers included Iscor, which produces coal for its own use; GFSA; and numerous independent medium to small coal companies.

Although there are 19 coalfields in the

Republic of South Africa, spread over an area of 300,000 km<sup>2</sup>, the main coal-producing area is the Witbank Basin, which accounts for 42% of the country's output. About 65% of the coal is produced from underground mining operations with the remainder coming from open pit mines. Most open pit mines are no deeper than 70 m.

Weak domestic demand resulting from the depressed state of the South African economy caused local sales of coal to decline by 1.6% to 130.2 Mmt. The largest domestic consumer of coal continued to be Eskom, followed by Sasol. Eskom uses just under 40% of the coal produced in the Republic of South Africa for power generation. About 89% of its energy output was derived from coal. Sasol, the only successful commercial oil-from-coal plant in the world, consumed about 21% of the country's coal production. Other significant domestic users were Iscor's metallurgical plants, the cement industry, and large municipalities.

The Republic of South Africa's coal exports, dominated by Amcoal, Rand Mines, and Trans-Natal, decreased slightly in 1992 to about 48.8 Mmt. About 92% of all coal exports was through Richards Bay Coal Terminal, 7% was through Durban, and very small quantities were occasionally exported through Port Elizabeth, Cape Town, and Maputo in Mozambique. The country ranked third in world coal export after Australia and the United States. About one-third of exports were to Asia with the balance to Western Europe. It is expected that Eastern Europe will emerge as an important market for South African coal in the longer term.

The major mining houses continued to participate in coal exploration and reserve acquisition programs. Prospecting activities were mainly concentrated in the established eastern Transvaal coalfields and in parts of the northern Transvaal, notably the Waterberg Coalfield, about 100 km north of Thabazimbi and bordering on Botswana. The Waterberg Coalfield is largely undeveloped, with the exception of Iscor's Grootegeluk Mine near Ellisras, 250 km northwest of

Pretoria. Extensive mineral rights are held by Sasol Coal in the Waterberg Coalfield, which may contain more than one-third of the Republic of South Africa's coal reserves. Railage rates are crucial to the development of the Waterberg field.

As a result of the discovery of excessive intrusion by dolerite dykes in coal reserves that made it impossible to produce sufficient coal to supply the Majuba power station, Randcoal's Majuba Mine, 70 km north of Newcastle, has been closed down and about 500 workers retrenched. Although about \$66 million already has been spent on developing the Majuba Colliery, about \$27 million will be salvaged in equipment. Eskom has accepted an offer from Randcoal whereby the company's Khutala Colliery, 25 km south of Witbank, will be expanded at a cost of \$190 million to supply 6 Mmt/a of coal for the first three generating sets at the Majuba power station. Khutala will continue to meet the full requirements of the Kendal power station. At full output this will amount to about 20 Mmt/a of coal for both power stations. Because Khutala is a low-cost producer with a consistent record of productivity improvements, the cost of the coal to be supplied to the Majuba power station under this arrangement will be of the same order as that originally planned in 1982, allowing for escalation. The coal for Majuba will be transported from Khutala by rail over a distance of 227 km. This will necessitate upgrading certain sections of the 160-km rail line to Richards Bay as well as the construction of a new 70-km line to the power station at Majuba. Eskom and Spoornet plan to spend about \$100 million on the line and coal loading facilities.

Amcoal's new open pit mine, Kromdraai Colliery, is now fully operational and is producing coal at a rate of 250,000 mt/month of salable product. The new mine replaced tonnage previously sourced from minipits and benefited through old coal processing facilities at Landau Colliery near Witbank.

Because of a drop in local sales, which amounted to 17% of income, Trans-

Natal's Delmas Colliery, 70 km east of Johannesburg, is to reduce its salable output of 3 Mmt/a by 23%. The mine will operate on a single shift basis, and about 450 workers will be retrenched. Trans-Natal has sold a trial cargo of 30,000 tons of coal to Kyushu Electric Corp. of Japan for use at the Matsuura power station.

Duiker Exploration Ltd., the Lonrho Management Services Ltd.-owned coal producer, has been awarded long-term supply contracts with Taiwan Power Company. The contracts, which will run until 1998 and will nearly double the size of Duiker's steam coal exports, are for the supply of 4.4 Mmt over 5 years at the rate of 800,000 mt/a for the first 3 years and 1 Mmt/a for the next 2 years. Duiker is one of the signatories to the coal export joint venture that is proposing the construction of a new 12-Mmt/a export terminal at Richards Bay.

**Natural Gas.**—The only developed gasfield in the Republic of South Africa is 90 km off the southern coast near Mossel Bay. Mossel Bay Gas Project (Mossgas), the Republic of South Africa's first oil-from-gas project, began commercial production in January 1993. It is estimated that Mossgas will produce 30,000 bbl/d of product, 67% gasoline, 30% diesel, and 3% kerosene. At this level, Mossgas will provide more than 8% of the Republic of South Africa's transport fuel needs. In early 1993, Engen, a subsidiary of Gencor, announced that it would not acquire one-third of Mossgas, as it had considered, and will also withdraw from its management. According to Engen, Mossgas' expected return on investment would be too low to justify the \$400 million capital expenditure. In addition, Engen was uncomfortable being linked to a project that is dependent on tariff protection for its commercial survival. Despite Engen's withdrawal, the Government did not intend to mothball Mossgas. However, the Central Energy Fund (CEF) will have to fund about 80% of the total project cost of about \$4 billion. CEF has been funded by a tax on fuel. Thus, in effect, the motoring public

is financing the capital costs of Moss gas.

**Petroleum Refining.**—Four domestic refineries processed imported crude oil—Gencor's Genref and Shell/British Petroleum's Sapref in Durban, Caltex in Cape Town, and Sasol's Natref in Secunda. They were all in the process of expanding and/or upgrading their facilities. The total design capacity of the four refineries is estimated at 433,500 bbl/d, and they were operating at or near full capacity. It was expected that South African refinery capacity will exceed demand for the next few years.

Engen, a subsidiary of Gencor, is South Africa's only integrated oil company. Phase one of its \$965 million upgrading of the Durban Genref refinery was completed in 1992. The 30% increase in capacity was absorbed immediately as the processing of crude for its subsidiary Trek was taken over by Shell/BP. Phase two of the expansion should come on-stream early in 1995. The immediate goal is a capacity of 120,000 bbl/d, with an eventual goal in a phase 3 expansion of 150,000 bbl/d. Engen also produces a full range of nonaromatic "aliphatic" solvents and is the only local producer of the aromatic solvents benzene, toluene, and xylene.

The \$100 million upgrading of the 25-year-old Caltex refinery at Milnerton near Cape Town will increase crude throughput capacity by 70% and production volume by 76%. The conversion from process control to a state-of-the-art distributed control system has been completed and the mothballed crude and vacuum distillation units have been successfully recommissioned. Construction of the catalytic polymerization plant, designed to produce a high-octane gasoline blend component from lighter streams that would otherwise go to LPG, was completed last year.

The Shell/BP-owned Sapref refinery in Durban is undergoing a \$165 million upgrading. Due for commissioning in the last quarter of 1993, the project will improve the energy efficiency of the refinery as a whole, reduce the environmental impact, and increase crude distillation capacity by 40%.

The \$145 million upgrading of Sasol's 30-year-old Natref refinery is scheduled to be completed in 1993. The project will increase throughput by 10% and enable the refinery to process a wider spectrum of crude oils.

**Synthetic Fuels.**—Sasol produces petroleum products from coal at its plants in Sasolburg and Secunda. Founded in 1950 as a parastatal to reduce the Republic of South Africa's dependence on imported oil, Sasol was privatized in 1979. Since its inception, Sasol has undertaken extensive diversification, and its activities now include coal mining, coal conversion, oil refining, fuels marketing, and the manufacture of chemicals, polymers, mining explosives, and fertilizers. Even with its share in the Natref refinery, Sasol produces less than 50% of the country's total fuel requirement. The oil companies are obliged to buy all of Sasol's fuel production prorated to their share of the local fuel market. Sasol, in turn, limits its fuel sales at pump level to 10% of the market. Sasol's export sales have increased over the past few years and now account for about 30% of nonfuel sales. Its \$1 billion investment program will likely increase this percentage as many of the new projects emphasize exports.

### Reserves

Geologically, the Republic of South Africa's mineral wealth was derived primarily from the Witwatersrand Super Group, the Bushveld Complex, and the Transvaal and Griqualand West Sequences. The Witwatersrand Super Group, dating from about 2.9 billion years, consists of successive layers of quartzite, conglomerates, siltstones, and shales in an elongated basin. It is considered to be the world's largest single repository of gold and uranium. Some PGM and silver are also present in the Witwatersrand. The Bushveld Complex is a layered mafic igneous intrusion into the overlying Transvaal Super Group and is dated at about 2 billion years. Within it are the world's largest known reserves of

chromium, PGM, and vanadium. Cobalt, copper, and nickel also are found in the Bushveld Complex and are recovered as byproducts in the mining of PGM. Within the vicinity of the contact between the Bushveld Complex and upper layers of the Transvaal Super Group are important reserves of andalusite, fluor spar, and tin. The Transvaal and Griqualand West Sequences, dating from about 2.6 billion years, are series of dolomites, ironstones, and shales found in northern Cape Province and in central Transvaal Province. Within it are found major reserves of amosite and crocidolite asbestos, iron ore, limestone, and manganese. (See figure 1.)

The Minerals Bureau of the Republic of South Africa reported the country's total reserves in terms of reserve base for many mineral commodities. (See table 5.) The Minerals Bureau reported a reserve base of 50.8 Mmt for combined andalusite, sillimanite, and kyanite, almost all of which was andalusite. The reserve base for lead of 4.8 Mmt contained metal was broken down further to 2.33 Mmt of demonstrated reserves and 2.43 Mmt of demonstrated marginal reserves. Of demonstrated reserves, Broken Hill's Black Mountain Mine had 1.54 Mmt, Gamsberg Mine had 715,000 tons, and Pering Mine had 86,000 tons. The zinc reserve base of 14.872 Mmt contained zinc was broken down to 11.768 Mmt of demonstrated reserves. The Black Mountain Mine had 726,500 tons, the Gamsberg Mine had 10.6 Mmt, the Prieska Mine had 15,248 tons, and the Pering Mine had 430,860 tons. Demonstrated marginal reserves of zinc were 3.1 Mmt. The only potash production in the Republic of South Africa was by Iscor at its Vanderbijlpark and Newcastle Works, where a byproduct, containing from 30% to 60% potassium chloride, is produced from iron ore at the sinter plant. However, potential resources, according to the Minerals Bureau, were 200 Mmt in phlogopite at the Phalaborwa Complex and 700 Mmt in glauconite in seabed sediments off Cape Town.

Other research centers involved in mineral reserve assessments in the

Republic of South Africa reported updated estimates for certain minerals. The Economic Geological Research Unit of the University of the Witwatersrand estimated that 40,000 tons of gold remained to be mined in the country, compared with about 42,000 tons mined to date. About 60% of this would be derived from existing mines. Recovery of the remainder would involve development of new deep-level mines. The Minerals Bureau of the Republic of South Africa reported a gold reserve base of 18,000 tons for current mining leases only. This figure excludes the gold reserve base of "independent" homelands within the Republic of South Africa.

The recoverable reserves of coal in the Republic of South Africa were estimated at 55 billion tons by the Minerals Bureau, ranking it fifth in the world. Most of the country's coal is of bituminous thermal-grade, with 2% anthracite and 1.6% metallurgical quality. Only a few deposits of lignite, estimated to be uneconomic, have been recorded in the southern Cape Province and KwaZulu in Natal.

Recoverable reserves of anthracite coal were 863 Mmt, mainly in Natal Province in the Kliprivier and Zululand Coalfields. About 31% of the total reserve occurs between 15 and 200 m depth, in seams 0.7 to 2 m thick. At these same depths, another 13% of the reserves was in seams 2 to 4 m thick. The remaining 56% of the reserves occurs at 200 to 500 m depth in seams 0.7 to 2 m thick.

## INFRASTRUCTURE

The country had a well-developed and maintained road, rail, and air transportation system, serving not only the Republic of South Africa but also southern Africa. The bulk of the country's transportation services fall under the control of Transnet, a state-owned company. The Republic of South Africa's road network is used by more than 100,000 trucks, about one-third of which are operated by professional haulers, including Transnet's Autonet road transportation arm and numerous private trucking companies. Rail

transportation is carried out by Spoornet, and petroleum is transported by Petronet. The country's seven commercial harbors are operated by Portnet. Air transportation is carried out by South African Airways, also part of Transnet, as well as numerous privately owned internal airlines.

In 1992, Spoornet conveyed 163.4 Mmt of freight including 105 Mmt of coal and ore, 17.9 Mmt of metals and minerals, and 11.3 Mmt of cement and explosives. As a result of increased coal exports, Spoornet upgraded its wagon fleet in 1992. A total of 800 new coal trucks is scheduled for delivery in Spoornet's 1994 financial year.

Of the country's main ports, Durban, which serves the Pretoria-Witwatersrand-Vereeniging commercial area, remained the busiest of the more than 80 ports on the African continent, followed by Cape Town, Richards Bay, Port Elizabeth, Mossel Bay, East London, and Saldanha Bay. As a result of the lifting of sanctions, more than 12,000 ships called at South African ports in 1992, reflecting a 4% increase in shipping traffic over that of 1991. Norwegian, Russian, and U.S. ships entered South African ports for the first time in many years.

Richards Bay handled the greatest volume of cargo among African ports. Richards Bay Coal Terminal (RBCT) has a coal export capacity of 53 Mmt/a. AGIP Spa of Italy, GFSA, Iscor, Sasol, and a number of smaller coal producers such as Duiker Exploration Ltd. and Messina Ltd. are considering either increasing their coal exports or entering the export market. The aforementioned coal companies and Portnet are conducting feasibility studies to establish the viability of a second coal terminal, the so-called Red Terminal at Richards Bay, to export 10 to 12 Mmt/a of coal starting in 1995. Sasol could export about 3 Mmt/a from its new open pit Syferfontein Mine, and this tonnage would provide a solid base for a new terminal. However, the existing large users of RBCT are strongly opposed to a second terminal, believing that an increase in exports of 10 Mmt/a will aggravate the world coal oversupply

situation and depress coal prices. They are, however, considering allowing Sasol to buy into RBCT, which would then make it unlikely that a second terminal would be built.

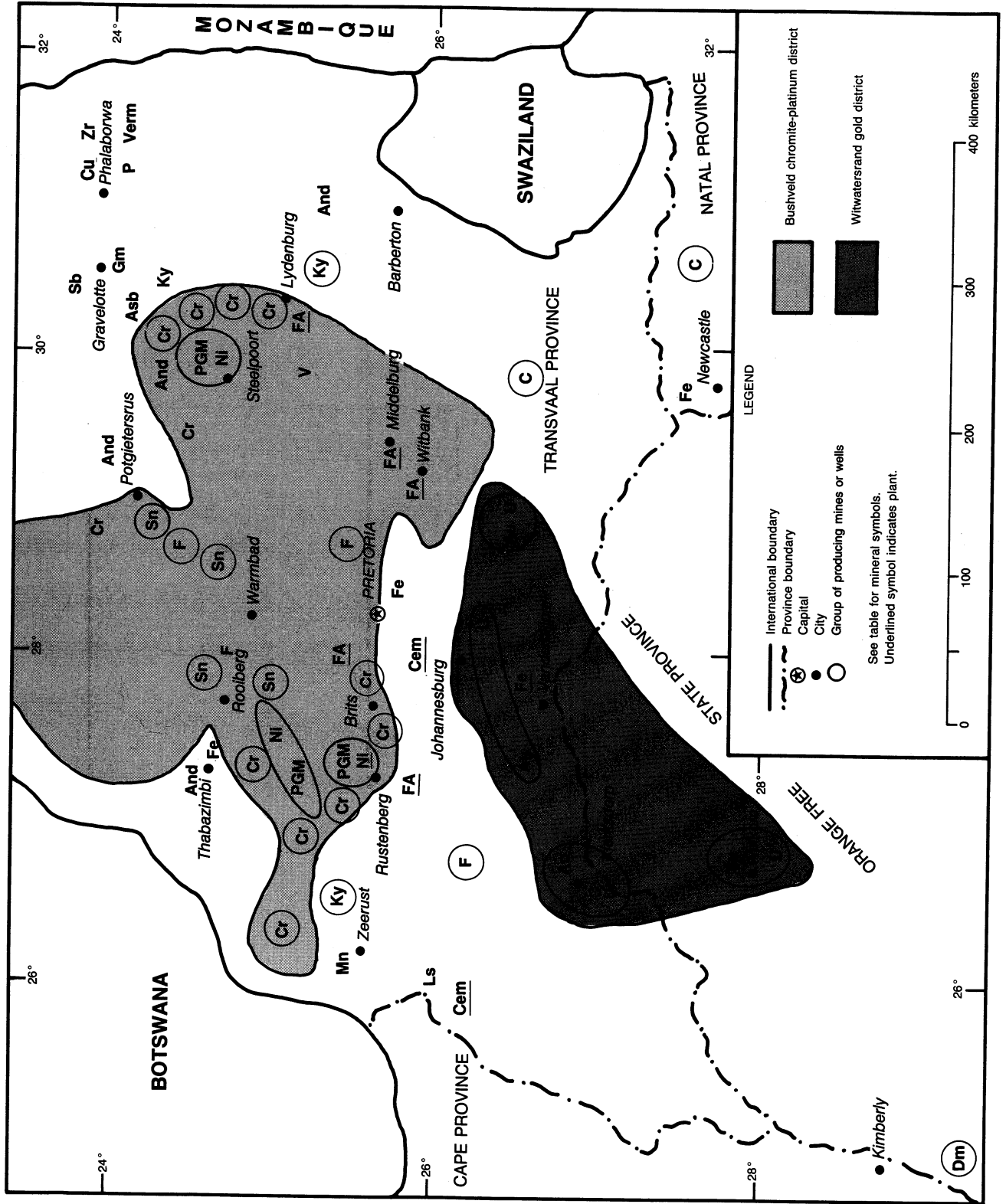
Coal exports through Durban are only a fraction of those through RBCT. Durban's port facilities are designed mainly for small consignments of high-quality-sized bituminous coal and anthracite that cannot be accommodated at Richards Bay and have a coal export capacity of 3.5 Mmt/a. An upgrading program, which would increase capacity to 5 Mmt/a, is in progress. The Port of Maputo in Mozambique, which is closer to the east Transvaal coalfields than are South African ports, is being considered as an export outlet by some coal companies. A 15-year contract has been awarded to a local project management company to manage the Matola coal terminal at Maputo. A contract already has been signed for the export of 1.3 Mmt/a of South African coal to Turkey, for a minimum of 5 years, through Matola.

In addition to fulfilling the requirements of the Republic of South Africa itself, the country's ports also served as outlets for landlocked countries such as Botswana, Lesotho, Swaziland, Zaire, Zambia, and Zimbabwe. Walvis Bay, which is jointly controlled by the Republic of South Africa and Namibia, handled most of Namibia's imports and exports. The Republic of South Africa is also a regional supplier of electricity and petroleum products, two of a number of examples of the dependence of neighboring countries on the Republic of South Africa's infrastructure and transportation networks.

Eskom, one of the largest utilities in the world with a nominal capacity of 39,060 MW, supplied the bulk of electricity used in the Republic of South Africa and more than one-half of the total electricity consumed on the African continent. Eskom's average price per kW•h sold was \$0.03, one of the lowest in the world. The mining industry consumed 30,840 GW•h of electricity in 1992, or 22% of Eskom's sales, compared with 31,366 GW•h in 1991.



FIGURE 1  
SOUTH AFRICA: WITWATERSRAND AND BUSHVELD MINERAL DISTRICT



Gold and uranium mines accounted for 72% of Eskom's sales of electricity to the mining industry, followed by platinum, 9%; coal, 8%; copper and other nondiamond, 4%; and diamond, 3%. In the manufacturing industry, the iron and steel sector used 28% or 10,885 GW•h, while the nonferrous sector used 17% or 6,669 GW•h. The bulk of Eskom's electricity was supplied by coal-fired power stations, with its Koeberg nuclear power station near Cape Town producing only 9,228 GW•h during 1992. Hydroelectric output was reduced as a result of the severe drought in southern Africa.

## OUTLOOK

The removal of sanctions allows the Republic of South Africa to compete with other mineral-producing countries in a number of areas. The country can be expected to acquire new markets, qualify for international mining finance capital, and gain access to prospecting rights. Exports of iron ore and steel are expected to increase as a result of the relaxation of embargoes. Coal exporters, who lost about 14 Mmt/a of coal export markets owing to sanctions and other trade restrictions, also should benefit from the removal of trade barriers. Coal exporters now are able to place on long-term contracts the substantial quantities of South African coal that moved onto the volatile spot market from 1986 to the end of the embargoes.

With higher gold prices in 1993, many of the Republic of South Africa's marginal gold mines, which have cut costs and operation to the bone in recent years, will be saved from closure. The rise in gold prices is also likely to result in an increase in capital expenditure on South African mines. Gold production is projected to increase by about 3% in 1993.

A modest increase in the volume of PGM exports, especially rhodium, is estimated based principally on an expected increase in demand for autocatalysts from Europe, following the introduction there of more stringent environmental regulations.

Chrome ore exports are forecast to be bolstered by restocking ahead of the long-awaited upturn in the world economy. Likewise, shipments of ferrochrome are expected to increase in line with an anticipated improvement in the stainless steel market. Owing to increases in production capacity, the Republic of South Africa's exports of titanium, zirconium, and zinc are expected to increase. In particular, the commissioning of ventures such as the Columbus, Alusaf, and other base metal projects is likely to lead to an expansion in exports of beneficiated mineral commodities.

Prospects for the Republic of South Africa's industrial minerals sector and for processed minerals are generally forecast to improve beyond 1993. Export volumes and prices are expected to maintain positive growth rates in the medium term. Environmental factors could, however, adversely affect exports of specific minerals such as asbestos and fluorspar.

With its large mineral resource base, the Republic of South Africa has great potential for increasing mineral production under favorable economic conditions. In the longer term, diversification of the economy away from mining is likely to continue. Increased foreign investment in the Republic of South Africa remains dependent on settlement of the economic and political issues confronting a new government. Changes in mining code, investment code, and tax law are likely to increase the level of risk to potential investors, both domestic and foreign based.

<sup>1</sup>Unless otherwise specified, reference to the Republic of South Africa includes Bophuthatswana, Ciskei, Transkei, and Venda, as well as the 10 tribal homelands, all within the boundary of the Republic of South Africa.

<sup>2</sup>Where necessary, values have been converted from South African rands (R) to U.S. dollars at the rate of R2.85=US\$1.00 for 1992, R2.76=US\$1.00 for 1991, and R2.59=US\$1.00 for 1990.

The Minerals Bureau of the Republic of South Africa reports a total sales figure of \$13.4 billion, down from \$14.4 billion in 1991, which excludes sales of minerals from homelands. The total sales of all crude and processed mineral commodities and products are estimated at about \$30 billion and include the following: crude minerals, about \$15 billion; petroleum products, estimated at \$8 billion; steel estimated at about \$3 billion; ferroalloys and other processed mineral products, about \$2 billion; cement, estimated at \$0.5 billion; fertilizers, estimated at \$0.5 billion; and others, \$1 billion.

<sup>3</sup>Raw Materials Group RMG AB, Stockholm, Sweden. Who Owns Who in Mining 1993. Roskill Information Services Ltd., London, 1993.

## OTHER SOURCES OF INFORMATION

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TABLE 1  
REPUBLIC OF SOUTH AFRICA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1988	1989	1990	1991	1992
<b>METALS</b>					
Aluminum metal, primary	170,400	165,900	159,489	169,390	172,795
Antimony concentrate: <sup>2</sup>					
Gross weight	10,855	8,838	8,113	7,533	6,465
Sb content	6,264	5,201	4,815	4,485	3,779
Beryl concentrate (11% to 12% BeO) kilograms	72	—	1,000	103	—
Cadmium, Cd content of cadmium cake <sup>3</sup>	37	40	40	40	40
Chromite, gross weight:					
More than 48% Cr <sub>2</sub> O <sub>3</sub> thousand tons	20	54	47	70	18
44% to 48% Cr <sub>2</sub> O <sub>3</sub> do.	2,721	2,583	2,383	2,673	1,904
Less than 44% Cr <sub>2</sub> O <sub>3</sub> do.	1,503	2,314	2,188	2,367	1,441
Total <sup>4</sup> do.	4,245	4,951	4,618	5,110	3,363
Cobalt:					
Mine output, Co content <sup>5</sup>	300	300	350	300	350
Refinery output:					
Metal, powder <sup>6</sup>	60	60	70	60	65
Sulfate, contained cobalt <sup>7</sup>	150	140	180	150	170
Total <sup>3 4</sup>	206	199	249	209	234
Columbium and tantalum:					
Columbite-tantalite concentrate:					
Gross weight kilograms	140	20	6	14	31
Cb content <sup>8</sup> do.	47	7	2	5	11
Ta content <sup>9</sup> do.	35	5	2	4	9
Copper:					
Mine output, Cu content	168,452	181,854	178,704	184,556	176,074
Metal:					
Smelter	180,600	184,800	176,000	164,700	152,800
Refined, primary	136,700	144,200	133,000	127,000	115,800
Gold, primary kilograms	621,000	607,460	605,100	601,110	614,100
Iron and steel:					
Ore and concentrate:					
Gross weight thousand tons	25,248	29,958	30,291	28,958	28,226
Fe content do.	16,461	19,461	19,689	18,819	18,350
Metal:					
Pig iron do.	6,171	6,543	6,257	6,968	6,498
Direct-reduced iron do.	759	772	882	863	854
Ferroalloys, electric arc furnace:					
Chromium ferroalloys do.	994	1,050	1,022	1,039	665
Ferromanganese do.	447	394	404	255	266
Silicomanganese do.	248	258	234	235	235
Ferrosilicon do.	87	93	78	68	64
Silicon metal do.	39	36	36	40	35
Ferrovanadium <sup>10</sup> do.	1	2	1	1	1
Total <sup>4</sup> do.	1,816	1,833	1,775	1,638	1,266
Crude steel do.	8,837	9,337	8,619	9,358	9,061
Lead:					
Concentrate, Pb content	90,233	78,171	69,417	76,262	75,806
Smelter, secondary	37,361	36,900	31,200	32,200	29,000

See footnotes at end of table.

TABLE 1—Continued  
**REPUBLIC OF SOUTH AFRICA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

Commodity	1988	1989	1990	1991	1992	
<b>METALS—Continued</b>						
<b>Manganese:</b>						
<b>Ore and concentrate, gross weight:</b>						
<b>Metallurgical:</b>						
More than 48% Mn	thousand tons	1,108	1,228	2,102	1,637	1,331
45% to 48% Mn	do.	674	1,357	610	181	279
40% to 45% Mn	do.	710	702	689	628	273
30% to 40% Mn	do.	1,405	1,518	917	653	491
<b>Total<sup>4</sup></b>	do.	<u>3,897</u>	<u>4,805</u>	<u>4,318</u>	<u>3,100</u>	<u>2,375</u>
<b>Chemical:</b>						
More than 65% MnO <sub>2</sub>	do.	2	1	6	1	16
35% to 65% MnO <sub>2</sub>	do.	122	77	69	45	73
Less than 35% MnO <sub>2</sub>	do.	2	—	9	—	—
<b>Total</b>	do.	<u>126</u>	<u>79</u>	<u>84</u>	<u>46</u>	<u>89</u>
<b>Grand total<sup>4</sup></b>	do.	<u>4,023</u>	<u>4,884</u>	<u>4,402</u>	<u>3,146</u>	<u>2,464</u>
Metal, electrolytic	do.	37	40	35	35	35
<b>Nickel:</b>						
Mine output, concentrate, Ni content		<sup>1</sup> 30,000	<sup>2</sup> 28,900	<sup>2</sup> 29,000	<sup>2</sup> 27,700	28,400
Metal, electrolytic		29,217	28,100	28,200	26,863	27,621
Platinum-group metals, metal content of concentrate, matte, refinery products	kilograms	131,722	133,684	141,913	142,861	152,891
<b>Silver:</b>						
Mine output, Ag content	do.	199,746	179,829	161,003	170,832	182,723
Metal <sup>5</sup>	do.	1,800	1,700	1,500	1,600	1,700
Thorium, monazite concentrate, gross weight (*55% rare-earth oxides) <sup>6</sup>		1,200	1,200	<sup>3</sup> 1,317	1,300	1,300
<b>Tin:</b>						
<b>Cassiterite concentrate:</b>						
Gross weight <sup>7</sup>		3,400	3,350	2,800	2,600	1,500
Sn content		1,377	1,306	1,140	1,042	582
<b>Metal:</b>						
Primary <sup>8</sup>		<sup>1</sup> 1,377	<sup>1</sup> 1,306	<sup>1</sup> 1,140	<sup>1</sup> 1,042	592
Secondary <sup>9</sup>		<sup>8</sup> 0	<sup>8</sup> 0	<sup>7</sup> 0	<sup>7</sup> 0	60
<b>Titanium:<sup>10</sup></b>						
Rutile concentrate		55,000	60,000	<sup>3</sup> 64,056	75,000	75,000
Titaniferous slag	thousand tons	700	725	840	<sup>r</sup> <sup>3</sup> 808	<sup>3</sup> 884
Uranium oxide (U <sub>3</sub> O <sub>8</sub> )		4,583	3,456	2,875	2,039	2,222
<b>Vanadium:</b>						
Vanadiferous slag, gross weight <sup>11</sup>		<u>80,000</u>	<u>80,000</u>	<u>70,000</u>	<u><sup>6</sup>60,000</u>	<u>55,000</u>
<b>V content:</b>						
Of vanadiferous slag <sup>12</sup>		11,300	11,300	10,000	<sup>8</sup> 8,460	7,730
Of V <sub>2</sub> O <sub>5</sub> and vanadate products <sup>13</sup>		6,330	7,270	7,100	<sup>6</sup> 6,500	6,300
<b>Total<sup>4</sup></b>		<u>17,631</u>	<u>18,567</u>	<u>17,106</u>	<u><sup>1</sup>14,962</u>	<u>14,033</u>
<b>Zinc:</b>						
<b>Concentrate:</b>						
Gross weight		176,180	145,452	139,266	<sup>r</sup> <sup>1</sup> 127,000	133,892
Zn content		89,551	77,334	74,792	64,425	71,928
Metal, smelter		85,193	84,997	91,900	<sup>9</sup> 91,659	83,208
Zirconium concentrate (baddeleyite and zircon) <sup>14</sup>		150,000	150,000	<sup>3</sup> 151,536	230,000	230,000

See footnotes at end of table.

TABLE 1—Continued  
**REPUBLIC OF SOUTH AFRICA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>**  
(Metric tons unless otherwise specified)

Commodity	1988	1989	1990	1991	1992
<b>INDUSTRIAL MINERALS</b>					
<b>Aluminosilicates:</b>					
Andalusite	259,556	284,617	283,677	209,824	230,333
Sillimanite	781	170	256	422	632
<b>Asbestos</b>					
Amosite	20,325	26,124	26,570	27,325	5,132
Chrysotile	113,468	115,420	103,410	101,650	103,660
Crocidolite	11,885	15,050	15,820	19,550	24,476
Total <sup>4</sup>	145,678	156,594	145,791	148,525	133,268
Barite	8,735	8,570	2,490	4,790	3,570
Calcite	65	—	—	2,556	13,764
Cement, hydraulic	8,486	8,030	7,811	7,296	7,361
<b>Clays:</b>					
Attapulgit	7,161	6,609	7,628	8,109	8,235
Bentonite	66,750	62,987	66,059	64,600	43,977
Fire clay	267,184	282,885	232,393	132,813	86,195
Flint clay, raw and calcined	139,112	128,586	130,174	123,849	123,721
Kaolin	152,500	139,711	132,421	134,485	131,765
Corundum, natural	2	2	2	—	—
<b>Diamond, natural:</b>					
Gem <sup>o</sup>	3,800	4,000	3,900	3,800	4,600
Industrial <sup>o</sup>	4,700	5,120	4,810	4,630	5,556
Total <sup>3 4</sup>	8,504	9,116	8,708	8,431	10,156
Diatomite	199	133	2,798	2,352	576
Feldspar	61,440	52,964	56,124	70,324	49,425
<b>Fluorspar:</b>					
Acid-grade <sup>o</sup>	283,000	310,000	262,000	240,000	230,000
Ceramic-grade <sup>o</sup>	8,000	9,000	7,500	6,000	5,500
Metallurgical-grade <sup>o</sup>	37,420	49,340	41,530	24,340	22,600
Total <sup>3 4</sup>	328,421	368,340	311,032	270,341	258,105
<b>Gemstones, semiprecious:</b>					
Rose quartz	44,165	47,210	17,842	41,206	100,834
Tiger's eye	368,462	279,617	550,245	467,260	620,827
Gypsum, crude	372,169	406,743	390,765	420,146	333,771
Industrial sand and gravel (quartz, glass sand)	2,011	2,182	1,986	2,068	1,750
Lime <sup>5</sup>	1,916	1,939	1,830	1,765	1,686
Magnesite, crude	74,088	75,695	114,182	92,634	60,085
Mica, scrap and ground	1,669	1,708	1,765	1,883	2,099
Nitrogen: N content of ammonia	471,800	455,200	456,200	457,000	540,500
Perlite	978	1,950	200	41	97
<b>Phosphate rock:</b>					
Gross weight	2,850	2,963	3,165	3,050	3,051
P <sub>2</sub> O <sub>5</sub> content	1,079	1,111	1,190	1,150	1,150
<b>Pigments, mineral, natural:</b>					
Ochers	1,944	1,180	2,710	999	890
Oxides	126	150	200	123	224
Total <sup>4</sup>	2,070	1,327	2,909	1,122	1,114
Salt	678,225	692,391	728,110	664,624	701,991

See footnotes at end of table.

TABLE 1—Continued  
**REPUBLIC OF SOUTH AFRICA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

Commodity	1988	1989	1990	1991	1992	
<b>INDUSTRIAL MINERALS—Continued</b>						
Silcrete <sup>5</sup>	815	4,079	1,244	—	—	
Sodium sulfate, natural	255	15	20	—	37,169	
<b>Stone, n.e.s.:</b>						
<b>Dimension:</b>						
Granite and norite	566,300	626,800	692,400	806,100	600,019	
Marble <sup>6</sup>	8,600	6,000	11,500	12,100	17,200	
Slate	42,300	33,900	29,400	26,282	26,344	
<b>Crushed and broken:</b>						
Limestone and dolomite	thousand tons	18,644	18,903	19,946	19,971	19,782
Nepheline syenite		260	141	200	20,966	174,864
Quartzite <sup>5</sup>		133	290	113	977	235
Shale		421,802	398,374	386,286	391,108	300,836
<b>Sulfur:</b>						
S content of pyrite	thousand tons	507	461	452	293	384
<b>Byproduct:</b>						
Metallurgy <sup>6</sup>	do.	110	100	110	105	100
Petroleum <sup>6</sup>	do.	120	120	120	120	120
Total <sup>3, 4</sup>	do.	738	682	683	517	605
<b>Talc and related materials:</b>						
Talc		10,111	11,596	11,179	8,235	13,882
Pyrophyllite (wonderstone)		3,162	3,942	2,759	4,448	3,053
Vermiculite		209,177	224,500	220,311	214,656	170,399
<b>MINERAL FUELS AND RELATED MATERIALS</b>						
<b>Coal:</b>						
Anthracite	thousand tons	4,951	4,208	3,622	2,689	3,345
Bituminous	do.	176,409	172,075	171,161	175,507	171,039
Total <sup>4</sup>	do.	181,360	176,283	174,784	178,196	174,383
<b>Petroleum refinery products:</b>						
Gasoline	thousand 42-gallon barrels	36,865	37,230	38,325	39,055	39,785
Jet fuel	do.	3,285	3,285	3,285	3,285	3,285
Kerosene	do.	3,285	3,285	3,285	3,285	3,285
Distillate fuel oil	do.	39,055	39,420	40,515	41,245	41,975
Residual fuel oil	do.	23,725	24,090	24,820	25,555	26,280
Liquefied petroleum gases	do.	1,095	1,095	1,095	1,095	1,095
Lubricants (including greases)	do.	2,555	2,555	2,555	2,555	2,555
Other <sup>7</sup>	do.	14,965	15,330	15,695	16,060	16,425
Total <sup>8</sup>	do.	124,830	126,290	129,575	132,135	134,685

<sup>5</sup>Estimated. <sup>6</sup>Revised.

<sup>1</sup>Table includes data available through July 20, 1993.

<sup>2</sup>Data are for the year ending June 30 of that stated.

<sup>3</sup>Reported figure.

<sup>4</sup>Data may not add to totals shown because of independent rounding.

<sup>5</sup>Domestic sales plus exports.

<sup>6</sup>Converted from reported m<sup>3</sup> figure using 1 m<sup>3</sup>=2.7 tons.

<sup>7</sup>Includes asphalt, coke, aviation gasoline, naphthas, paraffin wax, petrochemical feedstocks, unfinished oils, white spirits, and blending components.

<sup>8</sup>Refinery fuel and losses, amounting to 7,665 thousand 42-gallon barrels per year for 1988-92, are included in the output of the individual petroleum refinery products.

TABLE 2  
REPUBLIC OF SOUTH AFRICA: APPARENT EXPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

	1989	1990	Destinations, 1990	
			United States	Other (principal)
<b>METALS</b>				
<b>Aluminum:</b>				
Ore and concentrate	4,814	27	—	All to France.
Ash and residue	734	19	—	All to West Germany.
<b>Metal including alloys:</b>				
Scrap	2,637	1,941	—	Japan 2,247; United Kingdom 275; West Germany 221.
Unwrought	39,919	45,721	1,872	Japan 36,694; Hong Kong 3,165.
Semimanufactures	10,345	12,154	9,153	West Germany 2,189; United Kingdom 632.
<b>Antimony:</b>				
Ore and concentrate	293	27,267	—	Venezuela 27,117; France 150.
Oxides	165	2,657	2,657	
<b>Arsenic: Oxides and acids</b>				
	—	380	380	
<b>Cadmium: Metal including alloys, all forms</b>				
	70	6	—	All to United Kingdom.
<b>Chromium:</b>				
Ore and concentrate	1,489	1,351	520	Japan 537; West Germany 138; Netherlands 40.
Metal including alloys, all forms	20	24	—	Austria 20; France 4.
<b>Cobalt:</b>				
Oxides and hydroxides	—	63	24	Hong Kong 38.
Metal including alloys, all forms	250	1,235	752	France 368; United Kingdom 42.
<b>Columbium and tantalum:</b>				
Ore and concentrate	—	193	—	All to Austria.
Metal including alloys, all forms	( <sup>2</sup> )	1	1	
<b>Copper:</b>				
Ore and concentrate	10,540	30,501	—	Japan 30,499; France 2.
Matte and speiss including cement copper	288	300	—	All to West Germany.
Oxides and hydroxides	7	1	—	Do.
Sulfate	20	—	—	
Ash and residue	517	1,975	—	West Germany 1,796; Spain 179.
<b>Metal including alloys:</b>				
Scrap	7,081	7,650	—	West Germany 6,093; Belgium-Luxembourg 824; Austria 206.
Unwrought	120,377	87,153	910	West Germany 32,632; Belgium-Luxembourg 14,494; Japan 11,125.
Semimanufactures	7,202	6,182	2,479	Hong Kong 1,312; United Kingdom 872; Austria 809.
<b>Gold:</b>				
Waste and sweepings	value, thousands	\$14,130	\$3,133	— All to Switzerland.
Metal including alloys, unwrought and partly wrought	kilograms	168,060	22,593	3 West Germany 16,102; France 2,500; Japan 2,489.
<b>Iron and steel:</b>				
Iron ore and concentrate, including roasted pyrite	thousand tons	14,566	9,008	— Japan 4,805; Austria 1,315; West Germany 1,166.
<b>Metal:</b>				
Scrap		778	2,703	— Argentina 1,235; Turkey 1,193; West Germany 219.
Pig iron, cast iron, related materials		200,986	112,089	— Japan 64,873; Turkey 24,676; Switzerland 11,357.
<b>Ferroalloys:</b>				
Ferrochromium		827,786	895,824	172,368 Japan 274,194; West Germany 170,661; France 133,687.
Ferromanganese		278,275	226,014	130,906 France 22,382; West Germany 20,055.

See footnotes at end of table.



TABLE 2—Continued  
**REPUBLIC OF SOUTH AFRICA: APPARENT EXPORTS OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

	1989	1990	Destinations, 1990	
			United States	Other (principal)
<b>METALS—Continued</b>				
<b>Iron and steel—Continued:</b>				
<b>Metal—Continued:</b>				
<b>Ferroalloys—Continued:</b>				
Ferromolybdenum	17	20	—	All to Spain.
Ferronickel	115	337	18	Japan 176; West Germany 130.
Ferrosilicochromium	2,380	40	—	Canada 21; Japan 18.
Ferrosilicomanganese	151,844	136,323	50,987	Japan 41,516; West Germany 11,605; United Kingdom 9,411.
Ferrosilicon	22,061	8,697	—	Japan 4,431; West Germany 3,197; Spain 495.
Silicon metal	20,031	17,106	270	Japan 10,543; West Germany 5,871; Austria 405.
Unspecified	2,535	18,744	—	Hong Kong 10,205; Belgium-Luxembourg 8,142.
Steel, primary forms	160,734	7,004	—	Argentina 5,580; West Germany 850; Austria 346.
<b>Semimanufactures:</b>				
<b>Flat-rolled products:</b>				
<b>Of iron or nonalloy steel:</b>				
Not clad, plated, coated	63,246	225,398	—	Hong Kong 84,310; Turkey 58,457; Japan 33,274.
Clad, plated, coated	2,709	58,162	—	Hong Kong 31,379; Switzerland 7,800; Chile 5,326.
Of alloy steel	185	17,444	—	United Kingdom 5,117; Switzerland 4,438; Turkey 4,379.
Bars, rods, angles, shapes, sections	207,251	117,057	—	Turkey 35,956; Chile 18,252; Greece 17,478.
Rails and accessories	76,550	257	—	Chile 236; Hong Kong 21.
Wire	6,896	26,009	—	United Kingdom 7,850; France 6,065; West Germany 4,502.
Tubes, pipes, fittings	37,442	36,010	1	United Kingdom 6,800; Chile 6,796; Greece 6,756.
Unspecified	79,119	5,624	—	Argentina 3,372; Uruguay 1,439.
<b>Lead:</b>				
Ore and concentrate	95,527	78,599	—	France 44,413; Japan 23,068; West Germany 11,118.
Oxides	38	180	5	Canada 165; West Germany 5.
Ash and residue containing lead	—	112	—	All to France.
<b>Metal including alloys:</b>				
Scrap	155	—	—	—
Unwrought	12,040	393	—	United Kingdom 363; Netherlands 25.
Semimanufactures	115	65	—	Hong Kong 42; United Kingdom 23.
<b>Magnesium: Metal including alloys:</b>				
Scrap	69	73	—	Spain 44; West Germany 29.
Unwrought	—	3	—	All to Austria.
Unspecified	—	12	—	All to Japan.
<b>Manganese:</b>				
Ore and concentrate: Metallurgical-grade thousand tons	1,991	1,512	26	Japan 844; West Germany 212; Norway 193.
Oxides	5,171	4,657	2,775	Belgium-Luxembourg 914; Japan 336.
Metal including alloys, all forms	32,450	20,652	12,443	West Germany 2,400; Canada 2,138; Japan 2,138.
<b>Molybdenum:</b>				
Ore and concentrate	—	40	—	All to West Germany.
Metal including alloys, scrap	3	( <sup>2</sup> )	—	Do.
<b>Nickel:</b>				
Ore and concentrate	1	2	—	All to West Germany.
Matte and speiss	—	35,198	—	Norway 35,178; West Germany 20.

See footnotes at end of table.

TABLE 2—Continued  
**REPUBLIC OF SOUTH AFRICA: APPARENT EXPORTS OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

	1989	1990	Destinations, 1990	
			United States	Other (principal)
<b>METALS—Continued</b>				
<b>Nickel—Continued:</b>				
Metal including alloys:				
Scrap	1,141	402	—	France 383; West Germany 19.
Unwrought	3,533	9,771	2,019	France 3,708; West Germany 3,277.
Semimanufactures	718	1,130	388	Japan 723.
<b>Platinum-group metals:</b>				
Waste and sweepings	value, thousands	\$1,687	\$7,848	— United Kingdom \$7,841; Switzerland \$6.
Metals including alloys, unwrought and partly wrought:				
Palladium	kilograms	25,760	57,942	51,992 West Germany 2,847; Switzerland 1,529; Canada 782.
Platinum	do.	63,607	50,913	33,839 West Germany 8,633; Switzerland 5,720; France 2,659.
Rhodium	do.	4,386	6,165	5,494 West Germany 388; France 156.
Iridium, osmium, ruthenium	do.	2,603	3,772	2,903 West Germany 752; Switzerland 55.
Unspecified	value, thousands	\$184,238	\$280,673	\$78,609 Japan \$180,798; France \$21,239.
Silicon, high-purity		17,496	NA	
Silver: Metal including alloys, unwrought and partly wrought	value, thousands	\$11,987	\$131	\$44 France \$55; Hong Kong \$27.
<b>Tin:</b>				
Ore and concentrate		2,945	5,642	— Japan 5,629; Belgium-Luxembourg 13.
Ash and residue		—	41	— All to West Germany.
Metal including alloys:				
Scrap		5	—	
Unwrought		451	385	1 United Kingdom 271; Belgium-Luxembourg 43; West Germany 40.
Semimanufactures		3	—	
<b>Titanium:</b>				
Ore and concentrate		87,559	125,715	42,234 Belgium-Luxembourg 48,840; Netherlands 12,674; United Kingdom 9,007.
Oxides		252	40	— Canada 20; Colombia 20.
Metal including alloys:				
Scrap		3	—	
Semimanufactures		14	—	
<b>Tungsten:</b>				
Ore and concentrate		—	10	— All to Austria.
Metal including alloys:				
Scrap		25	—	
Unwrought		—	58	58
Unspecified		62	—	
<b>Uranium and thorium:</b>				
Ore and concentrate		1,773	798	— All to France.
Metal including alloys, all forms, uranium		NA	2,734	— France 2,483; West Germany 251.
<b>Vanadium:</b>				
Ore and concentrate		12,180	NA	
Oxides and hydroxides		2,485	5,873	916 Japan 3,768; Austria 733.
Ash and residue containing vanadium		20,906	18,890	— Austria 18,856; West Germany 34.

See footnotes at end of table.

TABLE 2—Continued  
**REPUBLIC OF SOUTH AFRICA: APPARENT EXPORTS OF MINERAL COMMODITIES<sup>1</sup>**  
(Metric tons unless otherwise specified)

	1989	1990	Destinations, 1990		
			United States	Other (principal)	
<b>METALS—Continued</b>					
<b>Vanadium—Continued:</b>					
Metal including alloys:					
Scrap	—	152	102	West Germany 50.	
Unspecified	17	(*)	—	All to Switzerland.	
<b>Zinc:</b>					
Ore and concentrate	18,314	9,323	—	All to Japan.	
Oxides	12	1	—	All to Chile.	
Ash and residue containing zinc	—	241	—	All to France.	
Metal including alloys:					
Scrap	64	—	—	—	
Unwrought	2,733	807	—	Hong Kong 507; Japan 300.	
Semimanufactures	1,062	4,165	4,085	Chile 60; United Kingdom 20.	
<b>Zirconium:</b>					
Ore and concentrate	120,998	57,263	15,928	Spain 21,000; Netherlands 17,329; Austria 1,393.	
Metal including alloys:					
Unwrought	107	148	—	United Kingdom 100; Spain 20; Chile 18.	
Semimanufactures	79	—	—	—	
<b>Other:</b>					
Ores and concentrates	6	1,347	—	Argentina 1,298; France 49.	
Oxides and hydroxides	25	1,260	1,141	United Kingdom 93; Argentina 25.	
Ashes and residues	102,408	268,841	268,531	West Germany 205; Argentina 42; Japan 35.	
Waste and scrap of precious metals					
value, thousands	—	\$20,202	\$6,496	West Germany \$13,706.	
Base metals including alloys, all forms	—	78	—	Hong Kong 65; Argentina 9.	
<b>INDUSTRIAL MINERALS</b>					
<b>Abrasives, n.e.s.:</b>					
Natural: Corundum, emery, pumice, etc.	38	73	—	West Germany 40; Spain 23; United Kingdom 10.	
Dust and powder of precious and semiprecious stones including diamond					
value, thousands	\$8	\$212	—	Argentina \$134; Sri Lanka \$39; West Germany \$25.	
Grinding and polishing wheels and stones	do.	\$8	—	France \$4; Sri Lanka \$2.	
Asbestos, crude	106,543	113,400	835	Japan 86,964; France 8,752; Thailand 7,745.	
Barite and witherite	—	118	—	All to France.	
Boron: Oxides and hydroxides	—	1	—	All to United Kingdom.	
Chalk	119	—	—	—	
<b>Clays, crude:</b>					
Bentonite	126	44	—	All to United Kingdom.	
Chamotte earth	8,558	3,141	—	Japan 3,123; West Germany 18.	
Fire clay	5,050	5,503	—	All to West Germany.	
Kaolin	20	159	—	Do.	
Unspecified	50,200	87	—	Argentina 45; West Germany 41.	
<b>Diamond, natural:</b>					
Gem, not set or strung	value, thousands	\$934,227	\$692,032	\$22,238	Switzerland \$446,412; Belgium-Luxembourg \$210,647.
Industrial stones	do.	\$41,170	\$7,047	—	West Germany \$4,886; Belgium-Luxembourg \$1,073; Japan \$712.
Dust and powder	do.	\$234	\$348	\$3	West Germany \$345.
Unsorted	do.	\$14,366	—	—	—

See footnotes at end of table.

TABLE 2—Continued  
**REPUBLIC OF SOUTH AFRICA: APPARENT EXPORTS OF MINERAL COMMODITIES<sup>1</sup>**  
(Metric tons unless otherwise specified)

	1989	1990	Destinations, 1990	
			United States	Other (principal)
<b>INDUSTRIAL MINERALS—Continued</b>				
<b>Feldspar, fluorspar, related materials:</b>				
Feldspar	1,568	60	—	All to West Germany.
Fluorspar	306,112	167,101	94,940	West Germany 71,750; France 351.
Unspecified	NA	36,117	—	All to Japan.
<b>Fertilizer materials:</b>				
Crude, n.e.s.	2,781	2,931	—	Belgium-Luxembourg 1,480; France 1,084; West Germany 346.
<b>Manufactured:</b>				
Nitrogenous	116	5,283	—	West Germany 5,241; New Zealand 42.
Phosphatic	—	171	—	Uruguay 146; France 25.
Unspecified and mixed	52,754	12,505	17	France 7,005; Japan 4,300; West Germany 1,003.
Graphite, natural	513	1,887	100	United Kingdom 1,768; West Germany 19.
Kyanite and related materials	128,463	128,987	17,354	West Germany 45,101; Japan 27,129; United Kingdom 21,144.
Lime	—	18	—	All to Belgium-Luxembourg.
<b>Magnesium compounds:</b>				
Magnesite, crude	NA	3,002	—	All to Venezuela.
Oxides and hydroxides	3,211	3,578	—	Canada 2,000; France 1,169; United Kingdom 250.
<b>Mica:</b>				
Crude including splittings and waste	838	225	—	Japan 136; West Germany 89.
Worked including agglomerated splittings	( <sup>1</sup> )	708	—	All to United Kingdom.
Phosphates crude thousand tons	1,435	958	—	Belgium-Luxembourg 444; Japan 249; West Germany 136.
Phosphorus, elemental	174	2,484	17	Japan 2,434.
<b>Pigments, mineral:</b>				
Natural crude	699	NA	—	All to West Germany.
Iron oxides and hydroxides, processed	41	40	—	All to West Germany.
<b>Precious and semiprecious stones other than diamond:</b>				
Natural value, thousands	\$4,619	\$10,960	\$1,352	Spain \$6,762; West Germany \$1,716; Hong Kong \$989.
Synthetic do.	\$889	\$14	\$6	West Germany \$5; Canada \$2.
Pyrite, unroasted	6	—	—	—
Salt and brine	3,799	NA	—	—
<b>Sodium compounds, n.e.s.:</b>				
Soda ash, manufactured value, thousands	NA	\$278	—	All to Sri Lanka.
Sulfate, manufactured	NA	755	—	All to United Kingdom.
<b>Stone, sand and gravel:</b>				
<b>Dimension stone:</b>				
Crude and partly worked	568,480	336,941	( <sup>2</sup> )	Japan 102,880; France 52,394; West Germany 51,378.
Worked	6,246	4,602	( <sup>2</sup> )	United Kingdom 1,518; West Germany 1,135; Japan 1,079.
Dolomite, chiefly refractory-grade value, thousands	—	\$1	—	All to New Zealand.
Gravel and crushed rock	37	—	—	—
Quartz and quartzite	3,418	895	669	Netherlands 186; Japan 18.
Sand other than metal-bearing	NA	3,412	700	France 1,855; Ireland 400.
Sand and gravel	26,282	NA	—	—
Talc, steatite, soapstone, pyrophyllite	588	679	1	West Germany 643; France 35.
Vermiculite, perlite, chlorite	161,160	153,276	31,623	United Kingdom 40,607; France 24,535; Japan 19,669.

See footnotes at end of table.

TABLE 2—Continued  
**REPUBLIC OF SOUTH AFRICA: APPARENT EXPORTS OF MINERAL COMMODITIES<sup>1</sup>**  
(Metric tons unless otherwise specified)

	1989	1990	Destinations, 1990	
			United States	Other (principal)
<b>INDUSTRIAL MINERALS—Continued</b>				
Other:				
Crude	48,758	9,698	—	Netherlands 4,619; West Germany 2,975; Spain 1,029.
Slag and dross, not metal-bearing	107,883	210,394	4,454	Japan 105,612; West Germany 62,389; United Kingdom 37,839.
<b>MINERAL FUELS AND RELATED MATERIALS</b>				
Asphalt and bitumen, natural	66	4,764	—	Spain 4,746; Trinidad and Tobago 18.
Carbon black	—	*45	—	Hong Kong 18; Argentina 14; United Kingdom 7.
Coal:				
Anthracite	thousand tons	31,402	1,378	— France 703; Netherlands 226; Japan 203.
Bituminous	do.	24,646	22,898	— Japan 4,837; Spain 4,654; West Germany 4,479.
Briquets of anthracite and bituminous coal		1,157	3,792	— United Kingdom 3,024; Switzerland 551; Ireland 174.
Lignite including briquets		NA	79,744	— Turkey 77,823; United Kingdom 1,921.
Unspecified	thousand tons	3,114	( <sup>2</sup> )	— All to Ireland.
Coke and semicoke		59,724	43,586	— Japan 38,553; Belgium-Luxembourg 5,033.
Petroleum:				
Crude	thousand 42-gallon barrels	632	NA	
Refinery products:				
Liquefied petroleum gas	42-gallon barrels	214,600	NA	
Gasoline	do.	12,657	18	— West Germany 9; United Kingdom 9.
Mineral jelly and wax	do.	195,158	212,363	9,436 West Germany 122,536; Japan 32,731; United Kingdom 20,903.
Kerosene and jet fuel	do.	99,115	84,755	35,000 Spain 49,755.
Distillate fuel oil	do.	27,259	59,262	— Spain 58,859; West Germany 351; United Kingdom 52.
Lubricants	do.	4,755	483	4 Hong Kong 245; Japan 213.
Residual fuel oil	do.	738,334	36,831	— Spain 36,630; Japan 201.
Bitumen and other residues	value, thousands	—	\$15	— All to Sri Lanka.
Petroleum coke	42-gallon barrels	6,402	—	

NA Not available.

<sup>1</sup>This table should not be taken as a complete representation of this country's mineral exports. These data have been compiled from United Nations information and data available from trading partner countries. Data presented are exports by the common customs area of Botswana, Lesotho, the Republic of South Africa, and Swaziland. Table prepared by Virginia A. Woodson.

<sup>2</sup>Unreported quantity valued at \$29,000.

<sup>3</sup>Unreported quantity valued at \$9,000.

<sup>4</sup>Unreported quantity valued at \$686,000.

<sup>5</sup>Less than 1/2 unit.

<sup>6</sup>Unreported quantity valued at \$3,150,000.

<sup>7</sup>Unreported quantity valued at \$1,630,000.

<sup>8</sup>Excludes unreported quantity valued at \$473,000 imported by Sri Lanka.

TABLE 3  
**REPUBLIC OF SOUTH AFRICA: APPARENT IMPORTS OF MINERAL COMMODITIES<sup>1</sup>**  
(Metric tons unless otherwise specified)

Commodity	1989	1990	Sources, 1990	
			United States	Other (principal)
<b>METALS</b>				
Alkali and alkaline-earth metals	—	15	6	Brazil 9.
<b>Aluminum:</b>				
Ore and concentrate	357	5	5	
Oxides and hydroxides	13,511	9,320	221	Netherlands 4,020; Japan 2,908; West Germany 1,650.
<b>Metal including alloys:</b>				
Scrap	853	1,504	967	Netherlands 537.
Unwrought	1	101	4	Netherlands 53; West Germany 42.
Semimanufactures	2,362	7,442	249	West Germany 1,775; Japan 1,721; Australia 1,652.
<b>Antimony:</b>				
Ore and concentrate	NA	5,351	—	All from Netherlands.
Oxides	—	27	—	All from West Germany.
<b>Beryllium: Metal including alloys, all forms</b>				
value, thousands	\$4	—	—	
<b>Bismuth: Metal including alloys, all forms</b>				
value, thousands	5	2	—	All from United Kingdom.
<b>Cadmium: Metal including alloys, all forms</b>				
value, thousands	\$3	—	—	
<b>Chromium:</b>				
Oxides and hydroxides	59	233	109	Hong Kong 68; Belgium-Luxembourg 56.
Metal including alloys, all forms	49	37	(?)	United Kingdom 35; West Germany 2.
Cobalt: Metal including alloys, all forms	71	85	1	United Kingdom 80; France 3.
<b>Columbium and tantalum: Metal including alloys, all forms:</b>				
Columbium (niobium)	5	2	2	
Tantalum	—	1	1	
<b>Copper:</b>				
Ore and concentrate	600	13,373	—	All from Turkey.
Oxides and hydroxides	119	147	100	West Germany 47.
Sulfate	1	3	—	All from West Germany.
Ash and residue containing copper	2,039	3,338	—	All from Canada.
<b>Metal including alloys:</b>				
Scrap	136	325	324	West Germany 1.
Unwrought	5	125	2	Belgium-Luxembourg 90; United Kingdom 33.
Semimanufactures	679	2,990	156	West Germany 1,876; Japan 281; Belgium-Luxembourg 174.
<b>Germanium: Metal including alloys, all forms</b>				
value thousands	\$1	—	—	
<b>Gold: Metal including alloys, unwrought and partly wrought</b>				
kilograms	182	NA	—	
<b>Iron and steel:</b>				
Iron ore and concentrate excluding roasted pyrite	30	—	—	
Pyrite, roasted	2	—	—	
<b>Metal:</b>				
Scrap	203	95	—	All from Hong Kong.
Pig iron, cast iron, related materials	18,505	262	—	United Kingdom 244; Belgium-Luxembourg 18.

See footnotes at end of table.

TABLE 3—Continued  
**REPUBLIC OF SOUTH AFRICA: APPARENT IMPORTS OF MINERAL COMMODITIES<sup>1</sup>**  
(Metric tons unless otherwise specified)

Commodity	1989	1990	Sources, 1990	
			United States	Other (principal)
<b>METALS—Continued</b>				
<b>Iron and steel—Continued:</b>				
<b>Metal—Continued:</b>				
<b>Ferroalloys:</b>				
Ferrochromium	34	56	—	West Germany 46; Japan 10.
Ferromanganese	617	101	—	Hong Kong 100; United Kingdom 1.
Ferromolybdenum	125	—		
Ferronickel	40	—		
Ferrosilicochromium	70	—		
Ferrosilicomanganese	5	—		
Ferrosilicon	362	1,447	403	Brazil 806; Hong Kong 98; France 67.
Silicon metal	310	603	333	Brazil 270.
Unspecified	1,911	1,989	387	Brazil 701; United Kingdom 378.
Steel, primary forms	1,844	15,109	17	Turkey 14,104; West Germany 541; Australia 375.
<b>Semimanufactures:</b>				
<b>Flat-rolled products:</b>				
<b>Of iron or nonalloy steel:</b>				
Not clad, plated, coated	16,155	13,045	4	West Germany 11,021; United Kingdom 982; Japan 928.
Clad, plated, coated	85,065	50,054	11,474	West Germany 15,209; Japan 9,704; Brazil 8,793.
Of alloy steel	9,353	21,853	62	Japan 11,610; West Germany 4,469; Austria 1,867.
Bars, rods, angles, shapes, sections	15,989	15,038	1,764	United Kingdom 4,291; Japan 2,012; West Germany 1,900.
Rails and accessories	3,778	1,214	—	United Kingdom 973; West Germany 38.
Wire	9,080	9,295	18	United Kingdom 2,503; Hong Kong 1,679; Brazil 1,436.
Tubes, pipes, fittings	74,528	86,265	430	Japan 18,758; West Germany 15,403; United Kingdom 6,393.
<b>Lead:</b>				
Ore and concentrate	—	7	—	Brazil 6; United Kingdom 1.
Oxides	18	132	—	Hong Kong 100; West Germany 21; Netherlands 5.
<b>Metal including alloys:</b>				
Scrap	NA	2,049	1,536	Canada 495; West Germany 18.
Unwrought	9	180	—	All from United Kingdom.
Semimanufactures	3	22	3	West Germany 10; United Kingdom 8.
Lithium: Oxides and hydroxides	54	122	94	West Germany 28.
<b>Magnesium: Metal including alloys:</b>				
Unwrought	120	165	140	Canada 17; United Kingdom 8.
Semimanufactures	58	59	43	Switzerland 10; West Germany 6.
<b>Manganese:</b>				
Ore and concentrate: Metallurgical-grade	7,597	8,223	—	Netherlands 8,212; France 11.
Oxides	7	1,128	34	Japan 1,051; Hong Kong 43.
Metal including alloys, all forms	11	4	—	West Germany 2; United Kingdom 2.
Mercury	150	30	—	All from United Kingdom.
<b>Molybdenum:</b>				
Ore and concentrate	18	94	—	Belgium-Luxembourg 52; Netherlands 42.
Oxides	value, thousands	\$2	—	

See footnotes at end of table.

TABLE 3—Continued  
**REPUBLIC OF SOUTH AFRICA: APPARENT IMPORTS OF MINERAL COMMODITIES<sup>1</sup>**  
(Metric tons unless otherwise specified)

Commodity	1989	1990	Sources, 1990	
			United States	Other (principal)
<b>METALS—Continued</b>				
<b>Molybdenum—Continued:</b>				
Metal including alloys:				
Unwrought kilograms	—	176	176	
Semimanufactures	—	24	3	Switzerland 12; Austria 8.
Unspecified	9	—		
<b>Nickel:</b>				
Oxides	1	—		
Metal including alloys:				
Unwrought	21	5	3	United Kingdom 1.
Semimanufactures	108	771	606	West Germany 76; United Kingdom 41; France 28.
<b>Platinum-group metals:</b>				
Waste and sweepings value, thousands	\$3	—		
Metals including alloys, unwrought and partly wrought:				
Palladium kilograms	161	188	—	All from West Germany.
Platinum do.	( <sup>2</sup> )	332	—	Do.
Rhodium do.	—	17	8	Do.
Iridium, osmium, ruthenium do.	—	12	12	
Unspecified value, thousands	\$94	NA		
Selenium, elemental	8	—		
<b>Silver:</b>				
Ore and concentrate value, thousands	\$2	—		
Waste and sweepings do.	\$201	NA		
Metal including alloys, unwrought and partly wrought kilograms	9,811	13,186	—	All from West Germany.
<b>Tin:</b>				
Oxides	10	—		
Metal including alloys:				
Unwrought	26	9	—	United Kingdom 8; Switzerland 1.
Semimanufactures	41	5	( <sup>2</sup> )	United Kingdom 3; West Germany 2.
Unspecified	2	—		
<b>Titanium:</b>				
Oxides	42	122	18	West Germany 71; Hong Kong 17; Japan 16.
Metal including alloys:				
Scrap	—	14	—	All from West Germany.
Unwrought	—	9	9	
Semimanufactures	—	35	26	United Kingdom 9.
Unspecified	12	2	—	All from Japan.
<b>Tungsten:</b>				
Ore and concentrate value, thousands	\$30	—		
Metal including alloys:				
Unwrought	—	7	3	Austria 2; United Kingdom 2.
Semimanufactures	—	19	—	West Germany 10; France 7; Austria 2.
Unspecified kilograms	44,000	28	—	All from Japan.
Uranium and thorium: Metal including alloys, all forms value, thousands	\$2	—		

See footnotes at end of table.



TABLE 3—Continued  
**REPUBLIC OF SOUTH AFRICA: APPARENT IMPORTS OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

Commodity	1989	1990	Sources, 1990	
			United States	Other (principal)
<b>METALS—Continued</b>				
Vanadium: Ash and residue	—	126	—	All from West Germany.
Zinc:				
Oxides	5	179	11	Hong Kong 126; United Kingdom 41.
Ash and residue containing zinc	1,056	539	181	West Germany 358.
Metal including alloys:				
Scrap	123	—	—	—
Unwrought	242	682	—	United Kingdom 391; Netherlands 220; West Germany 71.
Semimanufactures	9	20	10	United Kingdom 9.
Zirconium:				
Ore and concentrate	NA	3,876	—	Netherlands 2,233; Spain 1,164; West Germany 477.
Metal including alloys:				
Scrap	—	1	1	—
Semimanufactures	( <sup>2</sup> )	1	—	All from Belgium-Luxembourg.
Other:				
Oxides and hydroxides	14	6	6	—
Ashes and residues	207	93	—	United Kingdom 39; Australia 33; Brazil 21.
Base metals including alloys, all forms	—	234	—	All from Hong Kong.
<b>INDUSTRIAL MINERALS</b>				
Abrasives, n.e.s.:				
Natural: Corundum, emery, pumice, etc.	1,110	1,574	313	Turkey 666; Greece 483; Hong Kong 64.
Artificial:				
Corundum	2,552	2,955	49	West Germany 1,730; Brazil 610; Netherlands 260.
Silicon carbide	869	637	119	Argentina 448; Belgium-Luxembourg 70.
Dust and powder of precious and semiprecious stones including diamond value, thousands	\$523	\$379	\$30	West Germany \$349.
Grinding and polishing wheels and stones	441	425	( <sup>2</sup> )	West Germany 128; Hong Kong 112; Austria 47.
Asbestos, crude	96	125	96	West Germany 29.
Barite and witherite	511	1,207	208	Hong Kong 795; West Germany 164.
Boron materials:				
Crude natural borates	987	1,228	908	Netherlands 320.
Elemental value, thousands	—	\$6	—	All from West Germany.
Oxides and acids	235	391	47	Chile 205; Argentina 118.
Bromine value, thousands	—	\$4	—	All from West Germany.
Cement	24,089	56,143	1,938	Turkey 26,025; France 14,672; Belgium-Luxembourg 6,483.
Chalk	611,735	12,578	( <sup>2</sup> )	France 10,812; West Germany 1,762.
Clays, crude:				
Bentonite	2,834	666	650	Netherlands 16.
Fire clay	52	45	—	All from West Germany.
Kaolin	31,912	16,521	16,407	West Germany 61; Belgium-Luxembourg 30.
Unspecified	6,933	1,429	1,328	West Germany 101.
Cryolite and chiolite	330	—	—	—
Diamond, natural:				
Gem, not set or strung value, thousands	\$52,154	\$3,475	\$602	Hong Kong \$1,476; Switzerland \$1,245.

See footnotes at end of table.

TABLE 3—Continued  
**REPUBLIC OF SOUTH AFRICA: APPARENT IMPORTS OF MINERAL COMMODITIES<sup>1</sup>**  
(Metric tons unless otherwise specified)

Commodity	1989	1990	Sources, 1990		
			United States	Other (principal)	
<b>INDUSTRIAL MINERALS—Continued</b>					
<b>Diamond, natural—Continued:</b>					
Industrial stones	value, thousand	\$1,272	\$14	—	All from Switzerland.
Unsorted	do.	\$6,806	\$434	\$434	
Dust and powder	do.	\$625	NA		
Diatomite and other infusorial earth		5,066	4,552	4,505	Belgium-Luxembourg 30; Turkey 14.
Feldspar, fluorspar, related materials		—	19	—	Canada 18; Switzerland 1.
<b>Fertilizer materials:</b>					
Crude, n.e.s.		2	—		
<b>Manufactured:</b>					
Ammonia		—	30	28	Belgium-Luxembourg 1; West Germany 1.
Nitrogenous		80,743	11,974	—	Belgium-Luxembourg 11,893; West Germany 40.
Potassic		50,410	92,993	—	Canada 53,451; West Germany 33,392; France 6,150.
Unspecified and mixed		842	381	—	Belgium-Luxembourg 188; United Kingdom 145.
Graphite, natural		88	552	164	Brazil 357; West Germany 31.
Gypsum and plaster		20,304	22,709	172	Spain 15,742; West Germany 6,775.
Iodine		3	2	—	Japan 1; West Germany 1.
Kyanite and related materials		NA	4,913	—	United Kingdom 4,872; West Germany 41.
Lime		7,888	4,315	—	France 3,300; Japan 900; United Kingdom 60.
<b>Magnesium compounds:</b>					
Magnesite, crude		5	669	—	Hong Kong 600; West Germany 69.
Oxides and hydroxides		21,523	8,590	—	Austria 6,618; Japan 1,051; Netherlands 508.
Other		118	—		
<b>Mica:</b>					
Crude including splittings and waste		( <sup>c</sup> )	11	—	France 6; Switzerland 5.
Worked including agglomerated splittings		31	72	3	Brazil 36; United Kingdom 17; Austria 16.
Nitrates, crude		7,320	13,549	—	Chile 12,450; West Germany 1,099.
Phosphates, crude		42	33	—	All from United Kingdom.
<b>Pigments, mineral:</b>					
Natural, crude		12	331	—	All from Spain.
Iron oxides and hydroxides, processed		1,419	6,189	1,710	West Germany 4,172; Hong Kong 260.
<b>Precious and semiprecious stones other than diamond:</b>					
Natural	value, thousands	\$1,042	\$1,152	\$63	Switzerland \$701; West Germany \$151; Colombia \$108.
Synthetic	do.	\$80	\$37	—	Japan \$23; Austria \$14.
Quartz crystal, piezoelectric	kilograms	( <sup>c</sup> )	119	11	Japan 95; Switzerland 13.
Salt and brine		77,351	24,559	—	France 23,767; West Germany 792.
<b>Sodium compounds, n.e.s.:</b>					
Soda ash, manufactured		197,233	170,373	170,370	West Germany 3.
Sulfate, manufactured		11,653	1,734	—	West Germany 1,029; Hong Kong 705.
<b>Stone, sand and gravel:</b>					
<b>Dimension stone:</b>					
Crude and partly worked		1,269	367	—	Brazil 313; Turkey 30; Greece 22.
Worked		( <sup>c</sup> )	112	( <sup>c</sup> )	Greece 75; France 16; Belgium-Luxembourg 14.
Dolomite, chiefly refractory-grade		1,068	573	—	All from West Germany.
Gravel and crushed rock		1,183	1,413	1,188	France 219.

See footnotes at end of table.

TABLE 3—Continued  
REPUBLIC OF SOUTH AFRICA: APPARENT IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1989	1990	Sources, 1990	
			United States	Other (principal)
<b>INDUSTRIAL MINERALS—Continued</b>				
<b>Stone, sand and gravel—Continued:</b>				
Limestone other than dimension	—	324	—	Hong Kong 321; Japan 3.
Quartz and quartzite	23	252	—	West Germany 188; Brazil 64.
Sand other than metal-bearing	502	193	3	Belgium-Luxembourg 123; Canada 36; Netherlands 18.
<b>Sulfur:</b>				
<b>Elemental:</b>				
Crude including native and byproduct	308,320	225,856	411	Canada 225,200; West Germany 245.
Colloidal, precipitated, sublimed	33	2	—	All from United Kingdom.
Dioxide	4	—	—	—
Sulfuric acid	147	52	—	All from Netherlands.
Talc, steatite, soapstone, pyrophyllite	3,252	2,944	143	Belgium-Luxembourg 1,692; France 662; Austria 225.
Vermiculite	10,060	4,000	—	All from Greece.
<b>Other:</b>				
Crude	1,045	15,784	—	Turkey 15,050; West Germany 517; Hong Kong 140.
Slag and dross, not metal-bearing	54	52	17	France 35.
<b>MINERAL FUELS AND RELATED MATERIALS</b>				
Asphalt and bitumen, natural	262	516	361	Trinidad and Tobago 139; Argentina 16.
Carbon black	1,431	4,488	249	Argentina 3,096; Netherlands 634; West Germany 256.
Coal: Anthracite	1,248	50,037	50,037	—
Coke and semicoke	4,181	NA	—	—
Peat including briquets and litter	642	2,873	—	Canada 2,300; West Germany 538; Netherlands 35.
<b>Petroleum:</b>				
Crude	42-gallon barrels	67	—	—
<b>Refinery products:</b>				
Liquefied petroleum gas	do.	( <sup>2</sup> )	396	—
Gasoline	do.	132,176	8,753	245
Mineral jelly and wax	do.	215,606	269,986	424
Kerosene and jet fuel	do.	12,990	1,041	1,003
Distillate fuel oil	do.	64,298	6,854	20
Lubricants	do.	280,329	44,876	1,098
Residual fuel oil	do.	NA	160,866	—
Bitumen and other residues	do.	NA	9,369	145
Bituminous mixtures	do.	44,517	2,280	873
Petroleum coke	do.	362,417	564,778	562,138

NA Not available.

<sup>1</sup>This table should not be taken as a complete representation of this country's mineral imports. These data have been compiled from United Nations information and data available from trading partner countries. Data presented are imports by the common customs area of Botswana, Lesotho, the Republic of South Africa, and Swaziland. Table prepared by Virginia A. Woodson.

<sup>2</sup>Less than 1/2 unit.

<sup>3</sup>Unreported quantity valued at \$706,000.

<sup>4</sup>Unreported quantity valued at \$246,000.

<sup>5</sup>Excludes unreported value of 795 carats exported by Canada.

<sup>6</sup>Unreported quantity valued at \$115,000.

<sup>7</sup>Unreported quantity valued at \$26,000.

TABLE 4  
REPUBLIC OF SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity ownership <sup>1</sup>	Location of main facilities	Annual capacity
Aluminum	Aluminium South Africa (Pty.) Ltd. (Alusaf) (Gencor, 40.5%; IDC, 38%; Alusuisse-Lonzo Holding, Ltd., 15.3%)	Alusaf aluminum smelter at Richards Bay	170.
Andalusite	Rhino Andalusite Mines (Pty.) Ltd. (Anglovaal Ltd., 77%)	Timeball Mine, near Thabazimbi	120.
Do.	Damrec of France (private, 100%)	Annesley Mine at Penge, 50 kilometers north of Steelpoort	75.
Do.	do.	Andafrax Mine at Groot Marico, 60 kilometers west of Rustenburg	12.
Do.	Cullinan Minerals Ltd. (South African Mutual Life Insurance, Insurance, 44%; Fermain Nom Ltd., 8%; AAC)	Krugerspost Mine, near Lydenburg	50.
Do.	Verref Mining (Pty.) Ltd. (AAC)	Havercroft Mine at Penge, 50 kilometers north of Steelpoort	36.
Do.	Hoogenoeg Andalusite (Pty.) Ltd.	Hoogenoeg Mine, 60 kilometers northeast of Potgietersrus	15.
Antimony	Consolidated Murchison Ltd. (JCI, 24.1%; Middle Witwatersrand, 5.5%; Anglovaal Ltd., 2.4%)	50 kilometers west of Phalaborwa	9.5 Sb concentrate.
Asbestos	Gencor Ltd. (Gencor Beherend Bpk, 54.8%; AAC, 0.9%)	Penge Mine, 50 kilometers north of Steelpoort	48 amosite.
Do.	do.	Klipfontein Mine near Sishen	NA crocidolite.
Do.	Anglo Dutch Exploration & Mining Co. (Pty.) Ltd.	Stella Mine, 25 kilometers east of Barberton	NA chrysotile.
Chromite	Samancor Ltd. (Gencor, 41%; Delauney Ltd., 24.9%; De Beers, 8.7%; Genbel Investments Corp. Ltd., 1.6%; ASA Ltd., 0.3%)	Winterveld Mine at Steelpoort	1,000 ore.
Do.	do.	Henry Gould, 30 kilometers east of Rustenburg	640 ore.
Do.	do.	Mooinooi Mine, 30 kilometers west of Brits	456 ore.
Do.	do.	Millsell Mine, 8 kilometers east of Rustenburg	90 ore.
Do.	do.	Grasvalley Mine, near Potgietersrus	1,000 ore.*
Do.	Consolidated Metallurgical Industries (Pty.) Ltd. (JCI, 49.9%; AAC, 26.4%)	Purity Mine, near Rustenburg	360 ore; 252 concentrate.
Do.	Lavino South Africa (Pty.) Ltd. (Anglovaal Ltd., 51%; Middle Witwatersrand, 49%)	Grootboom Mine, near Lydenburg	500 ore.
Do.	Dilokong Chrome Mine (Pty.) Ltd. (Mining Corp. Ltd., 100%)	Dilokong Mine, near Lydenburg	480 ore.
Do.	Chromecorp Technology (Pty.) Ltd. (CI Chromeinvest AG, Germany, 50%; Investinox AG, Germany, 50%)	Chroombonne Mine near Rustenburg	576 ore; 432 concentrate.
Coal	Anglo American Coal Corp. Ltd. (AAC, 51.4%; ASA Ltd., 2.2%)	13 collieries in eastern Transvaal and Natal	46,000 anthracite and bituminous.
Do.	Trans-Natal Coal Corp. Ltd. (Gencor, 44%; Genbel Investments Corp. Ltd., 10.8%)	12 collieries in eastern Transvaal and Natal	40,000 anthracite and bituminous.
Do.	Duvha Opencast Services (Pty.) Ltd. (Rand Mines Ltd., 71%)	Duvha Colliery, 18 kilometers southeast of Witbank	11,000 bituminous.
Do.	Rietspruit Opencast Services (Pty.) Ltd. (Rand Mines Ltd., 50%; Shell S A, 50%)	Rietspruit Colliery, 30 kilometers southeast of Witbank	9,000 bituminous.
Do.	Sasol Mining (Pty.) Ltd.	Sigma Mine, 75 Kilometers south of Johannesburg	7,000 bituminous.
Do.	Sasol Mining (Pty.) Ltd.	Secunda Collieries, 75 kilometers south of Witbank	31,000 bituminous.
Do.	Incor Ltd. (De Beers, 3.4%; AAC, 0.7%)	Grootegeeluk Mine, 120 kilometers north of Thabazimbi	6,300 bituminous; 1,700 coking coal.

See footnotes at end of table.

TABLE 4—Continued  
**REPUBLIC OF SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992**

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity ownership <sup>1</sup>	Location of main facilities	Annual capacity
Coal—Continued:	Incor Ltd. (De Beers, 3.4%; AAC, 0.7%)	Durnacol Mine at Dannhauser, 40 kilometers south of Newcastle	1,200 coking coal.
Do.	Iscor Ltd. (De Beers, 3.4%; AAC, 0.7%)	Hlobane Mine, 100 kilometers east of Newcastle	700 coking coal.
Do.	do.	Tshikondeni Mine in Venda, about 100 kilometers southeast of Messina	200 coking coal.
Copper	Palabora Mining Co. Ltd. (Rio Tinto Zinc Corp. plc, 38.9%; AAC, 19.1%; De Beers, 9.5%; Middle Witwatersrand, 0.4%)	Palabora Mine and plant at Phalaborwa	130 metal.
Do.	O'Okiep Copper Co. Ltd. (GFSa, 82%; Mellon Securities Trust Co., 18%)	O'Okiep copper mine, 20 kilometers north of Okiep	40.
Do.	Black Mountain Mineral Development Company (Pty.) Ltd. (GFSa, 55.4%; Phelps Dodge Corp., U.S.A., 44.6%)	Black Mountain Mine, 100 kilometers northwest of Okiep	2.5 Cu in concentrate.
Diamond	De Beers (Anglo American Investment Trust Ltd., 25.8%; AAC, 6.9%; ASA Ltd., 0.3%)	Finsch Mine, 100 kilometers west of Kimberley	4.6.
Do.	do.	Kimberley Mines, Kimberley	.8.
Do.	do.	Koffiefontein Mine, 70 kilometers south of Kimberley	.2.
Do.	do.	Namaqualand Mines, 50 kilometers north of Port Nolloth	1.0.
Do.	do.	Premier Mine, 70 kilometers east of Pretoria	2.3.
Do.	do.	Venetia Mine, 150 kilometers north of Potgietersrus	.3.
Fluorspar	Transvaal Mining and Finance Co. Ltd. (Gencor, 100%)	Buffalo Mine, 110 kilometers northeast of Pretoria	200 acid-grade fluorspar.*
Do.	Vergenoeg Mining Corp. (Pty.) Ltd. (Bayer AG, Germany, 100%)	Vergenoeg Mine, 90 kilometers east of Pretoria	200 acid- and metallurgical-grade fluorspar.*
Do.	Phelps Dodge Mining (Pty.) Ltd. (Phelps Dodge Corp., U.S., 100%)	Witkop Mine, 130 kilometers west of Johannesburg	75 acid-grade fluorspar.*
Do.	Van Den Heever Vloeispaat Werke	Van Den Heever Mine, 120 kilometers west of Johannesburg	50.*
Gold	tons AAC (De Beers, 38.7%; ASA Ltd., 0.1%)	Freegold near Welkom, Vaal Reefs near Klerksdorp, Western Deep Levels, 70 kilometers southwest of Johannesburg	260 Au.
Do.	GFSa (GFSa Holdings Ltd., 43%; Anglo American Gold Investment Co., 10.8%; AAC, AAC, 8.9%; De Beers, 1.3%)	East Driefontein and West Driefontein, 65 kilometers southwest of Johannesburg; Kloof, 55 kilometers southwest of Johannesburg; and others	125 Au.
Do.	Gencor (Gencor Beherend Bpk, 54.8%; AAC, 0.9%)	Buffelsfontein near Klerksdorp; Beatrix, 35 kilometers southeast of Welkom, Winkelhaak, 120 kilometers southeast	90 Au.
Do.	Rand Mines Ltd. (Barlow Rand Ltd., 74%)	Harmony Mine, 20 kilometers southeast of Welkom and others	55 Au.
Do.	Anglovaal Ltd. (Anglovaal Holdings Ltd., 49.7%; South African Mutual Life Insurance, 10.7%; Middle Witwatersrand, 2.9%; De Beers, 2.8%)	Hartebeestfontein Mine near Klerksdorp and others	45 Au.
Do.	JCI (AAC, 39.8%; South African Mutual Life Insurance, 8.9%; De Beers, 8.4%)	Randfontein Mine, 20 kilometers west of kilometers southwest of Johannesburg; and others	41 Au.

See footnotes at end of table.

TABLE 4—Continued  
**REPUBLIC OF SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992**

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity ownership <sup>1</sup>	Location of main facilities	Annual capacity
<b>Iron and steel:</b>			
Iron ore	Iscor Ltd. (De Beers, 3.4%; AAC, 0.7%)	Sishen Mine at Sishen	21,500 ore.
Do.	do.	Thabazimbi Mine at Thabazimbi	2,500 ore.
Do.	Highveld Steel and Vanadium Corp. Ltd. (Anglo American Industrial Corp. Ltd., 51.8%; De Beers, 3.8%)	Mapochs Mine at Roossenekal, 60 kilometers west of Lydenburg	3,000 titaniferous magnetite ore.
Ferroalloys	Ferrometals Ltd. (Samancor Ltd., 100%)	Witbank	320 ferrochromium.
Do.	Tubatse Ferrochrome (Pty.) Ltd. (Samancor Ltd., 100%)	Steelpoort	300 ferrochromium.
Do.	Bathako Ferrochrome (Pty) Ltd. (Samancor Ltd., 100%)	Ruighoek Mine site, 80 kilometers southwest of Thabazimbi	20 ferrochromium.
Do.	Samancor Ltd. (Gencor, 41%; Delauney Ltd., 24.9%; De Beers, 8.7%; Genbel Investments Corp. Ltd., 1.6%; ASA Ltd., 0.3%)	Middelburg	300 ferrochromium.
Do.	do.	Krugersdorp, 30 kilometers west of Johannesburg	120 ferrochromium.
Do.	Consolidated Metallurgical Industries (Pty.) Ltd. (JCI, 49.9%; AAC, 26.4%)	Lydenburg	210 ferrochromium.
Do.	do.	Purity in Rustenburg	120 ferrochromium.
Do.	Chromecorp Technology (Pty.) Ltd. (CI Chromeinvest AG, Germany, 50%; Investinox AG, Germany, 50%)	Rustenburg	180 ferrochromium.
Do.	Feralloys Ltd. (Associated Manganese Mines of South Africa Ltd., 100%)	Machadodorp, 80 kilometers east of Middelburg	110 ferrochromium.
Do.	do.	Cato Ridge, 75 kilometers west of Durban	130 high-carbon ferromanganese.
Do.	Samancor Ltd. (Gencor, 41%; Delauney Ltd., 24.9%; De Beers, 8.7%; Genbel Investments Corp. Ltd., 1.6%; ASA Ltd., 0.3%)	Meyerton plant, 50 kilometers south of Johannesburg	240 high-carbon ferromanganese; 200 silicomanganese.
Do.	Transvaal Alloys Pty. Ltd., (Highveld Steel and Vanadium Corp., 100%)	Witbank	20 low-carbon ferromanganese; 175 silicomanganese.
Steel	Iscor Ltd. (De Beers, 3.4%; AAC, 0.7%)	Vanderbijlpark plant, 70 kilometers southwest of Johannesburg	4,300.
Do.	do.	Newcastle plant	2,000.
Do.	do.	Pretoria plant	800.
Do.	do.	Cisco plant near Cape Town	150.
Do.	do.	Corex plant in Pretoria	300.
Do.	do.	Ex-Usko plant in Vereeniging, 60 kilometers south of Johannesburg	450.*
Do.	Highveld Steel and Vanadium Corp. Ltd. (Anglo American Industrial Corp. Ltd., 51.8%; De Beers, 3.8%)	Witbank	1,000.
Do.	Columbus Stainless, Ltd. (AAC and De Beers, 33.3%; Gencor, 33.3%; IDC, 33.3%)	Middelburg stainless steel plant	120 stainless steel.*
Manganese	Associated Manganese Mines of South Africa Ltd. (Associated Ore and Metal Corp. Ltd., 45%; Anglovaal Ltd., 44%; Middle Witwatersrand, 6.9%)	Blackrock, Gloria, N'Chwaning Mines near Hotazel, 70 kilometers north of Sishen	1,500 ore.
Do.	Samancor Ltd. (Gencor, 41%; Delauney Ltd., 24.9%; De Beers, 8.7%; Genbel Investments Corp. Ltd., 1.6%; ASA Ltd., 0.3%)	Mamatwan and Wessels Mines near Hotazel, 70 kilometers north of Sishen	3,000 ore.

See footnotes at end of chapter.

TABLE 4—Continued  
**REPUBLIC OF SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992**

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity ownership <sup>1</sup>	Location of main facilities	Annual capacity
Petroleum products million 42-gallon barrels	Shell and British Petroleum South Africa Petroleum Refineries PL (Shell South Africa, 50%; British Petroleum Co., 50%)	Refinery in Durban	73 crude.
Do.	Caltex Oil SA PL (Private, 100%)	Refinery in Cape Town	33 crude.
Do.	National Petroleum Refiners of South Africa PL (Sasol, 100%)	Refinery in Secunda, 100 kilometers southeast of Johannesburg	28 crude.
Do.	Genref (Engen Ltd., 62%)	Refinery in Durban	24 crude.
Phosphate	Phosphate Development Corp. Ltd. (Foskor Ltd.) (IDC, 100%)	Foskor Mine at Phalaborwa	3,500 gross weight of phosphate rock.*
Platinum-group metals tons	Rustenburg Platinum Mines Ltd. (JCI, 32.6%; AAC, 23.9%; Lydenburg Platinum Ltd., 8.3%; ASA Ltd., 0.8%)	Rustenburg Mine near Rustenburg, Union and Amandelbult Mines near Northam, 50 kilometers south of Thabazimbi	70 PGM.*
Do.	Lebowa Platinum Mines Ltd. (Rustenburg Platinum Holdings, 21.5%; JCI, 20.1%; Lydenburg Platinum Ltd., 20.1%; AAC, 14.4%; Lebowa Homeland, 9%)	Atok Mine, 70 kilometers east of Potgietersrus	10 PGM.*
Do.	Impala Platinum Ltd. (Gencor, 40.7%; Genbel Investments Corp. Ltd., 10.8%; ASA Ltd., 0.4%; Rand Mines, Ltd., 0.4%)	Bafokeng North and Bafokeng South Mines, Wildebeestfontein North and Wildebeestfontein South Mines, about 20 kilometers north	40 PGM.*
Do.	Eastern Platinum Ltd. (Lonhro plc, United Kingdom, 73%; Impala Platinum Holdings Ltd., 27%)	40 kilometers northeast of Rustenburg	3 PGM.*
Do.	Western Platinum Ltd. (Lonhro plc, United Kingdom, 73%; Impala Platinum Holdings Ltd., 27%)	20 kilometers east of Rustenburg	10 PGM.*
Do.	do.	Karee Mine, 25 kilometers northeast of Rustenburg	5 PGM.*
Do.	Barplats Investments Ltd. (Impala Platinum Holdings Ltd., 38%; Rand Mines Ltd., 30.6%; Vansa Vanadium, 3.2%)	Crocodile River Mine near Brits	10 PGM.
Do.	Northam Platinum Ltd. (GFSA, 63%; New Wits Ltd., 3.1%)	Northeast of Northam, 20 kilometers south of Thabazimbi	10 PGM.*
Pyrophyllite	Wonderstone 1937 Ltd. (Associated Ore and Metal Co. Ltd., 100%)	Gestoptefontein Wonderstone Quarry near Ottosdal, 70 kilometers west of Klerksdorp	4.*
Titanium concentrate	Tisand (Pty.) Ltd./Richards Bay Minerals (Rio Tinto Zinc Corp. plc, 50%; Gencor, 50%)	Opencast operations near Richards Bay	125 rutile concentrate; 1,280 ilmenite.
Titanium slag	Richards Bay Iron and Titanium Corp./Richards Bay Minerals (Rio Tinto Zinc Corp. plc, 50%; Gencor, 50%)	Smelter at Richards Bay	1,000 slag.
Uranium tons	Vaal Reefs Exploration and Mining Co. Ltd. (Anglo American Gold Investment Co., 16.8%; AAC, 10.8%; ASA Ltd., 3.1%; Genbel Investments Corp. Ltd., 1.3%; Middle Witwatersrand, 0.9%; New Wits Ltd., 0.4%)	Mine and plant near Klerksdorp	2,000 uranium oxide.*
Do.	Buffelsfontein Gold Mining Co. Ltd. (Anglo American Gold Investment Co., 20.2%; AAC, 8.7%; Gengold Ltd., 8.6%)	Mine and plant, 15 kilometers southwest of Klerksdorp	400 uranium oxide.*
Do.	Hartebeestfontein Gold Mining Co. Ltd. (Zandpan Gold Mining Co., 15.5%; AAC, 7.5%; Anglovaal Ltd., 4.6%; Middle Witwatersrand, 2.8%; ASA Ltd., 2.2%)	Mine and plant, 5 kilometers southeast of Klerksdorp	400 uranium oxide.*

See footnotes at end of table.

TABLE 4—Continued  
**REPUBLIC OF SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992**

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity ownership <sup>1</sup>	Location of main facilities	Annual capacity
Uranium	tons	Western Areas Gold Mining Co. Ltd. (Elsburg Gold Mining Co. Ltd., 48.7%; JCI, 6.5%; Anglo American Gold Investment Co., 2.5%; AAC, 2.2%)	Western Areas Mine, 30 kilometers southwest of Johannesburg	500 uranium oxide.*
Do.		Free State Consolidated Gold Mines Ltd. (Freegold) (Orange Free State Investments Ltd., 49.9%; Anglo American Gold Investment Co., 6.5%; Welkom Gold Mining Co. Ltd., 5.2%; AAC, 3.2%; Middle Witwatersrand, 0.3%)	Mine and plant near Welkom	500 uranium oxide.*
Do.		Palabora Mining Co. Ltd. (Rio Tinto Zinc Corp. plc, 38.9%; AAC, 19.1%; De Beers, 9.5%; Middle Witwatersrand, 0.4%)	Palabora Mine and plant at Phalaborwa	200 uranium oxide.*
Vanadium	tons	Highveld Steel and Vanadium Corp. Ltd. (Anglo American Industrial Corp. Ltd., 51.8%; De Beers, 3.8%)	Mapochs Mine near Lydenburg	25,000 vanadium pentoxide.*
Do.	do.		Highveld slag plant in Witbank	17,000 vanadium pentoxide.
Do.	do.		Highveld Vantra plant in Witbank	8,000 vanadium pentoxide.
Do.		Vametco Minerals Corp. (Strategic Metals Corp., U.S.A., 100%)	Krokodilkraal Mine and plant near Brits	5,000 vanadium pentoxide.*
Do.		Transvaal Alloys Pty. Ltd., (Highveld Steel and Vanadium Corp., 100%)	Wapadskloof Mine and plant near Witbank	2,250 vanadium pentoxide.*
Do.		Vanadium Technology Ltd. (Vantech) (Chromecorp Technology (Pty.) Ltd., 100%)	Kennedy's Vale (ex Vansa Vanadium) Mine and plant near Lydenburg	3,600 vanadium pentoxide.
Do.		Rhombus Vanadium Holdings Ltd. (Rhombus Exploration Ltd., 50%; Usko Ltd., 50%)	Ba-Mogopa Mine and Usko plant near Brits	7,500 vanadium pentoxide.*
Vermiculite		Palabora Mining Co. Ltd. (Rio Tinto Zinc Corp. plc, 38.9%; AAC, 19.1%; De Beers, 9.5%; Middle Witwatersrand, 0.4%)	Palabora Mine and plant at Phalaborwa	230.*
Zinc		Zinc Corp. of South Africa Ltd. (GFSA, 56%; Iscor Ltd., 35%; New Wits Ltd., 9%)	Struisbult Springs Works in Springs, 35 kilometers southeast of Johannesburg	90 Zn.
Do.		Black Mountain Mineral Development Company (Pty.) Ltd. (GFSA, 55.4%; Phelps Dodge Corp., U.S.A., 44.6%)	Black Mountain Mine near Aggeneys, 100 kilometers northeast of Okiep	26 Zn in concentrate.
Zircon		Tisand (Pty.) Ltd./Richards Bay Minerals (Rio Tinto Zinc Corp. plc, 50%; Gencor, 50%)	Opencast operations near Richards Bay	300 zircon concentrate.
Do.		Palabora Mining Co. Ltd. (Rio Tinto Zinc Corp. plc, 38.9%; AAC, 19.1%; De Beers, 9.5%; Middle Witwatersrand, 0.4%)	Palabora Mine and plant at Phalaborwa	13.2 baddeleyite.*
Do.		Phosphate Development Corp. Ltd. (Foskor Ltd.) (IDC, 100%)	do.	12.5 baddeleyite.*

\*Estimated

<sup>1</sup>Abbreviations of company names used are as follows: Anglo American Corp. of South Africa Ltd. (AAC); De Beers Consolidated Mines Ltd. (De Beers); General Mining, Metals and Minerals Ltd. (Gencor); Gold Fields of South Africa Ltd. (GFSA); Investment Development Corp. of South Africa (IDC); and Johannesburg Consolidated Investment Co. Ltd. (JCI).



**TABLE 5**  
**REPUBLIC OF SOUTH AFRICA:**  
**RESERVES OF MAJOR MINERAL**  
**COMMODITIES FOR 1992**

(Million metric tons unless otherwise specified)

Commodity	Reserve base
Andalusite	51.
Antimony	tons 120,000 contained Sb.
Asbestos	8.
Chromium	3,200 chrome ore.
Coal	55,000.
Cobalt	tons 16,000 contained Co.
Copper	8 contained Cu.
Fluorspar	32.
Gold	tons 18,000 Au. <sup>1</sup>
Gypsum	86.
Iron ore	5,900 contained Fe.
Lead	4.8 contained Pb.
Manganese	4,000 contained Mn.
Nickel	12 contained Ni.
Phosphate rock	2,310 concentrate.
Platinum-group metals	
	tons 59,000 contained PGM. <sup>2</sup>
Silver	tons 10,000 Ag.
Titanium	31 contained Ti.
Uranium	tons 305,000 contained U. <sup>3</sup>
Vanadium	8 contained V.
Vermiculite	73.
Zinc	15 contained Zn.
Zirconium	7 contained Zr.

<sup>1</sup>The Economic Geology Research Unit of the Witwatersrand University's estimate of the gold reserves, including from potential new gold fields, is 40,000 tons Au.

<sup>2</sup>Revised from 30,200 tons of contained PGM.

<sup>3</sup>Recoverable at a cost of less than \$80/kilogram.

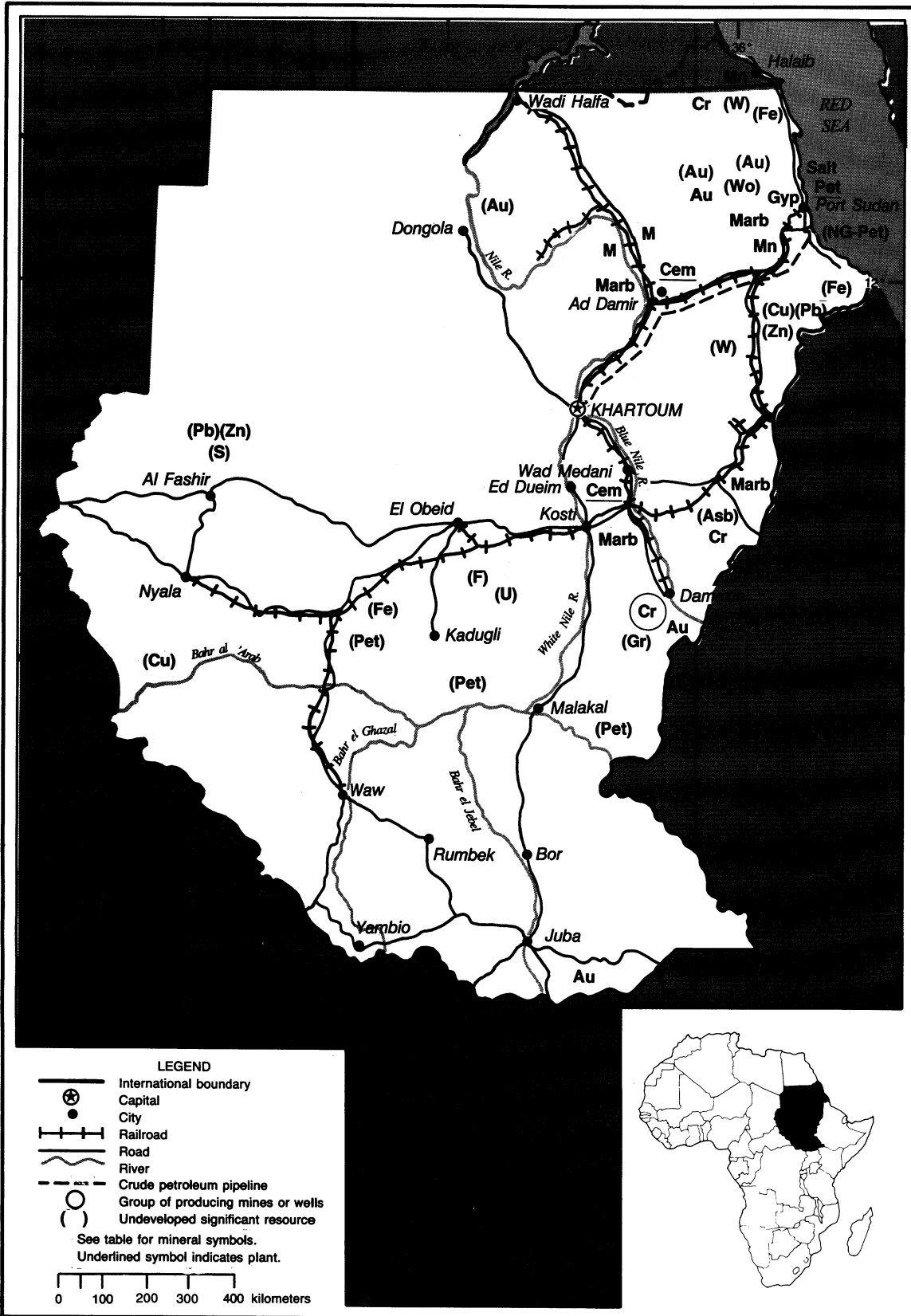
Source: Minerals Bureau, Department of Mineral and Energy Affairs, 1992.



# SUDAN

AREA 2,505,810 km<sup>2</sup>

POPULATION 28.3 million



## THE MINERAL INDUSTRY OF

# SUDAN

By Lloyd E. Antonides

The promising mineral potential of Africa's largest country, more than one-fourth the size of the United States, included oil and gas, gold, chrome and manganese ores, and several industrial minerals. Known mineral production consisted of cement, chromite, gold, gypsum, limestone, petroleum refinery products, and salt, and, in 1992, a very small first commercial production and processing of crude oil for domestic use. Nevertheless, the mineral industry contributed little to Sudan's GDP. Chromite, gold, and salt were the main mineral exports but provided less than 1% of export revenues. However, imports of petroleum refinery products and crude oil were very significant factors of trade.

The economy, with a GDP of more than \$5 billion<sup>1</sup> in 1992, had a real growth of nearly 10% for the year according to World Bank estimates. This was mostly due to an excellent year for agriculture in the eastern half of the country. The agriculture sector typically contributed nearly 40% to GDP, employed about 80% of the work force, and provided almost all of the exports, more than 50% of the total being cotton. But inflation rates of 100% or more and high deficits in the Government budget and the balance of trade persisted. Also, unemployment remained high, about 30%, and per capita GDP was still less than \$200.

Before 1991, the economy had been deteriorating since Sudan's independence in 1956. The military Government, established by coup in mid-1989, launched a comprehensive 3-year economic reform program in January 1990. In February 1992, floating of the local currency and lifting of subsidies on wheat and fuel had major impacts on the economy. The Sudanese pound

depreciated overnight from 15 per U.S. dollar to 90 per U.S. dollar.

By yearend 1992, the specific commercial goals of the plan were considered to have been largely met. But the overall economy was still not responding very strongly. The costly unresolved 10-year-old civil war in the south was a major fiscal problem involving the largest army in the sub-Sahara aside from the Republic of South Africa. There were other obstacles as well: continued drought in the west, difficulties with cotton sales, a population growth rate of about 3%, domestic and international political-religious controversies, and refugees from the western drought and southern war as well as nationals returning from terminated employment in the Gulf area. On the other hand, a reasonably well-trained work force was noted as a positive factor for growth.

A dispute with Egypt arose over mineral rights in the triangular zone along Sudan's border with Egypt and the Red Sea. Known as the Halaib area, the area apparently became important because of offshore oil concessions granted by Sudan. Also involved are manganese and iron deposits, some of which were exploited by Sudanese nationals in the past.

### GOVERNMENT POLICIES AND PROGRAMS

The Government professed a policy of encouraging foreign and, in particular, mineral venture investments as it had even before the Investment Encouragement Act of 1980. However, the commercial climate was not considered favorable by some observers because of the ramifications of Islamic law, instituted in 1983; problems with lengthy bureaucratic procedures; some political favoritism in issuance of business

licenses; regulations that discouraged new inflows of foreign exchange to banks; and other remaining subsidies and price controls.

The Government became involved in mineral projects, as in most if not all industrial ventures, through state-owned companies such as the Sudanese Mining Co. and the Public Petroleum Co. when private industries were nationalized in 1971. But in 1979, Sudanese nationals regained their control of at least certain companies, and thereafter the Government had no further involvement with such local firms. However, there usually was Government participation in any foreign company venture.

A new Minister of Energy and Mining was appointed in January 1993. The Geology and Mineral Resource Department of the Ministry continued to be active in producing geologic maps and investigating potentially economic mineral occurrences.

### PRODUCTION

Gold production showed a substantial jump in 1992 as a result of the buildup of operations at the Hassai Mine operated by the Bureau de Recherches Geologiques et Minières (BRGM). Cement manufacture and the associated limestone, shale-clay, and gypsum output also was estimated to have significantly increased because of expanded facilities that were installed in 1991.

Petroleum refinery production was reported to have nearly doubled in 1991, as revised figures show in table 1, and presumably continued in 1992. The quantities were generally within published capacity figures. Press reports had indicated the Government-owned refinery ran into difficulties securing crude. In April 1992, Libya suspended its sched-

uled shipments of about 700,000 bbl/month because of Sudan's continued failure to settle arrears of nearly \$1 billion. Also a supply deal with Iran failed to materialize. Finally Sudan began buying on the spot market at a cost of about \$20 million per month.

## TRADE

Mineral exports had little significance in value or volume to overall trade figures, but normally included chrome ore, gold, salt, and frequently manganese ore. Mineral commodity imports were significant to trade values and volumes, with petroleum refinery products and crude oil being the major components. Fertilizer as well as structural steel imports also were significant. In terms of value of all exports, mostly agricultural, the destinations were Western Europe for almost 50%, Arab countries for more than 15%, and the United States for about 3% in the fiscal year ending June 30, 1988. In that year, imports from Arab countries and Western Europe were equal sources for a combined total of about 65% and the United States for about 15%. Press reports indicated that during 1992 Iran had entered into trade and infrastructure assistance agreements with Sudan and was supplying military equipment and supplies and that Sudan was shipping meat to Iraq.

## STRUCTURE OF THE MINERAL INDUSTRY

State-owned companies have been a major factor in the mineral industry of Sudan since the early 1970's. However, private firms also have operated since 1979. Although larger mineral ventures often had foreign participation, there were a number of small domestically owned operations on which detailed information was not available. (See table 2.)

## COMMODITY REVIEW

### Metals

**Copper.**—A joint venture was concluded in 1989 between Armeno Resources of Vancouver, British Columbia, and the Government to develop the Hofrat en Nahas copper-gold deposit in Western Sudan. The venture apparently was terminated when sufficient funds could not be raised.

**Gold.**—The Ariab Mining Co. became 45% owned by BRGM late in 1991 when its wholly owned subsidiary company, SEREM, purchased shares previously held by Total Compagnie Miniere. BRGM earlier had been reported to have a 10% interest and Total a 30% interest. The balance of shares, 55%, remained with the Government's Sudanese Mining Co. Ariab was formed in 1990, but an earlier joint venture reportedly had been formed in 1981. BRGM had been working since about 1987 in the so-called Ariab Basin area centered about 200 km west of Port Sudan and continued as operator of the venture. During the last quarter of 1991, existing heap-leaching facilities were rehabilitated, and doré bullion was poured in December. During 1992, production steadily increased toward a goal of 100 kg/month. Presumably the operations are at the Hassai Mine site where a 150-mt/d open pit ore plant was operating in 1989.

Two other gold ventures that started up in the past few years, one by Minex (Greenwich Resources) and the other by Kenmare Resources, apparently have remained closed since 1990.

### Mineral Fuels

**Natural Gas.**—International Petroleum Corp. (IPC) of Canada, early in January 1993, revealed results of a seismic survey of the Suakin gas/condensate field in the so-called Delta Tokar block that is onshore and offshore southeast of Port Sudan. IPC planned a followup appraisal well in late 1993 on the more extensive and pronounced geological crest that was

indicated. Chevron made the original discovery with a well in 1976 but gave up the concession some years later. In 1987, the Pan Ocean Oil Co. and its partner United States Oil Co. acquired the block but let its license expire in 1991 without starting development. In December 1991, IPC gained a 6-year concession. It hoped to produce at least condensate because terms allow flaring of the gas if no market is found. In case of production the concession would be extended to at least 25 years. Sudan also granted IPC a block with hydrocarbon potential that lies onshore and offshore along the coast of the Halaib triangle, whose ownership is disputed with Egypt.

**Petroleum.**—Production of crude apparently started during the last half of 1992 from wells originally drilled in 1979 by Chevron in the Abu Gabra Field about 750 km southwest of Khartoum. Concorp International Ltd., reportedly a group of Sudanese business people with close ties to the political leadership, bought Chevron's last remaining concessions in June 1992. Subsequently, Concorp acquired a small 2,000-bbl/d topping refinery for installation in the area. It began trial production in September and commercial operation in December. Product mix was unclear but some motor gasoline from the plant was reportedly being sold in Khartoum in December. Expansion of crude production operations was planned to eventually reach 100,000 bbl/d.

In late December, a Vancouver, B.C., independent oil company, Arakis Energy Corp., and a private Sudanese company, State Petroleum Corp. (SPC), announced having acquired some rights from Concorp. Early in 1993 press reports indicated that SPC was also registered on the Vancouver stock exchange and that the Heglig and Unity Fields, east of Abu Gabra, were specifically involved. Production of 50,000 bbl/d was targeted, with a similar size refinery expected on-stream in 1995.

**Refinery.**—The Port Sudan oil refinery, started in 1984 by owners Royal

Dutch/Shell Oil Co. and British Petroleum Corp., subsequently became a 50-50 partnership with the Government-owned Public Petroleum Corp. It became wholly owned by the latter apparently some time in 1991 when Shell sold the 50% it had acquired in the intervening years.

## INFRASTRUCTURE

Sudan's transport system was considered inadequate for the country's size and terrain, which includes large desert and swamp areas. According to World Bank information, there was only 20,000 km of roads, of which about 10% was paved and another 30% improved. Roads were the primary transportation mode and were badly in need of repair. A 4,800-km railway network linked major cities but was in very poor condition and carried only a fraction of the tonnage it had in the early 1970's. A refined petroleum products pipeline 800 km from Port Sudan to Khartoum was opened in 1977. It mainly handled gasoline and diesel fuel, but was operating much below capacity, and more fuel was carried by tanker trucks. There also was about 3,000 km of waterways, mostly connected to the Nile, but that least expensive mode of transportation was little used. Airports were scattered throughout the country, about 10 of which had permanent surface runways. Port Sudan was a deepwater port on the Red Sea that was considered adequate for the near term with regular scheduled shipping services. Major foreign aid programs were directed toward improving the transportation system.

Electric power generation and distribution improvements also were a major focus of foreign aid. Hydropower was an important component, but liquid fueled steam-turbine units were widely used. The U.N. funded some work by the Government Energy Research Institute on solar power for rural areas in the west.

Telecommunications were reported barely adequate and poorly maintained by modern standards but consisted of a large and well-equipped system by African standards. Foreign funding was sought

for improvements.

## OUTLOOK

Continued political and economic instability appeared to deter consideration of exploiting the promising mineral potential of Sudan. Only some small-scale ventures by local business persons seemed likely in the near term. The generally poor infrastructure also would be an obstacle to any significant mineral production increases for some time.

<sup>1</sup>Where necessary, values have been converted from Sudan pounds (Ls) to U.S. dollars at the rate of Ls123.45=US\$1.00 in 1992, the "free" commercial bank average for the year. The new "free" bank rate began in February 1992 at Ls90.00=US\$1.00 and was Ls135.14=US\$1.00 at yearend.

## OTHER SOURCES OF INFORMATION

### Agency

Ministry of Energy and Mining  
Republic of the Sudan  
P.O. Box 2087  
Khartoum, Sudan  
Telephone: 755-95  
Telex: 22256

### Publication

Arab Oil & Gas Directory 1993, Arab  
Petroleum Research Center, 7, Avenue  
Ingres, 75016 Paris, France.

TABLE 1  
SUDAN: ESTIMATED PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992
Cement, hydraulic	140,000	150,000	<sup>3</sup> 166,538	170,000	250,000
Chromium: Chromite, mine output (%48 % Cr <sub>2</sub> O <sub>3</sub> ), gross weight	<sup>3</sup> 8,000	<sup>3</sup> 25,000	<sup>3</sup> 12,500	10,000	10,000
Gold, mine output, Au content kilograms	300	500	100	50	900
Gypsum and anhydrite, crude	<u><sup>3</sup>5,000</u>	<u><sup>3</sup>10,000</u>	<u>5,000</u>	<u>7,000</u>	<u>10,000</u>
Petroleum refinery products: <sup>4</sup>					
Liquefied petroleum gas thousand 42-gallon barrels	<sup>3</sup> 101	100	<sup>3</sup> 90	<sup>2</sup> 200	200
Gasoline do.	<sup>3</sup> 1,275	1,100	810	<sup>1</sup> 1,400	1,400
Jet fuel do.	<sup>3</sup> 669	400	<sup>3</sup> 330	<sup>6</sup> 600	600
Kerosene do.	<sup>3</sup> 128	100	100	100	100
Distillate fuel oil do.	<sup>3</sup> 2,026	1,500	1,380	<sup>2</sup> 2,400	2,400
Residual fuel oil do.	<sup>3</sup> 1,573	1,200	1,190	<sup>2</sup> 2,800	2,800
Other do.	<sup>3</sup> 208	150	150	<sup>3</sup> 300	300
Total, including refinery fuel and loss	5,980	4,550	4,050	<sup>7</sup> 7,800	7,800
Salt	50,000	<sup>3</sup> 91,000	<sup>3</sup> 68,262	75,000	75,000

<sup>1</sup>Includes data available through June 1, 1993.

<sup>2</sup>In addition to the commodities listed, the following are presumably produced but available information is inadequate to reliably estimate output: limestone for cement manufacture (at least 1.25 tons per ton of finished cement), as well as for agriculture, lime manufacture and construction aggregate and fill; clay and/or shale for cement manufacture (normally about 0.4 ton per ton of cement); and other locally used construction materials (clays, sand and gravel, stone, et al.). Also production of manganese ore (48% to 50% Mn) was reported for 1989 at 1,100 metric tons and 1990 at 60,000 metric tons.

<sup>3</sup>Reported figure.

<sup>4</sup>Refinery fuel and losses are included in output of individual products, except in 1988 where they are included in "Other."

TABLE 2  
SUDAN: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

(Metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity <sup>a</sup>
Cement	Atbara Cement Co. Ltd. (Government, 100%)	Atbara, 275 kilometers northeast of Khartoum	150,000
Do.	Nile Cement Co. (Government, 100%)	Rabak, 250 kilometers south of Khartoum	100,000
Chromite	Ingessana Hills Mines Corp. (Sudanese Mining Corp., <sup>1</sup> 100%)	Gam Mine, 500 kilometers south-southeast of Khartoum	15,000
Gold ore	Ariab Mining Co. (Bureau Recherches Geologiques et Minieres, 45%; and Sudanese Mining Corp., <sup>1</sup> 55%)	Hassai Mine, 200 kilometers west of Port Sudan	60,000
Gypsum	Sudanese Mining Corp. (Government, 100%)	Bir Eit Mine, 80 kilometers north of Port Sudan	15,000
Marble	Pentco Engineering & Trading Co. (private, 100%)	Port Sudan and Gedaref, 375 kilometers east-southeast of Khartoum	100,000
Mica	Sudanese Mining Corp. (Government, 100%)	Sheriek Mines, 400 kilometers north-northeast of Khartoum	1,800
Petroleum refinery products million barrels	Port Sudanese Refinery Ltd. (Public Petroleum Corp., <sup>1</sup> 100%)	Port Sudan	8.7

<sup>a</sup>Estimated.

<sup>1</sup>Government, 100%.

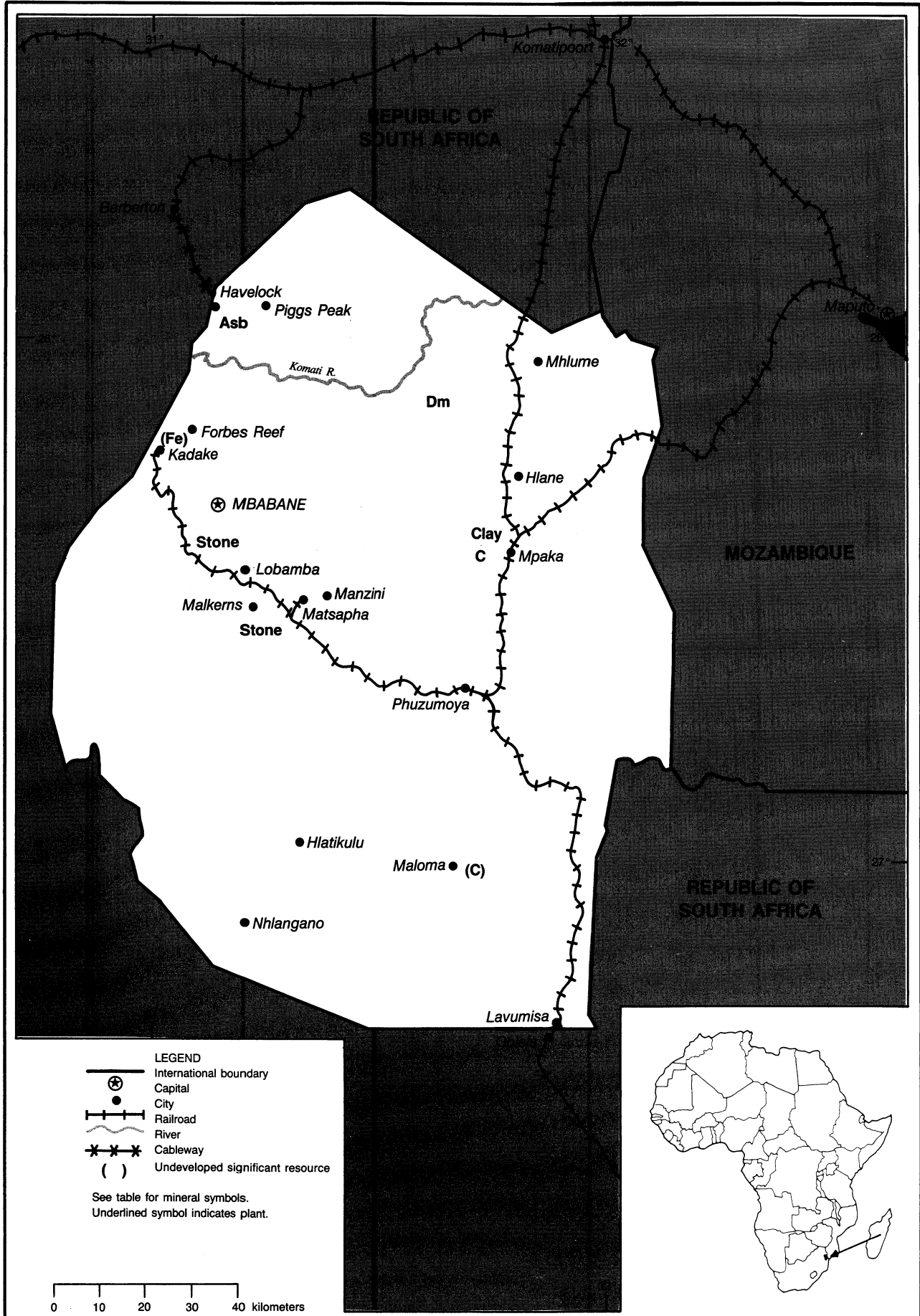




# SWAZILAND

AREA 17,360 km<sup>2</sup>

POPULATION 913,000



## THE MINERAL INDUSTRY OF

# SWAZILAND

By Hendrik G. van Oss

Swaziland's mineral industry performance was mixed in 1992 (see table 1). Although output was variable, revenues increased for all commodities except diamond, which declined. Overall, reported mining revenues increased 111% to \$30.1 million, notwithstanding a 3% decline in 1992 in the value of the local currency.<sup>1</sup> No data were available in 1992 for brick clay, but this output (as brick) is estimated to have been worth about \$5 million. Thus, the true total value of Swaziland's mineral production was about \$35 million, or about 3.6% of the country's GDP of \$969 million. Virtually all of Swaziland's mineral production except stone and some brick clay was exported. Excluding clay, this trade was worth almost \$27.5 million, or about 4.6% of total exports of \$594 million. Clay exports (as brick) were worth an estimated \$3 million.

Mineral commodity import data were not available for 1992, but are estimated to have declined slightly from 1991 levels to about \$125 million, about 18% of total imports. Petroleum products accounted for about \$100 million of this total and coal imports about \$5 million. Fertilizer imports are believed to have fallen slightly, to about \$15 million, because of drought. Virtually all mineral imports were from the Republic of South Africa. Imports of electricity, also from South Africa, were worth an estimated \$10 million in 1992.

Apart from the commodities presently being mined, Swaziland has been a significant regional producer in the past of iron ore and gold and has had modest production of tin and such industrial minerals as barite, fluorspar, and pyrophyllite. Mineral exploration in Swaziland in recent years has focused on coal, gold, and industrial minerals. Large

new coal reserves have been found, but the gold exploration work has yet to locate any large deposits.

About 17,300 Swazis were employed in the mining industry—about 1,000 in Swaziland and the rest in the Republic of South Africa. Repatriated and domestic wages are estimated to have totaled about \$70 million.

The Havelock (Bulembu) asbestos mine experienced a resurgence of production following its sale early in 1991 and a restart of production a few months later. Production in 1992 was reportedly of higher quality fiber than in recent years. Sales revenues increased almost fourfold to \$17.9 million. Apart from upgrading the mine and the processing plant, the company was reportedly exploring for additional chrysotile reserves at a newly discovered serpentine deposit between the workings and the Republic of South Africa border.

Rehabilitation work following the June 1991 mine collapse of the Emaswati coal mine near Mpaka allowed production to resume at a modest rate. Sales revenues in 1992 increased 24% to \$4.5 million owing to better coal prices. However, the costs of the repair work, together with increased electricity rates and railing tariffs, severely affected the profitability of the operation. Full rehabilitation of the mine, to include access to a new reserve block, would have required a new ventilation shaft and a new escape way. Further, the mine faced increasing future competition in the export market. Under these circumstances, the parent company decided to close the mine, and mining operations ceased July 31, 1992. Approximately 220 workers were retrenched. Sales contracts were met from stockpiles through yearend.

Closure of the Emaswati Mine was

partially offset by the news, in mid-July 1992, that the King had awarded a mining lease to Carbonex Co. of Denmark for the exploitation of the Maloma anthracite deposit. The mine, a 50-50 joint venture between Carbonex and the Government, was to be operated as Maloma Colliery Ltd. and was expected to come on-stream in early 1993. Production was expected to be at a rate of 250,000 to 300,000 mt/a.

Diamond production at the Dokolwayo Mine suffered from increasing stripping ratios and harder ore. Prices averaged about the same as those in 1991, which were 30% below prices in 1990. Accordingly, sales revenues in 1992 declined 12% to slightly less than \$5 million. The company was reportedly examining the continued viability of the operation.

Crushed stone output almost doubled in 1992, spurred by an increase in roadbuilding projects in various parts of the country. Sales of crushed stone increased 82% to \$2.8 million.

<sup>1</sup>Where necessary, values have been converted from Swazi emalangeni (E) to U.S. dollars at the rate of E2.85=US\$1.00.

**TABLE 1**  
**SWAZILAND: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992
Asbestos, chrysotile fiber	22,804	27,291	35,938	13,888	32,301
Coal, anthracite	164,845	165,122	150,967	122,502	100,220
Diamond					
carats	72,676	55,264	42,484	57,420	50,546
Stone: Quarry product					
cubic meters	107,205	128,463	155,347	128,759	232,860

<sup>1</sup>Includes data available through June 15, 1992.

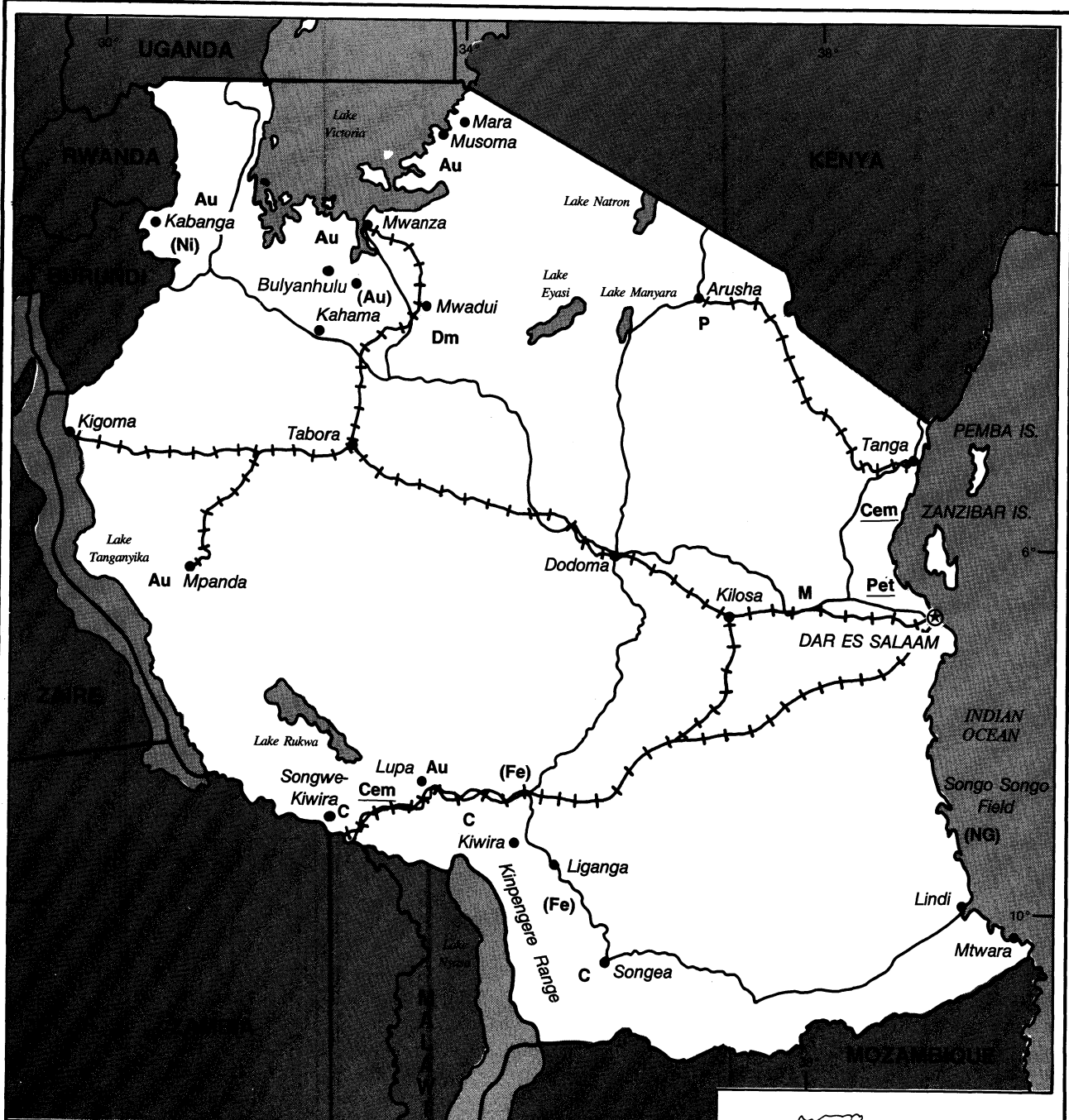
<sup>2</sup>In addition to the commodities listed, modest quantities of crude construction materials (brick clay and sand and gravel) are produced, but output is not reported quantitatively, and available information is inadequate to make reliable estimates of output levels.



# TANZANIA

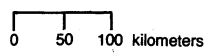
AREA 945,090 km<sup>2</sup>

POPULATION 27.8 million



- LEGEND**
- International boundary
  - Capital
  - City
  - Railroad
  - Road
  - Undeveloped significant resource

See table for mineral symbols.  
Underlined symbol indicates plant.



## THE MINERAL INDUSTRY OF

# TANZANIA

By David Izon

Tanzania had an agricultural economy, but mineral production accounted for the major share of export earnings. The important minerals in terms of value of production and foreign exchange earnings were diamond, gemstones, gold, phosphates, salt, and tin. The quality of Tanzania's diamonds was recognized worldwide. Recent activities in the minerals sector indicated that diamond and gold could play important roles in reviving the mineral economy of the country. Diamonds contributed about 85% of total mineral export earnings. The mineral industry made up about 0.3% of the GDP of \$7 billion<sup>1</sup> and less than 1% of the labor force in 1992.

The Government's reform programs focused on creating a hospitable investment climate for foreign and local investors. The Government abolished its policy of majority Government ownership in mining ventures. The Ministry of Water, Energy and Minerals, through its 18 regional offices, administered the issuing of exploration and mining licenses and the administration of claims and reconnaissance. The Mineral Resources Department of the Ministry of Water, Energy and Minerals also administered the national minerals information data base. The State Mining Corp. (STAMICO) conducted contract drilling and surveying services and provided field staff to exploration companies. Other agencies that were involved in the minerals sector were the Tanzanian Saruji Corp., the National Development Corp., and the Eastern and Southern Africa Mineral Resources Development Center.

### GOVERNMENT POLICIES AND PROGRAMS

In Tanzania, the 1979 Mining Act

applied to all mineral activities, but it was in the process of being updated in 1992. The National Investment Promotion Center was responsible for the administration of exploration and production. All minerals belong to the Government, and prospectors are required to be licensed. Exploration licenses were issued for a period of 1 year and could be renewed yearly. These cover specific areas and minerals. Mining licenses, when issued, give exclusive rights to investors to prospect, produce, and sell the minerals recovered. The mining licenses expire after 25 years or at the end of the estimated life of the deposit, whichever was shorter and renewable for a further 15 years.

In 1992, changes were introduced to simplify the tax system. According to the new rules, mining companies would be liable for income tax and royalties, while equipment imported before sustained production at a mine was exempted from customs duty and sales tax. Incentives included reduced tax rates on taxable income of mineral products during the first 4 years of production and reduced withholding tax on dividends paid overseas. Companies also could retain up to 70% of their mining-related earnings in foreign accounts. These policies were designed to ensure that investors could service their overseas obligations without recourse to Tanzanian foreign exchange markets.

The above policies were aimed at attracting foreign investors and providing support and incentives for small-scale miners to expand their operations and output. The Government continued with the economic policies and programs of the Economic Recovery Program. The reforms have led to the signing of development agreements by the Tanzanian

Government with some foreign firms and their local subsidiaries involving cobalt, copper, and nickel recovery.

### PRODUCTION

There was a decline in diamond output owing to depletion and low grades of the ore at Mwadui and equipment failure. However, gold output increased in 1992. Gold production is believed to be significantly underreported owing to the uncontrolled nature of the large number of small-scale miners and the inefficient Government purchasing procedures for gold by the Bank of Tanzania. According to the Ministry of Water, Energy and Minerals, 24 tons of gold was produced by private mining groups. A large portion is believed to have left the country illegally. Of the 6,000 kg bought by the Bank of Tanzania, 4,000 kg was sold in 1992. Output of phosphate and gypsum also increased, while gemstones and salt decreased. Although there was a decline in output, investment activities in 1992 indicated that the situation could improve. (See table 1.)

### TRADE

In 1992, major minerals traded included diamonds and gold, which accounted for about 85% of foreign exchange earnings. Other minerals of importance were gemstones.

The country's main trading partners remained the Federal Republic of Germany, Italy, the Netherlands, the United Kingdom, and neighboring east African countries.

Major imports from the United States were manufactured goods, machinery and transport equipment, and spare parts.

## STRUCTURE OF THE MINERAL INDUSTRY

The state owned all mineral rights in the country since so declared in 1964. The National Development Corp., formed in 1966, took over most of the private enterprises. STAMICO controlled the mineral industry and operated most mines and plants. The Mining Act of 1979 applied to investments that deal directly with mining. Major investors in mining operations were Placer Dome (Kahama) Ltd., Kabanga Nickel Co., and the United Nations Revolving Fund for National Resources Exploration. There were several underexplored and underdeveloped geological structures in Tanzania, covering an area more than 800,000 km<sup>2</sup>. These structures have great potential of locating extensive mineralization, including nickel and other minerals. Development of any new remote mineralized areas would have to provide for infrastructure development. (See table 2.)

## COMMODITY REVIEW

### Metals

Mineral exploration efforts in Tanzania continued in 1992, as new drilling activities increased the estimated nickel reserves to about 25.5 Mmt from the previous estimate of 20 Mmt. The Kabanga nickel deposit in northwestern Tanzania was also known to contain commercial amounts of copper and cobalt.

Although deposits of iron ore at Liganga and Njombe have been studied extensively, no production has occurred. Proven resources of about 45 Mmt were reported at the Liganga site grading 52% iron. The remoteness of Liganga could have been responsible for nonproduction.

**Gold.**—Gold output was reported to have increased significantly in 1992, based on purchases by the Bank of Tanzania. Small-scale gold mining activities were concentrated at Musoma, east of Lake Victoria, at Lupa southeast of Lake Rukwa, and at Mpanda, east of

Lake Tanganyika. Output was by artisanal miners only, and the only mechanized mine at Buckreef remained closed due to flooding. Small-scale miners were well organized in their mining efforts by local village authorities, and actual labor may be about 20,000 workers. The value of gold sales in 1992 was about \$40 million. However, based on estimates of smuggled gold, total sales may be as high as \$250 million.

A Canadian-based company, Tan Range Explorations, acquired a gold concession covering 207 km<sup>2</sup>. The company planned to begin exploration in early 1993. The area concerned covered the extension of the Bulyanhulu deposits in the Kahama district. The reported reserves in this concession was about 4.3 Mmt, grading about 11 g/mt gold, 12.05 g/mt silver, and 0.66% copper. Tan Range's Tanzanian subsidiary, Tan Can Mining and Mill-Ore Industries of Timmins Ontario, was also awarded \$91,600 by the Canadian Industrial Development Agency to install a portable tailings reprocessing plant that would be capable of treating 200 mt/d of tailings.

**Nickel.**—Sutton Resources and Romanex International of Canada, in a joint-venture partnership, continued exploration activities in two concessions northwestern of Tanzania for nickel, cobalt, lead, and platinum-group metals. BHP Minerals International, which held a 52% share in the project, was responsible for funding the exploration work. The concessions were granted to Kabanga Nickel Co. and Kagera Mining Co., subsidiaries of the Sutton Resources and Romanex International of Canada.

The deal covered reconnaissance, prospecting, and mining on 26,400 km<sup>2</sup> in the Kabanga area, which adjoins the Kagera area. The deposits were previously evaluated by the United Nations Development Program (UNDP) to have an approximate reserve of 40.5 Mmt grading 1.05% nickel, 0.11% cobalt, 0.21% copper, and 0.31 g combined gold and platinum per ton. The UNDP studies covered 101 target areas in the nickel-cobalt-copper belt of the Kabanga-Kagera concessions. The

Kabanga target was the only 1 of the 101 targets to be drilled. The previous calculations for the Kabanga target indicated reserves of about 18.5 Mmt grading 1.13% nickel, 0.078% cobalt, and 0.16% copper. Additional drilling by Kabanga Nickel Co. has increased the reserves at the Kabanga target area to 25.5 Mmt, grading 1.19% nickel, 0.10% cobalt, and 0.20% copper at a 0.5% nickel cutoff. The total reserves estimated at yearend 1992 were about 80 Mmt at the Kabanga-Kagera concessions. Based on the preliminary results, Sutton Resources envisaged a 15,000-mt/d open pit operation over a period of about 20 years.

### Industrial Minerals

Gemstones found in Tanzania included emerald, rhodolite, ruby, sapphire, tanzanite, and tourmaline. The value of foreign export earnings from gemstones in 1992 amounted to about \$3 million. Large reserves of bentonite occurred at Lake Manyara, Mount Gelai, and Sinya. Tanzania also has commercially viable deposits of graphite.

Diamonds played a significant role in the mineral economy of Tanzania in 1992. Operations at the Mwadui Mines continued to see a decline in production in 1992, but interest in exploration for diamonds increased. Tanex Ltd., a subsidiary of De Beers Centenary, acquired a diamond exploration and development license in January 1992 and undertook a detailed exploration program covering an area of about 23,000 km<sup>2</sup> in the Mwanza, Shinyanga, and Tabora regions. During the latter part of 1992, Tan Range Explorations of Canada also acquired concessions covering about 107 km<sup>2</sup> in Shinyanga, near the Mwadui diamond mine. Other parties that showed interest in diamond concessions were Reunion Mining Co. and RTZ, who submitted applications for diamond prospecting. Traditionally, about 90% of the diamond output has been from the 50-year-old Mwadui Mines and the nearby New Alamas Mines, about 200 km south of Mwanza.

## Mineral Fuels

Coal production was exclusively from the Kiwira and Ilima Mines, northeast of the Kipengere range. The mines were small-scale operations that produced about 39,000 tons, all processed for local consumption. The continued shortage of equipment and adequate funds resulted in limited output. The estimated output capacity of the mines was 150,000 mt/a, which was planned to be raised to 180,000 mt/a by 1995. Reserves were estimated to be about 1.2 billion tons.

## Reserves

Tanzania was estimated to have natural gas reserves of approximately 41 billion m<sup>3</sup>. All of the reserves were offshore in the Songo Songo Field 300 km off the southern coast. The total in situ coal reserves were 1.2 billion tons in nine main coalfields in the southern part of the Rift Valley. Iron ore resources were estimated at about 45 Mmt with an iron content averaging about 52% Fe. Gold reserves at the Bulyanhulu deposits were put at about 10 Mmt of ore. Diamond reserves were estimated to be about 3.8 million carats. Phosphate reserves were about 10 Mmt. There could be as much as 80 Mmt of nickel-cobalt-copper ore resources. There were no officially reported reserve figures for tin and other minerals.

## INFRASTRUCTURE

Although Tanzania's infrastructure system is the fourth largest in Africa, it is semideveloped, consisting of 3,600 km of total railroad and 50,000 km of roads, which also link neighboring countries. Dar Es Salaam is the ocean terminus of the railway to Kigoma and Lake Tangayika, and to Mwanza on Lake Victoria. Tanzania is connected to Zambia by three ground links: The Tanzania-Zambia Railway Authority (TAZARA) railroad, the Tanzania-Zambia highway (TANZAM), and the Tanzania-Zambia pipeline. The Tanzanian Railway Corp. (TRC) operates all the rail lines except TAZARA. TAZARA is used

to transport goods mainly for Zambia and Malawi, and the TRC handles freight for Burundi, Rwanda, Uganda, and eastern Zaire. The roads have deteriorated so much that their condition has an adverse effect on the economy of the country. Major ocean ports are at Dar Es Salaam, Mtwara, Tanga, and Zanzibar. Mwanza on Lake Victoria and Kigoma on Lake Tanganyika are inland ports.

Most mining projects and mineral deposits are in remote areas where the infrastructure is extremely poor. Tanzania relies largely on hydroelectric power for its electricity. The Tanzania Electric Supply Co. on the mainland and the Zanzibar State Fuel & Power Corp. on the island are responsible for all public power generation and delivery.

## OUTLOOK

Nonfuel minerals such as diamond and gold should continue to dominate the mineral economy of Tanzania for the near future. Development of key mineral resources such as coal, cobalt, diamond, gold, and nickel would further enhance the importance of those commodities to the country's economy.

The development of the Songo Songo natural gas fields is expected to continue on schedule because funding will be provided by Ocelot International Inc. of Canada. The Government's economic recovery program should continue to improve Tanzania's ability to attract investors and promote industrial growth.

Road and rail improvement projects being implemented or studied would help to alleviate transportation problems now barring the efficient distribution of commodities. Toll roads, when installed in the country, could raise funds for construction of additional infrastructure needed for remote areas.

<sup>1</sup>Where necessary, values have been converted from Tanzanian shilling (Tsh) to U.S. dollars at Tsh340=US\$1.00 in 1992.

## OTHER SOURCES OF INFORMATION

Ministry Water, Energy and Minerals  
Dar Es Salaam, Tanzania



TABLE 1  
TANZANIA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992 <sup>3</sup>
Cement, hydraulic	189,390	540,000	*540,000	*540,000	540,000
Clays:					
Bentonite <sup>4</sup>	75	75	75	75	70
Kaolin	528	1,554	2,021	1,739	1,700
Coal, bituminous	3,349	46,000	51,569	33,213	33,200
Diamond <sup>3</sup> carats	*150,000	*150,000	84,598	99,763	68,000
Gemstones, precious and semiprecious excluding diamond <sup>4</sup> kilograms	*9,400	11,398	38,700	59,630	59,600
Gold, refined <sup>5</sup> do.	3,000	3,500	3,500	4,200	6,000
Gypsum and anhydrite, crude	19,570	5,895	36,155	35,263	35,200
Lime, calcined and hydrated <sup>6</sup>	3,000	2,505	1,466	870	870
Limestone, crushed	792,454	986,537	861,253	553,436	553,400
Mica, sheet	( <sup>7</sup> )	( <sup>7</sup> )	( <sup>7</sup> )	( <sup>7</sup> )	( <sup>7</sup> )
Petroleum refinery products:					
Liquefied petroleum gas thousand 42-gallon barrels	73	49	*50	35	30
Gasoline do.	784	835	*800	858	850
Kerosene do.	325	321	*300	437	400
Jet fuel do.	232	107	*100	237	200
Distillate fuel oil do.	1,088	1,097	*1,000	820	800
Residual fuel oil do.	1,771	1,543	*1,500	1,568	1,500
Other do.	320	321	*300	470	450
Total including refinery fuel and losses do.	4,593	4,273	*4,050	4,425	4,400
Phosphate minerals:					
Apatite,	4,466	4,657	25,066	22,419	22,400
P <sub>2</sub> O <sub>5</sub> content <sup>8</sup> do.	1,385	1,444	7,771	6,950	6,940
Salt, all types	19,777	20,010	39,315	64,419	64,400
Sand, glass	12,043	13,101	6,365	4,263	4,200
Soda ash <sup>9</sup>	300	300	300	300	300
Tin, mine output, Sn content <sup>10</sup>	2	15	15	6	5

<sup>1</sup>Estimated.

<sup>2</sup>Includes data available through June 10, 1993.

<sup>3</sup>In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (other clays, sand and gravel, and stone) presumably are produced, but output is not reported quantitatively, and available information is inadequate to make reliable estimates of output levels.

<sup>4</sup>Diamond figures are estimated to represent 70% gem-quality or semigem-quality and 30% industrial-quality stones.

<sup>5</sup>Exports.

<sup>6</sup>Less than 1/2 unit.

TABLE 2  
TANZANIA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

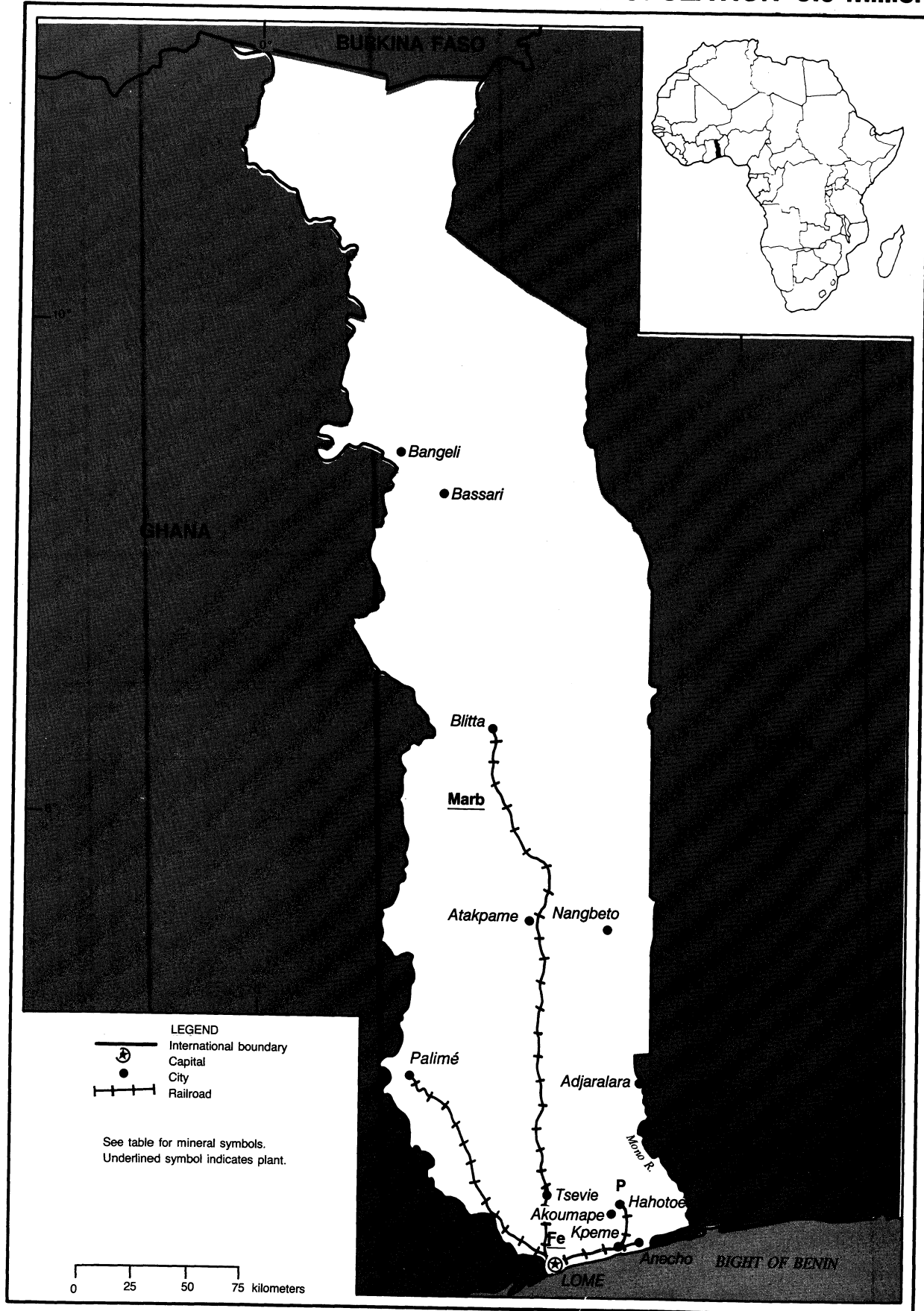
(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Cement	Tanga Cement Co. Ltd. (Government, 100%)	Tanga	500
Do.	Tanzania Portland Cement Co. (Government, 100%)	Wazo Hill, near Dar Es Salaam	600
Do.	Mbeya Cement Co. (Government, 100%)	Mbeya, southwest of Dar Es Salaam	250
Coal	State Mining Corp. (Government, 100%)	Songwe-Kiwira	150
Diamond	thousand carats Williamson Diamonds Co. (STAMICO, 50%; WILLCROFT of Canada, 50%)	Mwadui	3.5
Gold	thousand kilograms Place Dome (Kahama) Ltd. (Placer Dome, 90%; Government, 10%)	Bulyanhula	3
Petroleum, refinery products	thousand barrels Tanzania and Italian Petroleum Refining Co. Ltd. (Government, 50%; Agip Petroli SpA of Italy, 50%)	Dar Es Salaam	17

# TOGO

AREA 57,000 km<sup>2</sup>

POPULATION 3.9 million



## THE MINERAL INDUSTRY OF THE

# TOGO

By Philip M. Mobbs

A number of internal and external factors combined to make 1992 a poor year for the Togolese economy. Disruptive and often violent strikes, rising wages, weak domestic demand, and a fall in regional commerce adversely affected the subsistence agriculture dominated economy. The domestic turmoil resulted in most foreign investment and new international trade deals being put on hold. The year concluded with a nationwide general strike that began on November 16.

Phosphate rock exported by the Government-owned Office Togolaise des Phosphates (OTP) was the country's leading source of foreign exchange. However, the production of phosphate rock dropped sharply in 1992. Output at the Government-owned cement factory also decreased during the year.

In an effort to diversify its resources, Togo, with help from France's Bureau de Recherches Géologiques et Minières (BRGM) and the United Nations Development Program, continued a mapping and mineral exploration program. Through this effort, a number of mineralized sites containing base metals, bauxite, chromite, diamond, or gold had been identified. The Government had enacted a realistic environmental code and requested assistance from the United Nations in the revision of its mining legislation to promote foreign investments in minerals. Togo anticipated that a new mining code would stimulate potential investors to further investigate the mineral finds.

### GOVERNMENT POLICIES AND PROGRAMS

In August 1991, two decades of one-party rule came to an end when a transitional Government was organized to

oversee the country until democratic elections could be held in 1992. The elections were subsequently postponed until June and July 1993. The country's progressive economic liberalization plans were stalled because of the political and economic unrest.

During the 1990-92 time period, Togo proceeded with the privatization or simple liquidation of some of the state's unprofitable enterprises. The privatization stopped the outflow of Government funds but failed to create new jobs or attract new investment. Most future international investment will likely be in the export processing zones (EPZ) that were established in 1989 to attract foreign companies. By October 1992, 48 companies had been approved for the EPZ, 15 of which had begun operations.

### PRODUCTION

Concerns about the relatively high cadmium levels in the country's exceptionally high-grade phosphate ore had caused the recent decline in Togo's phosphate exports to its traditional markets in Western Europe and the United States. Togo has, however, successfully negotiated new foreign contracts.

Because of the general strike, most of the mineral industry and Government offices had been closed since mid-November. The abbreviated year exacerbated the year's already reduced output, resulting in the decreased production recorded for 1992. (*See table 1.*)

### TRADE

Togo had long enjoyed its status as a regional trade center owing to its port and

other infrastructure that were among the best in west Africa. Although approximately 25% of Togo's imports were officially reexported to neighboring countries, Togo's regional advantages continued to erode as its neighbors improved their own trade facilities. Togo had simplified its tax and tariff structure and eliminated export taxes in a bid to improve its relative position. Additionally, most of the products approved for production under the EPZ law were aimed at the west African regional market.

The country's products enjoyed preferential entry into the United States under the Generalized System of Preferences and into the EC under the Lome Convention. Exports to the United States have oscillated in recent years, dropping from \$3.7 million<sup>1</sup> in 1990 to \$2.9 million in 1991 and rebounding to \$6.1 million in 1992. Imports from the United States, which consisted mainly of aircraft, spare automobile parts, office equipment, and textiles, continued to decline from \$30.7 million in 1990 to \$23.9 million in 1991 to \$19.5 million in 1992.

Cement produced in Togo was from imported clinker, mainly from Germany, Greece, Norway, Spain, Tunisia, and Venezuela. Togo exported cement to Burkina Faso, Ghana, Guinea, Mali, Niger, and Nigeria.

Phosphate rock remained Togo's principal foreign exchange earner, accounting for approximately 25% of exports in 1991. In 1992, Togo's share of world phosphate exports dropped slightly. It exported mainly to Australia, Canada, Italy, New Zealand, and Poland.

### STRUCTURE OF THE MINERAL INDUSTRY

Togo's mineral industry was

dominated by the Government-owned phosphate producer, OTP. With 2,500 workers, it was by far the country's largest industrial employer. It operated phosphate strip mines centered around the cities of Hahotie and Akoumape, about 30 km from its treatment plant and export terminal at Kpeme.

The national marble company, Nouvelle Societe Togolaise de Marbre et de Matériaux (Sotoma), had produced crushed stone, decorative bricks, and roofing materials near the railway about 40 km south of Blitta. Sotoma closed in September 1991 owing to production and financial difficulties. The Government still hoped to find private investors to rent or buy the marble facilities.

Cimtogo, a joint venture with the Government and a Norwegian company, operated a cement factory in Lome. It was originally built to process clinker from the Cement Co. of West Africa (Cimao) project that Togo jointly owned with Côte d'Ivoire and Ghana. The Cimao clinker manufacturing plant, at Tabiligbo, 60 km northeast of the cement plant, shut down in 1984 when it was no longer able to compete with imported clinker. Cimtogo had increased its production capacity from 120,000 mt/a when it first opened in 1971 to 600,000 mt/a based on strong domestic and regional demand.

The U.S.-owned steel company, Societe Togolaise de Siderurgie, which had produced reinforcing rods from semifinished and scrap metal, was closed for financial reasons in October 1991. (See table 2.)

## COMMODITY REVIEW

### Industrial Minerals

In recent years, OTP has experienced a decline in phosphate rock exports to its traditional Western European and North American markets because of customer's concerns over potential liability resulting from the possible negative environmental impact of the relatively high cadmium content of its ores. Togo's phosphate ore contains about 50 to 60 parts per million of cadmium, which would need to be lowered to about 10 to 20 parts per million to compete with other world

phosphate suppliers in its traditional western markets. Cadmium removal procedures were being researched with grant money from the EC. Also under study was the development of new mining areas down dip of the current workings, which would allow access to lower grade phosphate ore with cadmium values within current international tolerances.

OTP struggled through the year, burdened by the Government mandated increases in wages, detrimental exchange rates, lower sales, and payments to the national treasury.

### Reserves

Industry sources estimate that Togo's total phosphate reserves were about 260 Mmt of commercial-grade ore. Togo also was reported to have had very large deposits of lower grade carbonate phosphates around Bassari, about 150 km north of the end of the rail line. The existing phosphate pit contained reserves for about 10 years at 1992 levels of mining. OTP was working with the BRGM on the development of a new mining area next to the current workings.

Apart from phosphate rock and small quantities of limestone, exploitation of minerals in Togo was negligible. A number of potentially valuable mineral deposits were known, but development awaited more detailed exploration and infrastructural improvements. A relatively large deposit of iron ore, estimated to total 95 Mmt, occurs east of Bassari. The deposit, which averages more than 40% iron, mainly as magnetite, has been investigated periodically by the local Bureau National de Recherches Minières (BNRM) and most recently in conjunction with the BRGM. Laterites containing 46% to 53%  $Al_2O_3$  and 18% to 30%  $Fe_2O_3$  occurred on Mount Agou, near Palimé, 100 km northwest of Lome. Manganese deposits were reported in the Bayega area in northern Togo.

A mineral inventory began in northern Togo in 1987 and later extended to other areas of the country. The exploration team, a joint venture between the BRNM and the BRGM, identified many gossans, some of which had elevated levels of arsenic, copper, lead, and zinc. They

also discovered a zone of gold anomalies about 60 km east of Bassari, which might become a target for further exploration. Diamond indications were revealed on the d'Akposso Plateau and in the surrounding alluvial basins, about 50 km north of Palimé. The exploration team also discovered potentially economic deposits of chromite, rutile, and uranium in the northwestern part of the country.

## INFRASTRUCTURE

Togo's highway network consisted of 1,762 km of paved road. The network linked the port and capital, Lome, with neighboring Benin, Burkina Faso, and Ghana. About 515 km of 1.0-m-gauge single-track railway connected Lome with the cities of Anecho, Blitta, and Palimé. All of the principal mineral deposits being mined had access to the rail lines. Exploitation of the iron and manganese deposits in the northern part of the country would require infrastructural improvements.

Phosphate was shipped through the port of Kpeme; most of the remainder of the nation's mineral exports and imports were processed through the port at Lome.

Much of Togo's electricity had been imported from Ghana's Akosombo hydroelectric plant and distributed by Communaute Electrique du Benin, a company set up jointly by the Governments of Benin and Togo in 1975. Compagnie Energie Electrique du Togo, the state utility, had a total installed electrical generating capacity of 179 MW. A 15- to 20-MW hydroelectric plant was proposed for Adjaralara, 75 km downstream from Nangbeto on the Mono River.

## OUTLOOK

The Government remained optimistic that it would be able to maintain or increase its market share of world phosphate exports despite recent concerns over the cadmium level of its ore. If current efforts to reduce cadmium levels in its phosphate ore fail, however, future contracts could be expected to be negotiated at lower prices. Togo's mineral economy should continue to be dominated by its phosphate industry well

into the next century. New industry attracted to the country by the Government's economic policies should provide an important economic buffer during periods of low phosphate prices. However, even with optimistic growth projections, the industrial sector will remain too small to isolate Togo from economic slowdowns when commodity prices are low and the recent trend toward civil unrest and strikes could effectively reduce anticipated international investment.

<sup>1</sup>Where necessary, values have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF264.5=US\$1.00.

#### OTHER SOURCES OF INFORMATION

Chambre de Commerce d'Agriculture et d'Industrie du Togo, Lomé: Bulletin Mensuel, bimonthly.

TABLE 1  
TOGO: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992 <sup>*</sup>
Cement <sup>3</sup>	377,838	389,070	398,530	388,000	350,000
Iron and steel, semimanufactures <sup>4</sup>	14,000	6,197	8,400	*6,000	—
Phosphate rock, beneficiated product:					
Gross weight thousand metric tons	3,464	3,355	2,314	2,965	2,100
P <sub>2</sub> O <sub>5</sub> content <sup>*</sup> do.	1,257	1,270	840	1,076	760
Stone, marble:					
Dimension square meters	11,000	11,206	6,500	—	—
Blocks	—	354	357	*250	—
Crushed	—	977	912	*600	—

<sup>\*</sup>Estimated.

<sup>1</sup>Includes data available through July 31, 1993.

<sup>2</sup>In addition to the commodities listed, Togo presumably produced a variety of crude construction materials (clays, sand and gravel, and other stone) but output is not reported quantitatively, and available information is inadequate to make reliable estimates of output levels.

<sup>3</sup>Produced from imported clinker.

<sup>4</sup>Iron rod production from semifinished metal.

TABLE 2  
TOGO: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Cement	Ciments du Togo (Cimtogo) (Government, 50%; Scancem ANS, Norwegian, 50%)	Lomé	600
Iron	Société Togolaise de Siderurgie (STS) (private U.S. interest, 100%)	do.	*120
Marble thousand square meters	Nouvelle Société Togolaise de Marbre et de Matériaux (Sotoma) (Government, 100%)	40 kilometers south of Blitta	*190
Petroleum products million barrels	Complex Pétrolier (Shell, 60%; Government, 40%)	Lomé	*7.3
Phosphate rock	Office Togolaise des Phosphates (OTP) (Government, 100%)	Near Hahotoé and Akoumapé	*3,600

<sup>\*</sup>Estimated.

<sup>1</sup>Closed in 1991.

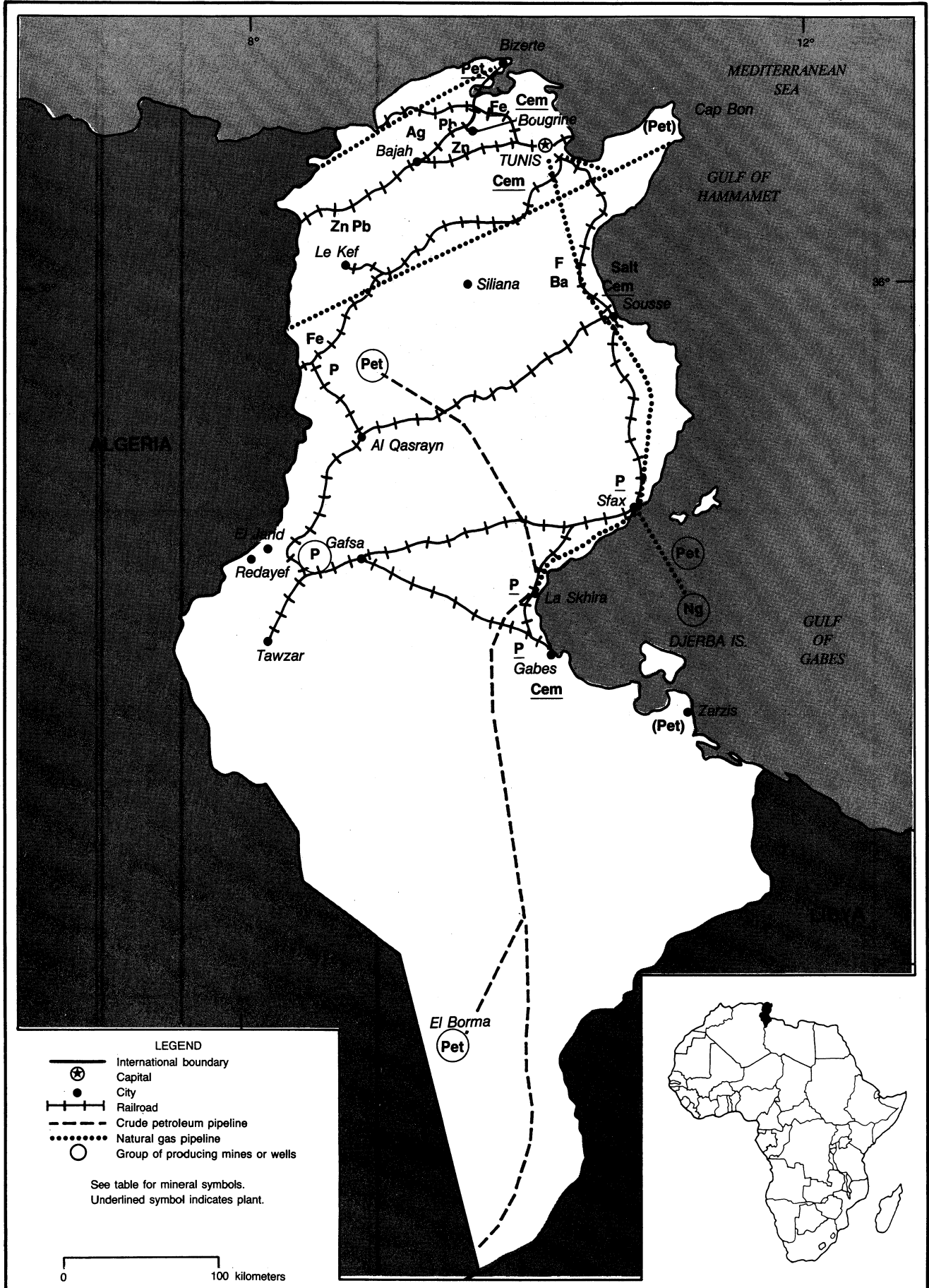
<sup>2</sup>Refinery closed in 1981. Facilities presently being used as a storage depot.

<sup>3</sup>Beneficiated product.

# TUNISIA

AREA 164,000 km<sup>2</sup>

POPULATION 8.5 million



## LEGEND

- International boundary
- Capital
- City
- Railroad
- Crude petroleum pipeline
- Natural gas pipeline
- Group of producing mines or wells

See table for mineral symbols.  
Underlined symbol indicates plant.

0 100 kilometers

## THE MINERAL INDUSTRY OF

# TUNISIA

By Thomas P. Dolley

Tunisia's main mineral commodities, hydrocarbons and phosphate rock, exhibited marginal but sustained growth in 1992. Indeed, the Tunisian economy as a whole has rebounded from the poorer performance of the past 2 years. The exportation of crude oil and phosphate rock and derivative fertilizers continued to be the dominant revenue generators in the mineral sector. Political strife exacerbated the earlier economic downturn. The Tunisian GDP has grown from about \$12 billion in 1991 to \$13 billion<sup>1</sup> in 1992. Export revenues from petroleum, phosphates, and chemicals account for \$1 billion of the GDP.

Efficient legislation by the Government, regarding the exploitation of hydrocarbons, in the late 1980's has aided Tunisia in forestalling consumption overtaking production. The mineral industry and economy have been strengthened by renewed international interest in Tunisia's petroleum resources.

Recent economic pressures on Tunisia have been eased by several factors. Most importantly is that crude oil production, averaging about 120 kbbl/d, now exceeds domestic petroleum consumption averaging 90 kbbl/d. This development has helped forestall imported fuel dependence. The burgeoning agricultural sector has had another successful consecutive harvest, thus lowering imported food costs. Additionally, receipts from the tourism industry recovered in 1992 from the previous year. The total revenue generated by tourism in 1992 exceeded \$1 billion.

### GOVERNMENT POLICIES AND PROGRAMS

Tunisia gained independence from France on March 20, 1956. The Tunisian

legal system is based on French civil law and Islamic law. Basic investment codes covering mining legislation in Tunisia were based on law No. 72-38 of 1972, concerning industries producing exclusively for the export market, and law No. 74-74 of 1974, concerning domestic industries.

The changes that were made in 1990 to the laws governing hydrocarbon exploration and production have succeeded in attracting more international investment. The legislation also allows for more foreign interest in the exploitation of low- and medium-sized hydrocarbon fields. Exploration agreements take three primary forms: an exploration license that allows the operator to undertake geological investigations before making a full commitment; an exploration permit allowing the operator the right to conduct seismic geophysical investigation with options for full prospecting; and, a prospecting permit that allows the operator to carry out geological exploration and drilling for up to 5 years.

The prospecting permit agreement nominally stipulates obligations by the operator and must be approved by law. If a hydrocarbon resource is to be developed, a joint-venture agreement is signed with the Tunisian parastatal *Entreprise Tunisienne d'Activités Pétrolières (ETAP)*. ETAP is obligated to cover its share of expenses if it chooses to participate. Tax and royalty rates have been lowered under the revised laws, and a sliding scale for royalties and taxation is based on a profit to investment ratio. A large signature bonus is not required; however, capital expenditures covering the operator's exploration, valued between 10% to 30% above those specified in the original statutes, have

been introduced. The Government also streamlined the administrative procedures concomitant with the operator applying for the exploration permit.

### PRODUCTION

Despite an increase in the 1992 production figures of phosphate rock and derivatives, along with hydrocarbons, production in the metals sector declined. This latter development and the decline in fluorspar production have been essentially driven by the global market. (*See table 1.*)

### TRADE

In 300 B.C., ancient Carthage, in present day Tunisia, was in the ascendant in mineral trade. Copper from Cyprus, iron from Elba, silver from Spain, and tin from what is now the United Kingdom were traded through the antiquarian port city. However, in 1992, the Government is more concerned with Tunisia's current trade relationship with the EC, with negotiations to resume in 1993.

The total value for exports in Tunisia for 1992 was about \$6 billion, representing a \$600 million increase over that of the previous year. Imports for 1992 were valued at \$6.9 billion. France is Tunisia's most important trading partner, reflecting the fact that more than 70% of Tunisia's trade is with EC countries. Contrasting the latter is Tunisia's trade with member nations in the Arab Maghreb Union comprising Algeria, Libya, Mauritania, Morocco, and Tunisia. Trade with these nations does not exceed 9% of total Tunisian trade.

Tunisia's phosphate rock exports surged in 1992 after flat sales in the



previous year. Nations in western Europe were the main purchasers of Tunisian phosphate. By midyear 1992, France had purchased 107 kmt of phosphate rock and Poland had purchased 133 kmt. Total phosphate rock exports for Tunisia in 1992 was 956 kmt. Total phosphoric acid sales totaled 543 kmt  $P_2O_5$ .

Another major source of revenue for Tunisia, in the form of natural gas, is the trans-Mediterranean pipeline. The pipeline carries Algerian natural gas to Italy via Tunisia. The pipeline's throughput capacity is 12 billion  $m^3$ , which is to be doubled by the construction of a parallel pipeline in 1993. Annual royalty payments to Tunisia from the pipeline are commonly in the form of 500  $Mm^3$  of natural gas. This agreement between Algeria and Tunisia has been stable since 1983.

## STRUCTURE OF THE MINERAL INDUSTRY

Phosphate rock production in Tunisia was entirely controlled and operated by the Government parastatal Compagnie des Phosphates de Gafsa (CPG), founded in 1895. CPG is the largest mining company in Tunisia. Le Groupe Chimique Tunisien (GCT) controls phosphate processing through its Tunisian-owned Société Industrielle d'Acide Phosphorique et d'Engrais (SIAPE) and Société Arabe des Engrais Phosphates et Azotes (SAEPA). In 1989, GCT absorbed Industries Chimiques Maghrebines and Société Engrais de Gabes, both companies being producers of phosphoric acid.

Hydrocarbon exploration and production was overseen with a series of production-sharing agreements between foreign operators and the Tunisian Government-controlled ETAP, usually with ETAP a 45% to 50% equity partner. (See table 2.)

## COMMODITY REVIEW

### Metals

The first privately owned and managed mine in Tunisia, the lead-zinc mine at

Bougrine, was to commence production in 1993. The operator of the mine, Société Minière de Bougrine (SMB), has equity ownership of 50% by Canada's Metal Mining Corp., which is in turn a subsidiary of Germany's Metallgesellschaft AG. The remaining equity ownership is by the Tunisian parastatal Office National des Mines, along with the Tunisian banks Société Tuniso Seoudienne d'Investissement (STUSID), Banque Tuniso Koweitienne de Développement (BTKD), and Banque de Développement Economique de Tunisie (BDET). Additional funding is to be provided by the World Bank's International Finance Corp. (IFC). Total capital development costs are estimated at \$75 million. The annual output of the mine is expected to be 38 kmt of zinc and 8 kmt of lead. Metall Mining reported that the resource contains minable ore reserves of 5 Mmt Grading 11.7% zinc and 2.6% lead.

### Industrial Minerals

**Cement.**—By mid-1992, privatization plans for seven cement plants in Tunisia were to be put into effect by the Government. After postponement of these plans since the 1980's, the Government appeared committed to privatization. Tenders for the privatization plan should be submitted by 1993, following a study financed by the IFC.

**Fluorspar.**—The underground fluorspar mine at Hamman Zriba, 60 km south of Tunis, suspended production in mid-1992. The mine was operated by Société Minière de Spath Fluor et Barytine (Fluobar) and was Tunisia's premier fluorspar source with a production capacity of 42 kmt/a. Fluobar is 51% owned by the Government with the remaining 49% owned by Société Industries Chimiques du Fluor (ICF).

Fluorspar output from the mine graded 97%  $CaF_2$  with 100% domestic utilization by ICF's Gabes  $AlF_3$  production facility. Despite 100% domestic use of the fluorspar, ICF stated that the company cannot remain globally competitive, and the mine was closed. The future for the

Gabes plant is unclear, but the Government is selling its 61.4% share in ICF.

**Phosphate Rock.**—Tunisian phosphate rock is mined primarily in the Gabes region from a variety of open pit and underground sources. Underground sources are waning, as open pit mining is more cost effective. The phosphate rock is produced for direct export or conversion to phosphatic fertilizers. Phosphatic fertilizer production, including triple superphosphate (TSP), totaled 820,876 tons for 1992.

Increased production of phosphate rock was driven by export demands in 1992. The increase was welcomed by CPG, which ended the previous year in deficit, owing to a declining world market. Additionally, by yearend 1992, the Government approved a capital increase in CPG of about \$14 million.

### Mineral Fuels

Petroleum exploration and production has steadily increased since 1990, primarily owing to new legislation enacted to attract foreign companies. The number of new wells drilled, both onshore and offshore, has tripled to 22 since 1989. Concomitantly, foreign capital investment in Tunisian oil has doubled to \$140 million over the same period. Though Tunisia was once predicted to be a net importer of crude oil by this period, careful planning and development of reserves has delayed this scenario for about 12 years.

Oil companies from the United States predominated the surge in exploration in Tunisia for 1992. Notable U.S. companies include Marathon Oil Co., with new production from the Belli Field at 10 kbbl/d, and Texaco's significant oil discovery 170 km south-southeast of Tunis in Upper Cretaceous carbonates. France's Société Nationale Elf Aquitaine and ETAP will be investing \$210 million to maintain annual oil production of 7 Mbbl for the Ashtart Field.

As of yearend 1992, natural gas provided about 17% to 33% of Tunisia's energy requirements. The 1991 agreement

between the United Kingdom's British Gas and ETAP has resulted in the announcement of the \$580 million development of the offshore Miskar gasfield. Although the production from the Miskar gasfield will be minimal for the export market, British Gas will sell 100% of production to the domestic market. According to the agreement with ETAP, the gas will be paid for in hard currency, and British Gas may transfer profits to other countries. Additionally, flexible royalties of between 2% and 15% have made development of the field attractive to British Gas.

### Reserves

Tunisia's reserves of phosphate rock are low grade but extensive. The African Development Bank estimated Tunisian phosphate rock reserves at 3.5 to 4 billion tons, which was approximately 5% of the global reserve of phosphate rock. Crude petroleum reserves have been estimated at 1.7 billion bbl; however, this figure will fluctuate based on an extensive exploration program currently under way and geologic complexity. Total estimated reserves of natural gas are 85 billion m<sup>3</sup>.

### INFRASTRUCTURE

A total of 2,115 km of railway was the primary mode of transportation of phosphate rock to chemical plants or seaports. Highways within Tunisia total 17,700 km. Crude oil pipelines are 797 km long and natural gas pipelines total 742 km. Tunisia has an electrical generation capacity of about 1.5 MkW. Combined cycle power stations, which generate electricity from natural gas, are a construction priority in Tunisia.

### OUTLOOK

Renewed petroleum exploration coupled with an improving trade situation have kept Tunisia in a reasonable fiscal situation. Tunisia should be in favorable position for cooperation with the EC. Recent petroleum discoveries and increased utilization of natural gas have helped to forestall energy imports.

<sup>1</sup>Where necessary, values have been converted from Tunisian dinars (D) to U.S. dollars at a rate of D0.885=US\$1.00.

### OTHER SOURCES OF INFORMATION

#### Agencies

National Office of Mines  
Departement de Geologie  
95 Avenue Mohamed V  
1002 Tunis Le Belvedere  
Tunisia

National Geological Survey  
Departement de Geologie  
95 Avenue Mohamed V  
1002 Tunis Le Belvedere  
Tunisia

Compagnie des Phosphate de Gafsa  
Cité Baycech  
Gafsa 2100  
Tunisia  
Tel: 06 22 022.

Société Tunisienne d'Expansion Minière  
(SOTEMI)  
Rue Mongi Slim  
Le Kef, Tunisia  
Tel: 20388.

Société Minière de Spath Fluor et Barytine  
(Fluobar)  
16 Rue Othman Ibn Affen  
Tunis, Tunisia  
Tel: 287 510.

TABLE 1  
TUNISIA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992 <sup>*</sup>	
<b>METALS</b>						
<b>Iron and steel:</b>						
Iron ore and concentrate, gross weight	thousand tons	325	280	291	295	<sup>2</sup> 291
Fe content	do.	<sup>1</sup> 172	<sup>1</sup> 148	<sup>1</sup> 154	<sup>1</sup> 156	<sup>1</sup> 151
<b>Metal:</b>						
Pig iron	do.	128	140	140	140	140
Steel, crude	do.	159	187	177	193	181
<b>Lead:</b>						
Mine output, Pb content		<u>3,653</u>	<u>2,702</u>	<u>2,966</u>	<u>1,285</u>	<u><sup>1</sup>1,362</u>
<b>Metal:<sup>3</sup></b>						
Primary <sup>4</sup>		2,200	2,200	2,200	750	<sup>3</sup> 913
Secondary		500	500	500	250	250
Total		<u>2,700</u>	<u>2,700</u>	<u>2,700</u>	<u>1,000</u>	<u>1,163</u>
Silver metal, primary	kilograms	933	933	930	900	900
Zinc, mine output, Zn content		8,500	10,000	7,000	9,353	<sup>4</sup> 4,090
<b>INDUSTRIAL MINERALS</b>						
Barite		18,868	33,104	30,885	22,366	<sup>3</sup> 30,179
Cement, hydraulic	thousand tons	3,228	3,228	3,300	3,300	3,300
Clays, construction <sup>*</sup>	do.	350	350	350	350	350
Flourspar, chemical and metallurgical-grades		55,416	53,575	40,974	37,580	<sup>1</sup> 13,750
Gypsum <sup>*</sup>		100,000	100,000	100,000	100,000	100,000
Lime	thousand tons	650	650	650	650	600
<b>Phosphate rock:</b>						
Gross weight	do.	6,103	6,610	6,258	6,352	<sup>3</sup> 6,400
P <sub>2</sub> O <sub>5</sub> content	do.	<sup>1</sup> 1,813	<sup>1</sup> 1,963	<sup>1</sup> 1,858	<sup>1</sup> 1,880	<sup>1</sup> 1,900
Salt, marine	do.	485	480	402	441	<sup>3</sup> 460
<b>MINERAL FUELS AND RELATED MATERIALS</b>						
<b>Gas, natural:</b>						
Gross <sup>*</sup>	million cubic meters	368	388	374	236	200
Dry	do.	184	190	200	200	150
<b>Petroleum:</b>						
Crude	thousand 42-gallon barrels	<u>37,230</u>	<u>37,595</u>	<u>36,500</u>	<u>38,690</u>	<u>40,259</u>
<b>Refinery products:</b>						
Gasoline <sup>*</sup>	do.	1,800	1,800	<sup>2</sup> 2,200	<sup>2</sup> 2,293	2,200
Kerosene <sup>*</sup>	do.	2,400	2,400	<sup>2</sup> 2,400	<sup>1</sup> 1,163	1,100
Distillate fuel oil <sup>*</sup>	do.	3,000	3,000	<sup>3</sup> 4,042	<sup>3</sup> 3,897	3,800
Other <sup>*</sup>	do.	400	400	<sup>3</sup> 400	400	400
Refinery fuel and losses <sup>*</sup>	do.	200	200	<sup>1</sup> 111	<sup>3</sup> 232	200
Residual fuel oil <sup>*</sup>	do.	4,000	4,000	<sup>3</sup> 3,857	<sup>3</sup> 3,511	3,500
Total <sup>*</sup>	do.	<u>11,800</u>	<u>11,800</u>	<u>13,010</u>	<u>11,496</u>	<u>11,200</u>

<sup>\*</sup>Estimated.

<sup>1</sup>Table includes data available through Oct. 1993.

<sup>2</sup>In addition to the commodities listed, a variety of crude construction materials (common clays, sand and gravel, and stone) is produced, but output is not reported, and available information is inadequate to make reliable estimates of output levels. Limestone quarried for cement manufacture is substantial; however, information is inadequate to make accurate estimates of output.

<sup>3</sup>Reported figure.

<sup>4</sup>From domestic and imported ores.

TABLE 2  
TUNISIA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

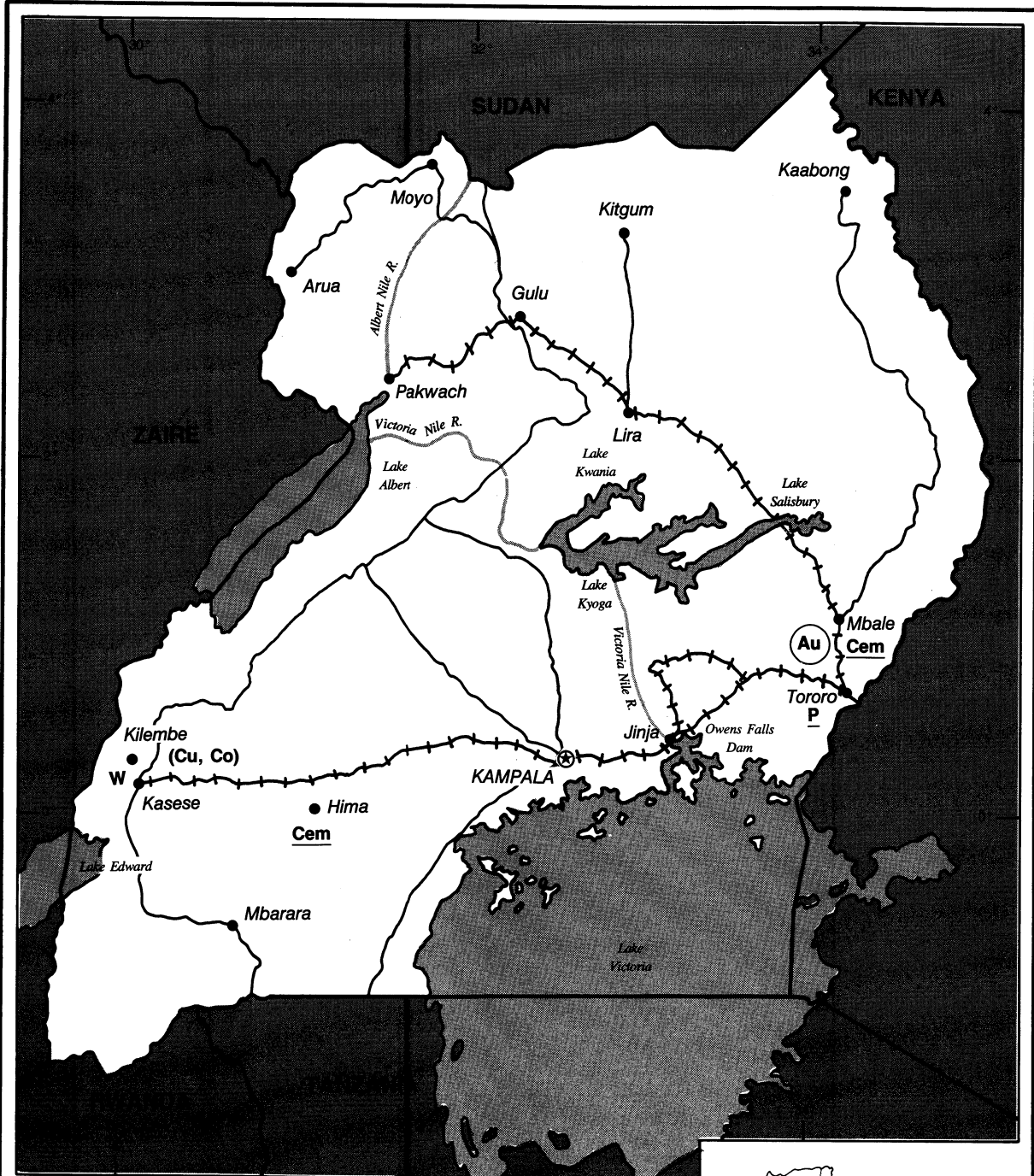
(Metric tons unless otherwise specified)

Major commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Barite	Société Tunisienne d'Expansion Minière (Government, 100%)	Zriba	30,000
Cement	million metric tons	do.	2.5
Iron ore	do.	Djebel Djerissa iron mine	295,000
Crude steel	do.	El Fouladh steel mill	200,000
Lead, zinc concentrate	do.	Fedj Hassen Mine, Bou Jaber	3,000 4,000
Petroleum, crude	thousand barrels	Elf Aquitaine, Entreprise Tunisienne d'Activités Petrolières (ETAP) (Société National Elf Aquitaine, France, 50%; ETAP, 50%)	Ashtart 9,125
Do.		Agip-Tunisia, Société Italo-Tunisienne d'Exploitation Petrolière (SITEP) (Azienda Generali Italiana Petroli-Tunisia, (Agip-Tunisia), Italy, 50%; SITEP, 50%)	El Borma 25,900

# UGANDA

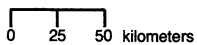
AREA 236,040 km<sup>2</sup>

POPULATION 19.4 million



- LEGEND**
- International boundary
  - Capital
  - City
  - Railroad
  - Road
  - River
  - Group of producing mines or wells
  - Undeveloped significant resource

See table for mineral symbols.  
Underlined symbol indicates plant.



## THE MINERAL INDUSTRY OF

# UGANDA

By David Izon

Uganda had no mineral production of world significance in 1992. However, the country has some mineral deposits such as copper that could affect the world's mineral economy if production resumed. The other mineral commodity of importance was cobalt, a byproduct of copper. The production of cobalt from copper tailings from the Kilembe Mine on a pilot basis is scheduled to begin in 1995. Uganda is an agricultural state, with a GDP of \$5.6 billion<sup>1</sup> in 1992. Agriculture accounted for about 98% of export earnings, with coffee leading the produced export commodities, accounting for 70% of foreign exchange earnings. The Ugandan Government through Uganda Railways Corp. leased six locomotives to Kenya to expedite the import-export process. Most of Uganda's exports passed through the port of Mombasa in Kenya.

The Government signed an agreement with Bureau de Recherches Géologiques et Minières of France (BRGM) and Barclays Metals Ltd. of the United Kingdom to process the Kilembe Mine tailings for cobalt. This agreement by Barclays Metals Ltd. and Societe d'Etudes de Recherches et d'Exploitations Minières (SEREM), a subsidiary of BRGM, was to invest \$50 million in Uganda's state-owned Kasese Cobalt Co. (KCCL). The investment was facilitated by a guarantee from the World Bank's Multilateral Investment Guarantee Agency. About \$40 million of the \$50 million would serve as insurance guarantee to the banks that made the loans for funding the project. KCCL is expected to convert existing stockpiles of cobalt sulfide at the Kilembe Mine to cobalt. The anticipated market for the cobalt is expected to be Europe and the United States. The project should have an

important development impact on Ugandan mineral industry as investors gain more confidence in the Government. The mine tailings were estimated to contain 1.1 Mmt of cobalt. Cobalt retrieval from the Kilembe Mine tailings by this method should take 12 years and is scheduled to commence in 1995. The Government held 45% equity in the venture, and BRGM and Barclays each held a 27.5% share.

Uganda's major export products, in order of importance, were coffee, salt, sugar, and tea. Its major trading partners were France, the Federal Republic of Germany, Kenya, the United Kingdom, and the United States. The country imported machinery, parts, and clothing mainly from the Federal Republic of Germany, the United Kingdom, and the United States. Uganda imported petroleum products from neighboring Kenya. In 1992, Uganda Railway Corp. and Kenya's Railway Corp. concluded an agreement to cooperate in exporting

coffee and petroleum products by rail.

Uganda was making efforts to increase mineral production with the addition of gold and iron ore to mineral output in 1992. A shortage of adequate financing for reconstruction or rehabilitation of degenerated mining equipment and facilities has hindered recovery of the mining industry. However, increasing confidence in the reform process and structural adjustment program has led to growth in foreign investment in the energy and mining sectors. (See table 1.)

Other mineral commodities, such as cement, limestone, and tungsten, had reasonable growth in output, but frequent power shortages at the Mobuku power station and the national grid disrupted the output capacity of the cement plant. Power failures at the Mobuku power station were due to the drought. Work on the Owen Falls Dam continued satisfactorily, hoping to add 30 MW at the completion of rehabilitation and upgrading in 1994. The Government

TABLE 1  
UGANDA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992
Cement, hydraulic	14,244	13,755	26,920	50,000	50,000
Gold					3,800
Iron ore					132
Lime, hydrated and quick <sup>3</sup>	500	500	1,500	2,000	1,500
Phosphate minerals: Apatite <sup>3</sup>	100	100	100	100	100
Salt, evaporated <sup>3</sup>	5,000	5,000	5,000	5,000	5,000
Tin, mine output, Sn content <sup>3</sup>	10	10	25	25	30
Tungsten, mine output, W content <sup>3</sup>	4	4	4	4	66

<sup>1</sup>Estimated. <sup>2</sup>Revised

<sup>3</sup>Includes data available through Aug. 2, 1993.

<sup>2</sup>In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (clays, sand and gravel, and stone) presumably are produced, but output is not reported quantitatively, and available information is inadequate to make reliable estimates of output levels.

<sup>3</sup>Reported figure.

continued the phosphate extraction studies at the Tororo apatite deposits, with emphasis on market sources. Other important projects in 1992 were the Gasohol Development project, the geothermal energy project funded by OPEC and the Government of Iceland through UNDP, the minihydropower development and rehabilitation projects funded by the Governments of Korea and Austria, and the petroleum exploration program in the Rift Valley area.

There were no officially reported reserve figures for minerals, but the outlook was encouraging. The country's continued efforts to revive its mining industry and improve its infrastructure should lead to growth of the mineral industry and may help stabilize the economy. The cobalt project under way, if managed properly, could stimulate foreign investors' confidence in the economy. Also, the completion of the phosphate mine and fertilizer plant could

enhance production of food crops and provide an additional export commodity. The addition of gold and iron ore extraction to mineral output should add to the country's revenue and foreign exchange sources.

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<sup>1</sup>Where necessary, values have been converted from Ugandan shillings (USH) to U.S. dollars at USH1,200.00=US\$1.00 in 1992.

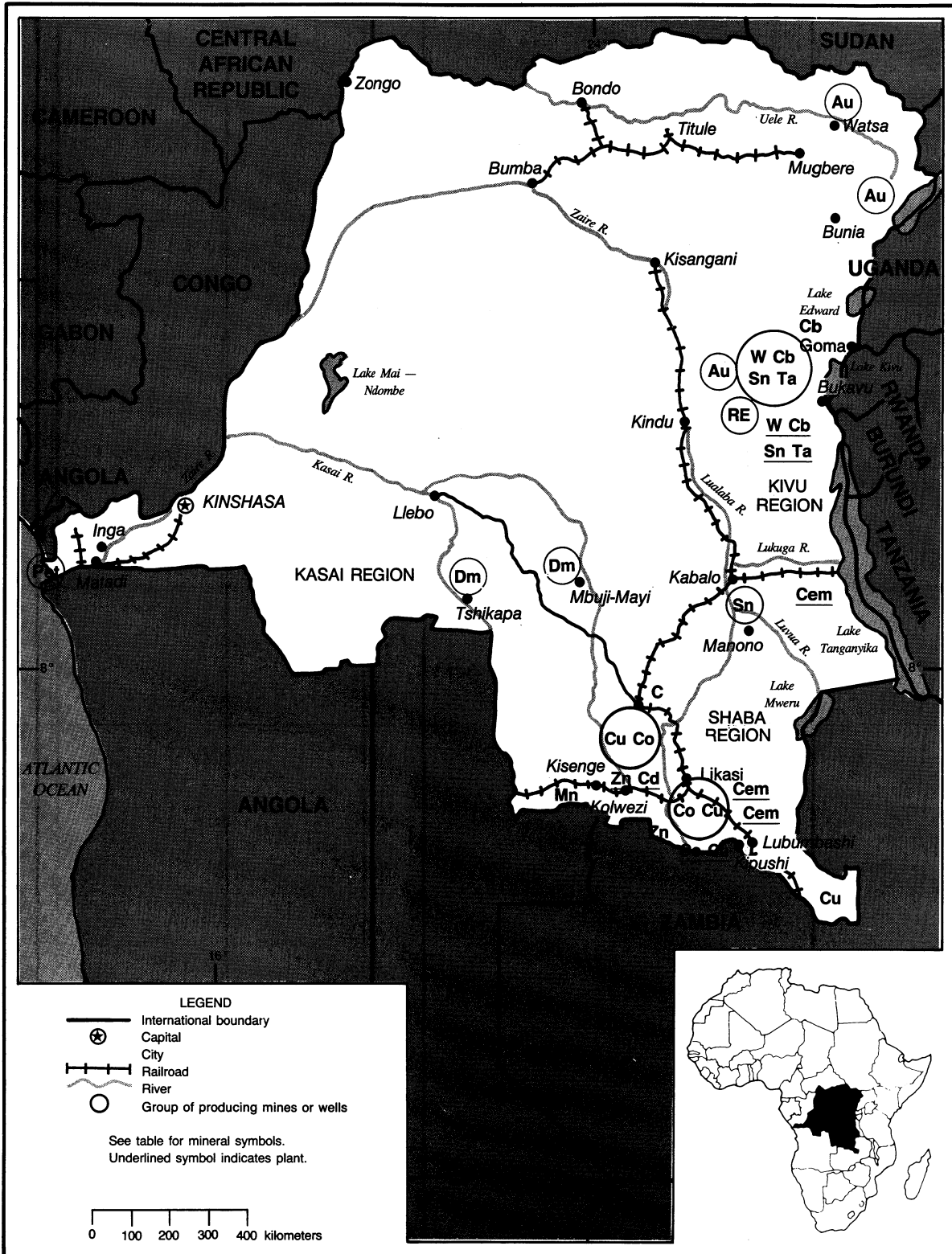




# ZAIRE

AREA 2,345,410 km<sup>2</sup>

POPULATION 39 million



## THE MINERAL INDUSTRY OF

# ZAIRE

By Michael M. Heydari

The overall decline of Zaïre's mining industry continued at a rapid pace in 1992 as production of copper and cobalt, the two major foreign currency earners, continued its precipitous slide. Finished copper production declined 39% in 1992, following a 34% decline in 1991, to 135,180 tons. Cobalt metal output fell 23%, following a 14% drop in 1991, to 6,628 tons. The decline in overall cobalt output in 1992 despite the availability of stockpiled intermediate-grade cobalt hydrate suggests that recovery from ore has declined. Stockpiled cobalt hydrate accounted for about 38% of the feed to refineries. Gold, silver, and zinc production also declined.

Historically, the mining industry had accounted for 25% of the GDP and about three-quarters of total export revenues. However, in 1992, lower production and sales of copper and cobalt resulted in a drop of about 40% in revenues of La Générale des Carrières et des Mines (Gécamines), the parastatal mining company responsible for most mineral production. Gécamines incurred an estimated loss of about \$200 million and had difficulty meeting its payroll obligations. Payment to several suppliers and contractors were suspended. Consequently, the company was unable, for the second year in a row, to make tax payments to the Government. This eliminated the source of about 25% of total Government revenues and caused a critical shortage of foreign exchange in the country. The drop in export revenues further aggravated the company's already weak cash-flow situation and negatively affected the Zairian economy. The poor output performance of Gécamines was due primarily to a lack of investment funds, aging equipment, insufficient equipment maintenance, spare parts and

fuel shortages, and poor management.

### GOVERNMENT POLICIES AND PROGRAMS

Despite a drop in foreign assistance and in receipts from vital exports such as copper, cobalt, and coffee, Government spending accelerated during 1992. This resulted in four-digit inflation that pushed prices to record levels as wages failed to keep pace. The Government introduced 5 million zaïre (ZZ) bills, which further fueled inflation.

The country was in political and economic chaos as it had two governments and two rival Prime Ministers, one appointed by the National Conference and the other by the President. The former was recognized by Zaïre's main Western donor nations, Belgium, France, and the United States. The stalemate resulted in a situation where no decision was made about the long-overdue overhaul of Gécamines; statements as to privatization plans and the lay off of up to one-half of the labor force issued by one Prime Minister were declared null and void by the other Prime Minister. This left various interested foreign mining companies, including South African concerns, with no real counterpart to negotiate with.

In late 1992, as a condition for further financial assistance, the World Bank asked Gécamines to undertake a number of steps aimed at restructuring and privatizing the company. These steps included suspending unprofitable operations; curbing the diversion of Gécamines assets and resources; and conducting a comprehensive audit of technical, financial, and social aspects of operations by a management consulting team. However, it was unlikely that

Gécamines would agree to full implementation of these measures.

### PRODUCTION

Gécamines faced multiple crises in production, transportation, and finance, placing the company on the verge of collapse. Production from the Kolwezi area was about one-third of its 1989 level, partly because of the continued impact of the Kamoto Mine cave-in. The resulting shortfall in production idled facilities throughout the enterprise. Efforts to make up for lost underground mine production with that from open pits were severely hampered by parts and fuel shortages owing to a lack of cash or credit. The Kov and Dikuluwe open pit mines remained partially flooded. Management was overwhelmed by a flood of internal and external problems and scattered its effort and scarce resources without achieving any meaningful results.

Gécamines had more than 36,000 employees with 1991 payroll expenses of more than \$400 million—equivalent to about 50% of 1991 gross earnings. Employees' benefit packages included subsidized foodstuffs, free medical care, and a system of at least 35 different types of cash bonuses. Gécamines increased salaries several times in 1991 and 1992 in response to strikes and threats of strikes. However, in spite of the pay increases, salaries did not keep pace with inflation as the price of major staples soared. Gécamines' disaffected labor force was involved in theft and pilferage. It was widely believed that the company was overstaffed and every facility could effectively operate with only a fraction of the existing personnel. In early 1993, there were reports that Gécamines planned to dismiss one-half of its work

force. Such layoffs, if implemented, would be consistent with the World Bank and IMF recommendations and the continuing decline in output at Gécamines. (See table 1.)

## TRADE

Exports of mineral commodities dropped sharply in 1992 owing, primarily, to a fall in copper and cobalt production. The main mineral commodities exported were as follows: copper, \$343 million; cobalt, about \$200 million; diamond, about \$200 million; crude petroleum, about \$170 million; gold, about \$40 million; and zinc, \$21 million.

Zaire's main trading partners, in order of importance, were Belgium, the United States, Japan, France, Germany, and the Republic of South Africa. Imports by the United States from Zaire were about \$250 million, 17% less than those in 1991, consisting mainly of crude petroleum, \$117 million; gem diamond, \$90 million; cobalt, \$28 million; refined copper cathode, \$5 million; unwrought zinc, \$5 million; and tantalum ore and concentrate, \$3 million. U.S. exports to Zaire were \$33 million in 1992—slightly more than one-half the value in 1991—and consisted mainly of wheat, used clothing, spare parts, and mining and transport equipment. (See tables 2 and 3.)

## STRUCTURE OF THE MINERAL INDUSTRY

Zaire's Government maintained at least part ownership, and generally majority ownership, of nearly all the productive and service sectors of the economy. Gécamines, the principal parastatal company, operated on its own fiscal regime. Its holdings included subsidiary companies that produced coal, cement, and other materials required for its primary mineral interests.

Legislation exists relating to all aspects of the mineral industry. Article 10 of the Constitution states that the soil and subsoil belong to the state. Prospecting

and exploration, and exploitation in the mineral sector is regulated by Ordinance No. 81-013 of April 2, 1981. All such undertakings require permits from the Ministry of Mines and Energy. (See table 4.)

## COMMODITY REVIEW

### Metals

**Cobalt.**—Zaire's total cobalt production dropped 23% from its 1991 level to 6,628 tons. The rate of decline was far below that of copper, about 39%, owing to the utilization of about 4,100 tons contained cobalt of previously stockpiled cobalt hydrates as additional feed to the refineries. For many years Gécamines has been precipitating excess cobalt as hydrate from its hydrometallurgical plants' cobalt leach circuits and stockpiling this material for later use. At the current rate of drawdown of cobalt hydrates, it is estimated that there are sufficient stockpiles outside of the Luilu plant to sustain the current cobalt production level through 1994. There are additional stockpiles of cobalt hydrate and matte at Shinkolobwe, about 20 km west of Likasi. The Shinkolobwe Mine supplied uranium for the Manhattan project in the early 1940's and earlier radium for Madame Curie. Stockpiles at Shinkolobwe are being assessed for grade, quantity, and recoverability. Gécamines has undertaken a technical and economic study of the solvent extraction technique to treat its existing and future tailings. It placed more emphasis on cobalt as a primary foreign currency earner and increased the production of white alloy and cobalt-nickel matte to about 1,600 tons, in terms of cobalt content. This accounted for one-quarter of total cobalt production. The white alloy contains 50% cobalt, 40% iron, and 10% copper.

In the second half of 1992, with the steadily declining cobalt prices, Gécamines was forced to offer its cobalt at prices below the producer price jointly set by Zambia Consolidated Copper Mines (ZCCM) and Gécamines. The producer price had been set at \$55/kg

(\$25 per pound). The free market price decreased to about \$33/kg (\$15 per pound) by the end of 1992. In November, the producer price was set at \$40/kg (\$18 per pound). Gécamines announced that it had reached an agreement with Russian officials, traders, and producers to undertake measures to stabilize the cobalt market. Zairian cobalt was mostly trucked to South African ports for export to European, Japanese, and North American destinations. Several incidents of theft of cobalt, at the mines and shipment points, were reported during the year. It is estimated that up to 100 mt/month of cobalt, worth about \$40 million per year at current spot prices, is diverted by local officials.

In November 1992, Kokkola Chemicals Oy (KCO), a subsidiary of Outokumpu Oy of Finland, entered into a contract to purchase cobalt raw material from Gécamines's Lubumbashi smelter's convertor slag stockpile. The latter contains an average of 8.5% cobalt, 10% copper, 5% zinc, and 7% lead. Under terms of the contract, highly favorable to KCO, the latter will have available at its Kokkola, Finland, facilities a ready supply of cobalt slag without requiring it to pay for such material until it is used. KCO has agreed to purchase 45,000 tons of cobalt slag and to use a minimum of 11,000 tons and 20,000 tons in 1993 and 1994, respectively. Approximately 13,500 tons was expected to be delivered to the Kokkola facility by mid-April 1993, with the remaining amount to arrive in Kokkola by the end of May 1993. The price payable under the contract for cobalt and copper derived from the cobalt slag is based on prices quoted in Metal Bulletin at the time KCO uses the cobalt slag. The contract provides that the parties will renegotiate the agreement upon an unforeseen material change in the circumstances of either party that might render the contract unfair. Gécamines still has about 5,000 tons of uncommitted convertor slag available at the Lubumbashi smelter.

Cobalt prices continued to decline in early 1993, in spite of Zaire's crisis, as the U.S. Defense Logistics Agency auctioned cobalt from its strategic

stockpiles. In the first quarter of 1993, about 22,500 kg of cobalt rondelles and 11,500 kg of granules were sold at prices ranging from \$29.85/kg (\$13.55 per pound) to \$30.84/kg (\$14.02 per pound).

**Columbium-Tantalum.**—Société Minière et Industrielle du Kivu (Sominki) continued to produce columbite and tantalite concentrate. Société Minière du Kivu (Somikivu)—a joint venture of Gesellschaft für Electrometallurgie, GmbH of Germany (70%); the Government of Zaïre (20%); and Sominki (10%)—operated the Lueshe Mine, 70 km north of Goma. The deposit is a carbonatite with pyrochlore mineralization. Average ore grade is 2.90%  $Cb_2O_5$ , and pyrochlore concentrate containing 69% to 73%  $Cb_2O_5$  is produced. The concentrate was trucked to Mombassa in Kenya and then shipped to Hamburg, Germany, and thence to the Gesellschaft für Electrometallurgie, GmbH plant in Nurnberg, Germany.

**Copper.**—Owing to numerous difficulties, including a lack of production from the Kamoto underground mine, which suffered a major cave-in September 1990, Gécamines' copper production dropped to less than one-third of its 1989 level and hit a 20-year low in 1992.

Completion of the mobile KOV Mine's in-pit crusher/conveyor belt system, supplied by Krupp of Germany, was delayed. The overburden removal operation continued. Dewatering operation at the Dikuluwe-Mashamba open pit in Kolwezi progressed very slowly due to equipment breakdown and lack of spare parts. Repair work on Kolwezi concentrator's dry grinder mills was interrupted as a result of riots in October 1992.

The Lubumbashi smelter stopped operation in 1992 owing to the lack of raw materials and technical problems. Several scheduled re-startup attempts in early 1993 were postponed. Lack of coal and coke, lime, and sulfuric acid contributed to smelter and refinery stoppages. Theft of copper reached higher

proportions with about 500 mt/month to 600 mt/month of copper being stolen in Kolwezi, by among others, security forces. In addition, theft of fuel, lubricants, electric cables, and spare parts continued. Tribal conflicts between Kasai and Katanganese workers continued throughout Shaba. In Kolwezi, all Kasai workers were fired by Gécamines.

The contract to sell Sodimiza's concentrate to Marc Rich expired in December 1992. Starting in 1993, concentrates from the two Sodimiza's operations, Kinsenda and Musoshi Mines, about 100 km southeast of Lubumbashi, were to be sent to the Lubumbashi smelter. In late 1992, two underground chambers collapsed at the Kinsenda Mine. A number of workers were injured, mostly due to air blast.

In 1992, Gécamines' production cost was estimated at more than \$3.30/kg (\$1.50 per pound) in the face of copper prices of less than \$2.20/kg (\$1.00 per pound) and falling; in early 1993, copper prices fell to less than \$1.76/kg (\$0.80 per pound).

**Gold.**—Gold production is in part by medium-sized companies and in part by artisanal miners. The former include Sominki and the Office des Mines d'Or de Kilomoto (Okimo). It is difficult to estimate the quantity of artisanal production, which is mostly smuggled across the eastern and northeastern borders. Zaïre's formal gold output continued its downward trend, largely due to obsolete equipment and lack of new development work at the mines. Sominki gold production was primarily from two operations, the Mobale underground mine at Kamituga, 100 km southwest of Bukavu, and the Lugushwa alluvial operation. Plans for rehabilitation of the old Kilomoto gold operations, including modernization of the processing facility, and development of a new gold mine at Kilomoto have been further postponed pending resolution of the country's economic and political crises. Foreign participants in these projects included Republic of South Africa's Gold Fields, Belgian and French investors, and the International Finance Corp. (IFC). The

operation produced about 108 kg of gold in 1992.

**Zinc.**—Electrolytic zinc metal production fell from 38,206 tons in 1990 to 28,321 tons in 1991 to 18,833 tons in 1992. Zinc output was a byproduct of Gécamines' Kipushi Mine west of Lubumbashi. The Kipushi Mine's production dropped to very low levels owing to shortages of spare parts and hydraulic fluid for the drilling equipment. Pumps at the mine could barely handle water levels during the dry season and were overwhelmed by heavy rainfall.

### Industrial Minerals

The Société Minière de Bakwanga (MIBA), 80% owned by the Zairian Government, remained the major official diamond producer in Zaïre. It sells its output to a subsidiary of the De Beers Consolidated Mines group under contract. The company's 1992 production dropped to about 4.3 million carats from 7.2 million carats in 1991 and an 11-year high of 9.6 million carats in 1990. Throughout 1992, MIBA's operations ran at about 40% of capacity owing to shortages of chemicals, fuel, and spare parts. The overall grade of the deposits mined was about 5 carats/m<sup>3</sup>. MIBA's diamond sales in 1992 amounted to \$46.3 million. Because of its production difficulties, MIBA was granted an export duty exoneration by the Zairian Customs Administration, known by its French acronym OFIDA. In early 1993, OFIDA and MIBA were embroiled in a dispute over duties on MIBA's 1992 exports as OFIDA claimed that it had granted MIBA only a duty deferral.

The balance of diamond output was by artisanal workers who have historically accounted for the largest portion of diamond production in Zaïre. Output by artisanal workers is purchased by buyers/counters known as "comptoirs." Among these is a subsidiary of De Beers and other companies owned by various interests. Production in 1992 by artisanal workers, scattered throughout the diamond regions of Tshikapa and Mbuji Mayi, was estimated at more than 10

million carats. The ratio of gem to industrial diamond recovered by artisanal workers is higher than that for MIBA, but their level of recovery is lower.

In 1992, the dozen registered diamond trading houses exported about \$185 million worth of diamond from Zaïre. However, the "unregistered" trade in diamonds has been estimated to be as high as two times the official amounts; most of it by smuggling through underinvoicing of legally recorded diamonds on their way to the principal diamond-cutting center in Antwerp, Belgium.

An alluvial diamond deposit, previously termed as a substantial new find near Kisangani, proved to have a reserve valued at less than \$3 million. Wye Resources Corp., a Canadian company, has arranged initial private financing through a shareholder loan to enable it to begin sampling at its diamond concessions in Zaïre. The company holds four contiguous placer areas in a remote part of the country that, reportedly, is unaffected by the series of unrests in Kinshasa.

### Mineral Fuels

The assets of several oil companies, including Chevron Overseas Petroleum, Inc. and Mobil Oil Corp. of the United States, Petrofina of Italy, and Royal Dutch/Shell Petroleum Co. of the Netherlands, were seized, "requisitioned," on May 29, 1992, by the Government in a move to control petroleum production and distribution. The requisitioning was not reversed until September 3, 1992, when a new Government was in place. During the requisitioning, fuel distribution and sales were handled by the parastatal Petrozaire. The latter sold gasoline and diesel at a substantial loss, could not account for a large proportion of the cash proceeds from its fuel sales, and ultimately was unable to replace the stocks that it had sold.

Zaïre Gulf Co., the country's sole offshore oil producer, continued to produce at an average level of 23,000 bbl/d throughout 1992. Onshore oil production resumed as of January 1992,

after a 3-month hiatus, but Zaïre Rep Co., the country's sole onshore producer, restricted its production to only 3,000 bbl/d—30% of capacity—pending resolution of its claims against the Government of Zaïre for the losses it suffered in the 1991 lootings.

Zaïre imported 137,000 bbl of crude oil from Nigeria that was refined in the Soziri-Muanda refinery. The Soziri-Muanda refinery, which resumed processing crude in late December 1991, was idle for all but 4 of the first 5 months of 1992 because of lack of insurance coverage for crude and product at the refinery. Petroleum exports to the United States amounted to 7.5 Mbbl. Coal production from the Luena Mine was halted as a result of tribal conflicts in Shaba. Coal was imported from Zambia.

### Reserves

Zaïre's major mineral reserves are considered sufficient for many years of production, although reserves of high-grade ores are limited. However, inadequate financing for transportation, mine development, and maintenance of mining operations will inevitably result in reduced levels of exploitation. In its 1977 Annual Report, the Zairian Department of Mines and Energy reported reserves as of December 31, 1977, for a number of major operating companies. Reserve data for recent years are incomplete. (See table 5.)

### INFRASTRUCTURE

Zaïre is a landlocked country except for a small coastal area on the Atlantic Ocean where the Port of Matadi is located. Matadi has a capacity of about 2 Mmt/a. Zaïre has a combination of railroad, road, and riverboat transport to move equipment, food, and other supplies into the mining and mineral processing regions and to move ores, concentrates, and finished mineral products, both within the country and for export. Much of this transport network is in varying degrees of disrepair or requires upgrading. Locomotive and railroad car shortages continue to limit the availability

of ore at the mills, as well as limiting the quantity of finished products available for export. The major companies involved in transportation and electrification are Government-owned; small, private trucking and riverboat companies provide limited local service. Mineral products are normally shipped on the Voie Nationale, the only transport route entirely within Zaïre, as well as other routes to Dar es Salaam in Tanzania and to ports in the Republic of South Africa. It takes 45 days to get copper seaborne by rail transport, either via Zambia and Zimbabwe or eastward along the Tazara railway, operated by both Zambia and Tanzania.

Owing to rail and river transport problems, most cobalt and copper wirebar products are currently shipped by truck to the Port of Durban in the Republic of South Africa. In the case of cobalt, convoys of 10 to 12 trucks leave Likasi and arrive at Durban after 7 to 10 days. There is usually a waiting period of 8 to 10 days for vessel connection at the port. A portion of the electricity consumed in the Shaba region, site of most of the country's mining activity, is via the 1,800-km Inga-Shaba electric line. Gécamines is also dependent on imported coke and petroleum refinery products for its mine and metallurgical operations.

### OUTLOOK

The short-term economic prospects for Zaïre are poor. The inability to meet copper and cobalt production goals has led to a continued decline of the country's most important company, Gécamines.

Despite predictions of Gécamines operations coming to a "grinding halt" in 1993, it is expected that the company can continue operating, albeit at a very low capacity, until a decision about the privatization is made. Copper and cobalt production is expected to fall drastically in 1993 to about 60,000 mt/a and 2,500 mt/a, respectively. Problems faced by Gécamines will continue to be flooding of open pit mines; lack of spare parts and lubricants; theft of finished products and machinery; and personnel disruption because of the tribal conflict in Shaba.

Demand for U.S. mining and materials handling equipment is expected to remain strong in the long run. Gécamines has bought heavily from U.S. suppliers but is currently having difficulty paying its debts. The MIBA diamond mines and Kilomoto gold mines are also good potential customers. MIBA has recently placed a new order for additional earthmoving equipment. However, any major projects will likely have to await a new structural adjustment program and the payment of a substantial portion of Zaïre's existing debt arrears.

Because of its size and wealth of resources, Zaïre's long-term potential is more promising and the country could remain an important supplier of copper, cobalt, and diamond for years to come. Much of Zaïre's future mineral output will depend on the availability of financing. Zaïre's prospects depend on its ability to achieve political and economic stability, mobilize its resources, control Government spending, and renew multilateral and bilateral aid programs.

#### **OTHER SOURCES OF INFORMATION**

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TABLE 1  
ZAIRE: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1988	1989	1990	1991	1992	
<b>METALS</b>						
Cadmium, smelter	281	224	127	65	84	
<b>Cobalt:</b>						
Mine output:						
Ore milled:						
Gross weight	thousand tons	13,833	13,324	11,898	8,415	5,641
Co content		46,800	37,700	39,500	20,900	13,300
Concentrate produced:						
Gross weight	thousand tons	1,613	1,464	1,290	902	631
Co content		26,000	18,400	19,000	9,900	5,700
Refinery input, Co content:						
Concentrate <sup>o</sup>		26,000	18,400	19,000	9,900	5,700
Hydrates		—	—	3,194	5,483	4,106
Scrap		31	27	49	517	1,113
Total <sup>o,2</sup>		26,031	18,427	22,243	15,900	10,919
Metal, Co content: <sup>3</sup>						
Luilu cathodes		4,914	4,814	3,474	2,989	2,629
Shituru refinery:						
Cathodes		1,912	3,492	3,117	2,439	1,837
Granules <sup>4</sup>		3,200	1,005	3,356	2,686	583
White alloy, matte		—	—	34	506	1,580
Total <sup>2,5</sup>		10,026	9,311	9,981	8,620	6,628
<b>Columbium and tantalum:</b>						
Columbite-tantalite concentrate:						
Gross weight	kilograms	33,550	48,020	35,830	57,000	29,000
Cb content <sup>o</sup>	do.	8,700	12,500	9,100	15,000	7,500
Ta content <sup>o</sup>	do.	9,400	13,400	10,000	16,000	8,000
Pyrochlore concentrate:						
Gross weight	do.	287,000	711,000	900,000	*1,000,000	1,048,050
Cb content <sup>o</sup>	do.	130,000	320,000	400,000	450,000	450,000
<b>Copper:</b>						
Mine output by company: <sup>6</sup>						
Ore mined:						
Gross weight:						
Gecamines	thousand tons	14,187	11,510	12,115	7,936	6,892
Sodimiza	do.	1,176	946	769	684	558
Total <sup>2</sup>	do.	15,363	12,456	12,885	8,620	7,450
Cu content:						
Gecamines	do.	653	504	489	292	261
Sodimiza	do.	32	20	21	18	14
Total <sup>2</sup>	do.	686	524	509	310	275
Concentrate:						
Gross weight:						
Gecamines	do.	1,765	1,591	1,403	992	631
Sodimiza	do.	60	40	38	31	23
Total <sup>2</sup>	do.	1,825	1,630	1,441	*1,023	654

See footnotes at end of table.

TABLE 1—Continued  
**ZAIRE: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

Commodity		1988	1989	1990	1991	1992
<b>METALS—Continued</b>						
<b>Copper—Continued:</b>						
<b>Mine output by company—Continued:</b>						
<b>Cu content:</b>						
Gecamines	thousand tons	506	455	396	252	159
Sodimiza	do.	29	*17	17	*13	9
<b>Total<sup>2</sup></b>	<b>do.</b>	<b>535</b>	<b>472</b>	<b>413</b>	<b>*265</b>	<b>168</b>
<b>Metal:</b>						
<b>Intermediate products:</b>						
Electrowon cathode		307,100	280,800	229,100	*180,000	*140,000
<b>Smelter:<sup>7</sup></b>						
Black copper		12,000	15,000	9,500	*5,000	*2,000
Blister		147,665	153,380	117,174	52,536	19,898
<b>Total<sup>2</sup></b>		<b>466,765</b>	<b>449,180</b>	<b>355,774</b>	<b>*237,536</b>	<b>*161,900</b>
<b>Finished products:<sup>3</sup></b>						
Blister		147,665	153,380	117,174	52,536	19,898
Electrowon cathode <sup>8</sup>		87,970	87,242	80,566	65,569	67,240
Refined, wirebar		202,784	181,570	140,868	103,992	47,503
Other		—	—	—	—	539
<b>Total</b>		<b>438,419</b>	<b>422,192</b>	<b>338,608</b>	<b>222,097</b>	<b>135,180</b>
Gold <sup>9</sup>	kilograms	12,500	10,600	9,300	8,800	7,000
Silver <sup>9</sup>	do.	*74,000	70,000	84,000	80,000	60,000
<b>Thorium:</b>						
Monazite concentrate, gross weight (*55% rare-earth oxides)		168	175	124	*120	*50
<b>Tin:</b>						
Mine output, Sn content		2,771	2,346	2,221	*1,522	1,020
Smelter, primary <sup>9</sup>		*118	100	90	70	50
Tungsten, mine output, W content		20	16	17	*15	—
<b>Zinc:</b>						
<b>Mine output:</b>						
<b>Ore milled:</b>						
Gross weight	thousand tons	1,386	1,297	1,340	1,042	619
Metal content		141,500	127,700	114,700	81,400	45,900
<b>Concentrate:</b>						
Gross weight		176,000	156,400	144,600	99,300	53,600
Metal content		75,700	72,800	61,800	42,400	22,300
Metal, primary, electrolytic		61,091	54,043	38,206	28,321	18,833
<b>INDUSTRIAL MINERALS</b>						
Cement, hydraulic		495,000	*460,000	460,581	*250,000	174,052
<b>Diamond:</b>						
Gem	thousand carats	2,724	2,663	2,914	*3,000	8,934
Industrial	do.	15,439	15,092	16,513	*14,814	4,567
<b>Total<sup>2</sup></b>	<b>do.</b>	<b>18,163</b>	<b>17,755</b>	<b>19,427</b>	<b>17,814</b>	<b>13,501</b>
Lime		100,300	100,208	92,011	82,933	64,593
Stone, crushed <sup>9</sup>		*457,946	475,000	450,000	360,000	280,000
<b>Sulfur:</b>						
Byproduct of metallurgy, S content of sulfuric acid from sphalerite <sup>9</sup>		32,000	29,000	23,500	16,000	11,000

See footnotes at end of table.



TABLE 1—Continued  
**ZAIRE: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

Commodity	1988	1989	1990	1991	1992
<b>INDUSTRIAL MINERALS—Continued</b>					
<b>Sulfur—Continued:</b>					
<b>Sulfuric acid, gross weight:</b>					
From sphalerite	96,994	87,478	70,736	48,596	33,158
From imported sulfur	59,550	60,932	61,445	50,545	36,259
<b>Total</b>	<b>156,544</b>	<b>148,410</b>	<b>132,181</b>	<b>99,141</b>	<b>69,417</b>
<b>MINERAL FUELS AND RELATED MATERIALS</b>					
Coal, bituminous* thousand tons	<sup>9</sup> 112	130	100	60	<sup>9</sup> 61
<b>Petroleum:</b>					
Crude thousand 42-gallon barrels	10,728	10,119	10,597	9,955	8,698
<b>Refinery products:</b>					
Liquefied petroleum gas do.	6	5	4	4	3
Gasoline do.	399	578	687	375	201
Kerosene and jet fuel do.	508	613	756	468	199
Distillate fuel oil do.	833	1,027	1,541	714	317
Residual fuel oil do.	398	867	1,182	383	193
Refinery fuel and losses do.	105	222	150	111	56
<b>Total<sup>2</sup></b> do.	<b>2,249</b>	<b>3,312</b>	<b>4,320</b>	<b>2,055</b>	<b>969</b>

<sup>1</sup>Estimated. <sup>2</sup>Revised.

<sup>3</sup>Table includes data available through July 20, 1993.

<sup>4</sup>Data may not add to totals shown because of independent rounding.

<sup>5</sup>Products shown are primarily salable products.

<sup>6</sup>Granules are produced from cathode produced primarily at Shituru and are not double counted.

<sup>7</sup>In the U.S. Bureau of Mines' world production table the refinery production of cobalt in Zaire excludes white alloy and matte, which require further processing.

<sup>8</sup>In the U.S. Bureau of Mines' world production table the mine production of copper in Zaire is the sum of (1) blister, black copper, and Sodomiza concentrate copper content (by concentration or cementation), and (2) electrowon cathode (by leaching).

<sup>9</sup>In the U.S. Bureau of Mines' world production table the smelter production of copper in Zaire is the sum of blister, black copper, and electrowon cathode.

<sup>10</sup>The portion of electrowon cathode that is exportable for further processing and may include high-purity cathode.

<sup>11</sup>Reported figure.

TABLE 2  
**ZAIRE: APPARENT EXPORTS OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

Commodity	1989	1990	Destinations, 1990	
			United States	Other (principal)
<b>METALS</b>				
Alkali and alkaline-earth metals	3	—		
<b>Aluminum: Metal including alloys:</b>				
Scrap	19	—		
Unwrought	100	—		
Cadmium: Metal including alloys, all forms	250	105	—	West Germany 89; United Kingdom 13.
<b>Cobalt:</b>				
Ore and concentrate	3	99	—	All to Belgium-Luxembourg.
Oxides and hydroxides	51	17	15	France 2.
Metal including alloys, all forms	4,318	17,157	889	West Germany 12,852; Japan 2,100.
<b>Columbium and tantalum:</b>				
Ore and concentrate	51	105	81	Japan 24.
Ash and residue containing columbium and tantalum	25	320	—	All to West Germany.

See footnotes at end of table.

TABLE 2—Continued  
ZAIRE: APPARENT EXPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1989	1990	Destinations, 1990		
			United States	Other (principal)	
<b>METALS</b>					
<b>Copper:</b>					
Ore and concentrate	value, thousands	—	\$3	—	All to Chile.
Matte and speiss including cement copper		1,947	NA	—	
Ash and residue containing copper		—	14	—	All to Spain.
<b>Metal including alloys:</b>					
Scrap		6,160	417	—	France 168; Spain 130; West Germany 19.
Unwrought		183,131	297,448	10,651	Belgium-Luxembourg 218,259; West Germany 46,501; Japan 5,282.
Semimanufactures		—	2	—	All to Belgium-Luxembourg.
Gold: Metal including alloys, unwrought and partly wrought	kilograms	1,185	384	( <sup>c</sup> )	Belgium-Luxembourg 360; Switzerland 24.
<b>Iron and steel: Metal:</b>					
Scrap		4,124	35	—	All to United Kingdom.
Steel, primary forms		—	30	—	All to Austria.
<b>Semimanufactures:</b>					
Flat-rolled products: Of iron or nonalloy steel, not clad, plated, coated	value, thousands	—	\$3	—	All to Sri Lanka.
Wire	do.	—	\$1	—	All to West Germany.
Tubes, pipes, fittings		—	1	—	All to Belgium-Luxembourg.
Manganese: Metal including alloys, all forms		—	2	—	All to Republic of Korea.
<b>Nickel:</b>					
Oxides and hydroxides		20	—		
Metal including alloys, scrap		—	1	1	
Silver: Metal including alloys, unwrought and partly wrought	value, thousands	\$68	\$41	\$41	
<b>Tin:</b>					
Ore and concentrate		NA	1,853	—	Netherlands 1,036; Spain 793.
Ash and residue containing tin		—	20	—	All to West Germany.
Titanium: Ore and concentrate		30	—		
<b>Tungsten:</b>					
Ore and concentrate		19	—		
Metal including alloys, semimanufactures	kilograms	—	200	—	All to Belgium-Luxembourg.
Uranium and thorium: Ore and concentrate		87	—		
Vanadium: Metal including alloys, scrap		NA	4,458	—	All to West Germany.
<b>Zinc:</b>					
Ore and concentrate		1,949	NA		
Metal including alloys, unwrought		16,299	13,403	9,975	Taiwan 2,680; Republic of Korea 500.
<b>Other:</b>					
Ores and concentrates		69	81	81	
Ashes and residues		381	NA		
Base metals including alloys, all forms		—	11	—	All to Argentina.
<b>INDUSTRIAL MINERALS</b>					
<b>Abrasives, n.e.s.:</b>					
Dust and powder of precious and semiprecious stones including diamond	value, thousands	\$1,835	\$1,426	\$900	Japan \$511; Canada \$15.

See footnotes at end of table.

TABLE 2—Continued  
**ZAIRE: APPARENT EXPORTS OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

Commodity	1989	1990	Destinations, 1990		
			United States	Other (principal)	
<b>INDUSTRIAL MINERALS</b>					
Abrasives, n.e.s.—Continued:					
Grinding and polishing wheels and stones	257	12	—	All to Belgium-Luxembourg.	
Asbestos, crude	—	72	—	All to West Germany.	
Barite and witherite	3	—	—	—	
Chalk	150	—	—	—	
Diamond, natural:					
Gem, not set or strung	value, thousands	\$66,739	\$271,926	\$65,916	Belgium-Luxembourg \$205,351; Switzerland \$475.
Industrial stones	do.	\$14,525	\$21,141	\$14,450	West Germany \$2,309; China \$1,609.
Unsorted	do.	\$209,254	NA	—	—
Dust and powder	do.	\$42	\$154	—	West Germany \$131; France \$23.
Graphite, natural	—	3	—	—	All to Belgium-Luxembourg.
Precious and semiprecious stones other than diamond:					
Natural	value, thousands	\$2,011	\$661	\$266	West Germany \$173; Switzerland \$109.
Synthetic	do.	\$120	NA	—	—
Other: Crude	do.	—	\$3	\$3	—
<b>MINERAL FUELS AND RELATED MATERIALS</b>					
Petroleum:					
Crude	42-gallon barrels	309,043	496,306	—	Netherlands 495,441; Belgium-Luxembourg 865.
Refinery products:					
Residual fuel oil	do.	82,684	16,739	—	All to Belgium-Luxembourg.
Asphalt	do.	—	21	—	Do.

NA Not available.

<sup>1</sup>Owing to a lack of available official trade data published by Zaïre, this table should not be taken as a complete presentation of this country's mineral exports. These data have been compiled from trade statistics of individual trading partners unless otherwise specified. Table prepared by Virginia A. Woodson.

<sup>2</sup>Unreported quantity valued at \$323,000.

TABLE 3  
ZAIRE: APPARENT IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1989	1990	Sources, 1990	
			United States	Other (principal)
<b>METALS</b>				
<b>Aluminum:</b>				
Oxides and hydroxides	259	36	—	All from United Kingdom.
Metal including alloys, semimanufactures	247	508	—	Hong Kong 216; Belgium-Luxembourg 146; Netherlands 100.
Cadmium: Metal including alloys, all forms	28	—		
Chromium: Metal including alloys, all forms value, thousands	\$8	—		
Cobalt: Metal including alloys, all forms	—	2	—	Mainly from France.
<b>Copper:</b>				
Sulfate	6	—		
<b>Metal including alloys:</b>				
Scrap value, thousands	\$1	—		
Unwrought	2	5	—	Belgium-Luxembourg 4; Spain 1.
Semimanufactures	36	41	6	Belgium-Luxembourg 32; France 3.
Gold: Metal including alloys, unwrought and partly wrought value, thousands	\$5	—		
<b>Iron and steel: Metal:</b>				
Scrap	6	—		
Pig iron, cast iron, related materials	27	—		
<b>Ferrous alloys:</b>				
Ferrosilicochromium	—	86	—	All from West Germany.
Ferrosilicochromium	140	—		
Unspecified	1	—		
Steel, primary forms	19	—		
<b>Semimanufactures:</b>				
<b>Flat-rolled products:</b>				
<b>Of iron or nonalloy steel:</b>				
Not clad, plated, coated	12,787	5,633	—	West Germany 5,061; Netherlands 523; France 49.
Clad, plated, coated	2,657	2,338	—	Brazil 673; West Germany 576; Belgium-Luxembourg 517.
Of alloy steel	334	139	11	Belgium-Luxembourg 106; France 20.
Bars, rods, angles, shapes, sections	7,751	5,116	—	Belgium-Luxembourg 2,367; France 1,335; Japan 547.
Rails and accessories	16,733	2,490	—	Belgium-Luxembourg 930; France 910; United Kingdom 601.
Wire	370	1,117	143	Brazil 405; Belgium-Luxembourg 398; China 118.
Tubes, pipes, fittings	6,216	7,761	2,777	France 3,546; Belgium-Luxembourg 683.
<b>Lead:</b>				
Oxides	148	2	—	All from West Germany.
<b>Metal including alloys:</b>				
Unwrought	82	131	—	Belgium-Luxembourg 130; Switzerland 1.
Semimanufactures	32	24	—	Belgium-Luxembourg 23; West Germany 1.
Manganese: Oxides	—	24	—	Japan 16; France 8.
Mercury value, thousands	\$1	—		
Molybdenum: Metal including alloys, unwrought	—	292	292	
Nickel: Metal including alloys, semimanufactures	3	1	—	All from Switzerland.

See footnotes at end of table.

TABLE 3—Continued  
ZAIRE: APPARENT IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1989	1990	Sources, 1990	
			United States	Other (principal)
<b>METALS—Continued</b>				
Platinum-group metals: Waste and sweepings				
value, thousands	\$116	NA		
Rare-earth metals including alloys, all forms	—	1	—	All from France.
Silver: Metal including alloys, unwrought and partly wrought				
kilograms	1,463	NA		
Tin: Metal including alloys:				
Unwrought	1	—		
Semimanufactures	value, thousands	\$2	—	
Titanium:				
Oxides	33	77	—	Belgium-Luxembourg 43; Canada 18; United Kingdom 16.
Metal including alloys, semimanufactures	—	38	—	All from United Kingdom.
Zinc:				
Oxides	5	21	9	Belgium-Luxembourg 7; France 5.
Metal including alloys: Semimanufactures	10	—		
<b>INDUSTRIAL MINERALS</b>				
Abrasives, n.e.s.:				
Natural: Corundum, emery, pumice, etc.				
	2	—		
Artificial:				
Corundum				
	—	1	—	All from Switzerland.
Silicon carbide				
	1	6	—	All from Belgium-Luxembourg.
Grinding and polishing wheels and stones	84	28	—	Belgium-Luxembourg 21; France 6; Austria 1.
Asbestos, crude	—	212	—	All from Canada.
Barite and witherite	200	10	—	All from Belgium-Luxembourg.
Bromine	value, thousands	—	\$3	— All from West Germany.
Cement	1,509	568	—	France 338; Belgium-Luxembourg 230.
Chalk	24	22	—	All from France.
Clays, crude:				
Bentonite				
	58	15	—	All from Netherlands.
Kaolin				
	16	—		
Unspecified				
	76	1,546	1,546	
Cryolite and chiolite	—	3	—	All from Belgium-Luxembourg.
Diamond, natural:				
Gem, not set or strung				
	value, thousands	NA	\$126	— All from Switzerland.
Industrial stones				
	do.	\$1	—	
Diatomite and other infusorial earth	262	238	2	France 229; Belgium-Luxembourg 7.
Fertilizer materials:				
Crude, n.e.s.				
	2	40	—	All from France.
Manufactured:				
Ammonia				
	—	30	—	Belgium-Luxembourg 19; France 5; West Germany 4.
Nitrogenous				
	12,279	997	—	West Germany 888; Belgium-Luxembourg 55; France 54.
Phosphatic				
	9	5	—	All from Belgium-Luxembourg.
Potassic				
	1,781	406	—	Belgium-Luxembourg 250; West Germany 156.
Unspecified and mixed				
	9,547	3,077	—	Belgium-Luxembourg 3,076; West Germany 1.
Gypsum and plaster	8,254	8,780	—	Japan 8,500; France 214; Morocco 42.

See footnotes at end of table.

TABLE 3—Continued  
**ZAIRE: APPARENT IMPORTS OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

Commodity	1989	1990	Sources, 1990	
			United States	Other (principal)
<b>INDUSTRIAL MINERALS—Continued</b>				
Kyanite and related materials	—	20	—	All from United Kingdom.
Lime	734	1,486	—	Belgium-Luxembourg 1,450; United Kingdom 31; China 5.
<b>Magnesium compounds:</b>				
Magnesite, crude	4	6	—	All from France.
Oxides and hydroxides	5	4	—	All from Belgium-Luxembourg.
Other	124	—		
Mica: Worked including agglomerated splittings	1	—		
Nitrates, crude	—	42	—	All from West Germany.
Phosphates, crude	189	27	—	France 21; Belgium-Luxembourg 6.
<b>Pigments, mineral:</b>				
Natural, crude	NA	165,900	165,900	
Iron oxides and hydroxides, processed	3	16	—	West Germany 10; Belgium-Luxembourg 6.
Precious and semiprecious stones other than diamond: Natural value, thousands	\$73	\$2	—	All from France.
Salt and brine	156	181	12	Belgium-Luxembourg 88; United Kingdom 79.
<b>Sodium compounds, n.e.s.:</b>				
Soda ash, manufactured	254	94	—	All from West Germany.
Sulfate, manufactured	41	45	—	All from United Kingdom.
<b>Stone, sand and gravel:</b>				
<b>Dimension stone:</b>				
Crude and partly worked	750	28	—	Mainly from Belgium-Luxembourg.
Worked	NA	330	—	Belgium-Luxembourg 140; Greece 130.
Gravel and crushed rock	3	157	—	China 130; Japan 15; Belgium-Luxembourg 9.
Quartz and quartzite	NA	144	—	All from West Germany.
Sand other than metal-bearing	24	93	—	Japan 88; Belgium-Luxembourg 5.
<b>Sulfur:</b>				
Elemental: Crude including native and by product	184	20	—	All from Belgium-Luxembourg.
Dioxide	26	—		
Sulfuric acid	330	397	—	Belgium-Luxembourg 296; Netherlands 94; United Kingdom 7.
Talc, steatite, soapstone, pyrophyllite	676	879	80	France 518; Belgium-Luxembourg 279.
Vermiculite, perlite, chlorite	233	34	34	
Other: Crude	371	215	215	
<b>MINERAL FUELS AND RELATED MATERIALS</b>				
Asphalt and bitumen, natural	2	20	19	Belgium-Luxembourg 1.
Carbon black	644	95,899	95,899	
Coal: Briquets of anthracite and bituminous coal	11	—		
Coke and semicoke	3,501	1,311	—	Belgium-Luxembourg 1,301; China 10.
Peat including briquets and litter	19	—		
<b>Petroleum refinery products:</b>				
Liquefied petroleum gas 42-gallon barrels	—	46	—	All from France.

See footnotes at end of table.

TABLE 3—Continued  
**ZAIRE: APPARENT IMPORTS OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

Commodity	1989	1990	Sources, 1990		
			United States	Other (principal)	
<b>MINERAL FUELS AND RELATED MATERIALS—Continued</b>					
<b>Petroleum refinery products—Continued:</b>					
Gasoline	42-gallon barrels	30,210	26	—	United Kingdom 17; Belgium-Luxembourg 9.
Mineral jelly and wax	do.	8,346	3,133	—	West Germany 2,149; Belgium-Luxembourg 661; France 323.
Kerosene and jet fuel	do.	178,205	NA		
Distillate fuel oil	do.	116,093	5,775,451	5,775,220	France 216; Belgium-Luxembourg 15.
Lubricants	do.	219,954	651,057	593,432	Spain 42,588; Belgium-Luxembourg 9,912; France 2,387.
Residual fuel oil	do.	10,010	NA		
Bitumen and other residues	do.	5,921	612	—	Belgium-Luxembourg 521; Spain 91.
Bituminous mixtures	do.	42	255,071	241,648	Spain 12,120; Belgium-Luxembourg 1,267.

NA Not available.

<sup>1</sup>Owing to a lack of available official trade data published by Zaire, this table should not be taken as a complete presentation of this country's mineral imports. These data have been compiled from trade statistics of individual trading partners unless otherwise specified. Table prepared by Virginia A. Woodson.

TABLE 4  
**ZAIRE STRUCTURE OF THE MINERAL INDUSTRY FOR 1992**

(Metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners (ownership)	Location of main facilities	Annual capacity
Cobalt	Générale des Carrières et des Mines du Zaïre (Government, 100%)	Shituru at Likasi	9,000 Cu as granules.
Do.	do.	Luilu at Kolwezi	9,000 Cu as flakes.
Columbium-tantalum	Société Minière du Kivu (Gesellschaft für Elektrometallurgie, GmbH, Germany, 70%; Government, 20%; Sominki, 10%)	Lueshe, 70 kilometers north of Goma	1,000 pyrochlore concentrate.
Do.	Société Minière et Industrielle de Kivu (Sominki) (Lencourt Ltd., 71.7%; Government, 28.3%)	Northern Kivu region	60 concentrate.
Copper	Générale des Carrières et des Mines du Zaïre (Government, 100%)	Lubumbashi	165,000 blister Cu.
Do.	do.	Shituru at Likasi	250,000 refined Cu.
Diamond million carats	Société Minière de Bakwanga (Government, 80%; Société d'Entreprise et d'Investissements S.A., 20%)	Mbuji Mayi	9.2.
Do.	Artisanal miners (private, 100%)	Tshikapa	15.
Gold kilograms	Société Minière et Industrielle de Kivu (Sominki) (Lencourt Ltd., 71.7%; Government, 28.3%)	Eastern Zaïre	3,000.*
Do.	Office des Mines d'Or de Kilomoto (Okimo) (Government, 100%)	do.	3,000.*
Do.	Kilomoto Mining International (Kimin) (Okimo, 51%; Gold Fields of South Africa, 23.4%; Mindev and Associates, 15.6%; IFC, 10%)	Kivu region, eastern Zaïre	500.*
Do.	Artisanal miners (private, 100%)	Eastern and northeastern Zaïre	3,000.*
Tin	Société Minière et Industrielle de Kivu (Sominki) (Lencourt Ltd., 71.7%; Government, 28.3%)	Kalima, Kindu	1,000 Sn in concentrate.
Zinc	Générale des Carrières et des Mines du Zaïre (Government, 100%)	Kipushi	85,000 Zn in concentrate.
Do.	do.	Kolwezi	75,000 refined Zn.

\*Estimated.

**TABLE 5**  
**ZAIRE: RESERVES OF MAJOR**  
**MINERAL COMMODITIES FOR**  
**1992**

(Thousand tons unless otherwise specified)

Commodity	Reserve
Cobalt	2,949
Copper	45,671
Gold kilograms	85,986
Manganese, manganese dioxide	<sup>1</sup> 3,000
Tin, cassiterite	<sup>2</sup> 654

<sup>1</sup>Reserves of carbonate ore were reported to be several million tons.

<sup>2</sup>Includes 200,000 tons in Gécamines concession and 300,000 tons in Société Zairetain's concession.

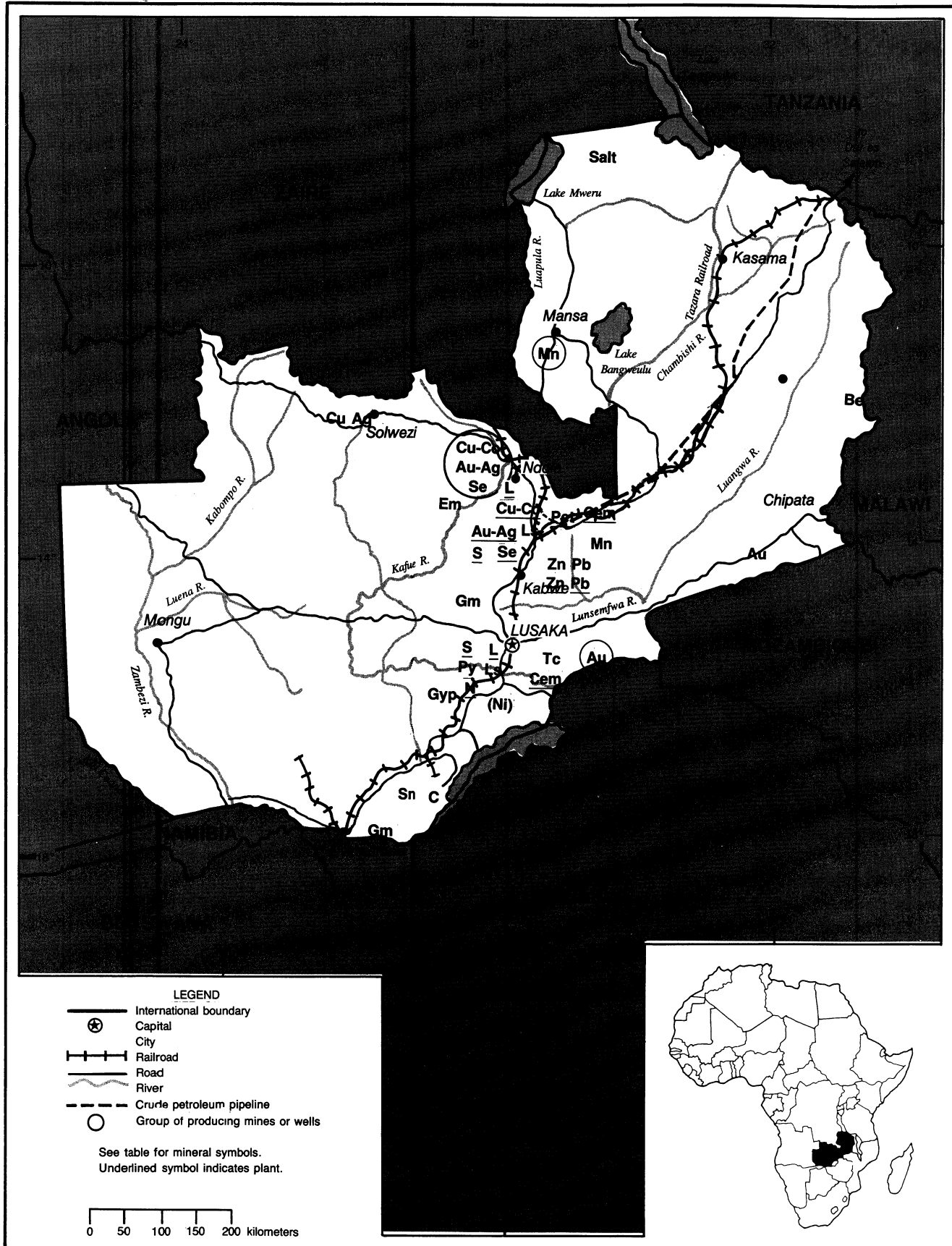
Sources: 1977 Annual Report of the Department of Mines and Energy; 1983 Annual Report of the Société Minière et Industrielle du Kivu; and 1985 Minerals Perspective, Zaïre, U.S. Bureau of Mines.



# ZAMBIA

AREA 752,610 km<sup>2</sup>

POPULATION 8.7 million



## THE MINERAL INDUSTRY OF

# ZAMBIA

By Lloyd E. Antonides

Copper mining remained Zambia's major economic activity in 1992. It continued to place the landlocked country among the world's four largest producers of copper ore and the six largest producers of refined new copper. Its byproduct cobalt production was the world's second largest. Gemstone production was also significant, but a large portion was unrecorded because of smuggling. In emeralds, Zambia is reputedly the world's largest supplier in volume, more than 40% of the total, and second in value, 25% of the total. More limited values of a number of other metals and metal ore concentrates also were produced, as well as industrial minerals and coal. Additional occurrences of a variety of potentially valuable minerals were widespread geographically in the Texas-sized country. However, few were definitively explored, particularly those in the generally higher terrain to the east and in the lower flats to the west of the more developed and populated 1,000-m-high central plateau along the "line of rail."

The continental divide of drainage to the Indian and Atlantic Oceans serves as the northern border with Zaire in western Zambia and continues into the northeast, forming a central spine of increasingly higher ground up to the Tanzanian border. The Zambezi River provides much of the southern border, most of which is with Zimbabwe, and drains a large part of the country—all that is south of the continental divide. Owing to the tropical latitude and moderate elevation, the climate is pleasantly mild, similar to southern California but subject to distinct wet and dry seasons. About one-half of the country is covered by forest consisting mostly of second growth savanna woodland, and about one-half by

cropland and pasture.

Geologically, Precambrian sedimentary and metamorphic rocks with some igneous formations of localized granitic basement and a few small basic intrusions occur over most of the eastern and north central areas, generally under moderate soil cover. Younger Karoo sedimentary rocks with an occasional basaltic flow are often exposed in the several rift valleys as well as underlying normally eroded river valleys. Karoo formations underlie a thick cover of more recent Kalahari windblown sands in the western third of the country. The north-central copper-cobalt deposits are in Proterozoic sediments of the Katanga group, mostly carbonaceous marine shales and graywackes.

Mineral commodities production, predominately copper, was estimated to contribute only 8% to 20% to GDP, according to various sources, and to employ only about 15% of the country's wage-earning work force of about 400,000. However, the sector's export earnings of more than \$1.25 billion<sup>1</sup> were the source of more than 90% of total foreign exchange and a major source of Government revenue—30% to 50% by various estimates. In comparison, agriculture accounted for about 20% of GDP and manufacturing, 25%. A good potential for growth of the mining industry was indicated by the many known mineral deposits that were not yet defined.

Historically, the country's economy, because of overwhelming dependency on one commodity, copper, began to have difficulties when copper prices fell about 60% in the mid-1970's. The resulting debt and economic disruption was only partially cushioned by the rise of copper prices in the 1980's. In addition, copper production, and the dependent economy,

also suffered from political events: the nationalization (acquisition of 51% ownership) of the mining companies by the Government in 1970; assumption of direct management by the Government from the former owners (Anglo American Corp. and AMAX Inc.) in 1974; subsequent efforts to assign and train native Zambians for staff positions; and then the merger of the previous two principal mining groups into Zambia Consolidated Copper Co. (ZCCM) in 1982 with further emphasis on Zambianization of staff. At the same time the Government limited the retention of earnings by ZCCM to have foreign exchange for its own purposes. Thus company expenditures on mine development and repair and replacement of capital assets was insufficient to maintain the production rate. Copper output was almost 700,000 mt/a at its peak in 1976, dropping to barely 400,000 mt/a in 1991. However, 1992 results indicate a reversal in the trend with about a 10% increase in production.

Nevertheless, Zambia's economy in 1992 remained in a precarious state with GDP further declining. But a very stringent economic reform program previously agreed upon with the World Bank and International Monetary Fund was being rigorously pursued by the new Government elected in October 1991. It proceeded despite widespread economic dislocations and soaring inflation. Inflation, being about 200% per year, was called the most serious economic problem affecting reform early in 1993 even though it had been given constant attention for years. But a strong plan for reduction was reported in place. Additionally, during 1992 the economy was affected by a devastating regional drought, a short but severe outbreak of

cholera in the Copperbelt town of Kitwe, and continued prevalence of AIDS that was seriously weakening the work force.

Improvement in Government administration also was considered to be a critical need for effectively implementing and sustaining the economic reform. Some observers felt the bloated bureaucracy—50% of the wage earning work force was in the civil or military service—generally lacked the skills, motivation, incentives, and lower level leadership needed to carry out programs and thus required immediate training.

For the population in general, the low level of skills, lack of self-reliance, and very unequal distribution of income were seen as additional restraints on economic revitalization that must be overcome through education.

Furthermore, heavy foreign debt remained an obstacle to the economic reform, and foreign aid of various kinds was expected to be an essential requirement for some time.

## **GOVERNMENT POLICIES AND PROGRAMS**

A relatively short and peaceful political transition from one-party rule to a multiparty system culminated in the October 1991 elections that completely changed the Government. Inaugurated in November 1991 and committed to democracy and a market economy, the new Government began taking steps early to privatize most of the more than 100 parastatal companies that dominated the country's economy. Proposals on 17 companies had been sought by the Zambia Privatization Agency prior to the September 1992 mission to Zambia by potential U.S. investors that was cosponsored by the U.S. Agency for International Development and the Overseas Private Investment Corp. Thirty more firms were put up for sale in February 1993. In the minerals sector, Chilanga Cement Ltd. was scheduled for privatization in 1993, and ZCCM was to be eventually included. For these two, alternative new organizational and ownership structures and financial

approaches were being studied in early 1993.

The Government was promoting the private sector and actively sought foreign investment. It sponsored an investment conference in Atlanta in June 1992 and in April had participated in a similar conference sponsored by the Confederation of British Industry. Five of the world's eight largest private mining organizations demonstrated some interest in Zambia mineral ventures, especially privatization of ZCCM: RTZ Corp. of the United Kingdom, Anglo American Corp. of South Africa Ltd., Broken Hill Pty Co. Ltd. of Australia, Phelps Dodge Corp. of the United States, and Gencor Ltd. of South Africa.

As part of the economic reform program, Government actions included adoption of a free market in currency and interest rates, removal of price and import controls, and reduction of subsidies and trade barriers. Also, retention of foreign currency earnings and repatriation of all aftertax profits were allowed and business taxes were lowered. In addition, a 1991 investment act contained attractive provisions for foreign investors and was to be further improved in 1993 to enhance private investment. However, the act did not specifically provide for foreign investment in mining, and a separate new draft mining investment law was being reviewed by the World Bank early in 1993. In general, foreign ownership of land and mineral rights was still a somewhat controversial matter.

The annual 3-year Public Investment Program issued in March 1992 contained allocations to new projects to improve infrastructure and services for the small-scale mining sector as well as to investments in the large copper mines, the mainstay of the economy. Projects to advance development of a number of minerals also were cited, as was establishment of a gemological training institute. A gem unit was to be added to the Geological Survey Department, and a mineral data library and small mine equipment rental scheme were planned.

## **PRODUCTION**

The most significant change in production of minerals reported during 1992 was the reversal of the prior year's dip in copper production. It was achieved by the new management, appointed in November 1991 by the new Government, which concentrated on its core business and was freed to use foreign exchange earnings to pay suppliers and buy needed equipment and parts. Data on finished copper in ZCCM's Annual Report for the year ending March 1993 (listed under 1992 in table 1) showed a 17% increase over the previous year. Although cobalt output was only 1% above the prior year because of a third-quarter shutdown of the Nkana cobalt plant, lead and zinc each had a 15% gain. Gemstones showed a substantial increase, although this may only have reflected less smuggling and better reporting. (See table 1.)

## **TRADE**

Copper, cobalt, zinc, and lead, in order of value, were usually considered the major mineral exports. However, gemstones were said to have been very significant in export value for some time, possibly second to copper, despite absence of official records. Although official published trade data were unclear, based on ZCCM sales (cobalt, copper, lead, and zinc) the European Community was the leading destination for exports for a number of years and Japan a close second. Cobalt and copper were also among the major exports to the United States, which was not a significant trading partner.

Petroleum, including crude and refined products, was by far the major import. Fertilizer components were reportedly the second largest import, particularly phosphorus and potassium because only some nitrogen compounds were made domestically. Structural steel was another important import of mineral origin. The Arabian Gulf States were a principal source of imports because of oil purchases. The Republic of South Africa was also a principal source of imports, at

least partly because of transshipments from overseas sources. Mining equipment was normally the largest import from the United States.

## STRUCTURE OF THE MINERAL INDUSTRY

The Government dominated the industry. The state-owned Zambia Industrial and Mining Corp. Ltd. (ZIMCO) held a majority interest in all principal commercial and industrial ventures. ZCCM, the largest entity in the minerals sector, was owned 60.3% by ZIMCO, 27.3% by Zambia Copper Investments Ltd. (50.0% Minorco S.A., in turn, owned more than 60% by the Anglo American Corp.-DeBeers Centenary AG group), and, early in 1993, 12.4% by the public, including institutions. ZCCM had a number of subsidiaries not directly related to production of copper or even any other mineral commodity. One division of ZCCM produced zinc, lead, and pyrite (for sulfuric acid), and apparently a Small Mines Development Unit operated at least one mine for gemstones and one for gold, as well as one for copper. Other units also produced lime and marble, and ZCCM also owned shares in several ventures not associated with minerals such as the national airlines. Divestiture of noncore businesses began in 1992.

The privatization program and new investment and mining acts were expected to result in formation of many new private companies. A number of the world's leading resource groups showed interest in Zambia's mining sector, particularly in ZCCM. But early in 1993, the Government remained undecided as to the extent of holding a continued interest in mineral ventures.

ZIMCO also had a Mineral Exploration Department (MINEX) that worked in areas other than ZCCM's properties and also provided services to other subsidiaries. Subsidiaries in the minerals sector included: Reserved Minerals Corp., 100% owned, which in turn owned 100% of Mindeco Small Mines Ltd., producer of several industrial

minerals, and 55% of Kagem Mining Ltd., reportedly the country's largest gemstone producer, 45% of which was owned by the Hagura organization, probably a private partnership; Chilanga Cement Co., 60% owned through Indeco Ltd., a wholly owned subsidiary of ZIMCO; Nitrogen Chemicals of Zambia Ltd., 100% owned, producer of ammonia for fertilizers; Maamba Collieries Ltd., 100% owned, the country's sole coal producer; and Indeni Petroleum Refinery Co. Ltd., 50% owned through Indeco Ltd. with at least some portion believed owned by Agip SpA., of Italy, the operating manager. Additionally, among more than 100 companies, ZIMCO also had majority or full ownership of some minerals-related businesses, such as crushed stone, glass, and ceramics firms; Metal Marketing Corp. of Zambia, a minerals and metals trading firm; as well as Tazama Pipelines Ltd. (the crude oil pipeline from Dar es Salaam); Zambia Railways Ltd.; domestic and international airlines; and electric utilities.

## COMMODITY REVIEW

### Metals

**Cobalt.**—ZCCM's announcement of short-term production expansion possibilities of several hundred tons probably helped ease prices in mid-1992 although reduced consumption and a surge in Russian exports undoubtedly helped more. However, commodity markets remained volatile over the uncertainty of supply from Zairean and Russian sources in early 1993. Free market prices had climbed from less than \$15 per lb in mid-1991 to more than \$30 at yearend 1991 because political events in Zaire were causing losses in production, and then slid down again to the \$15 range by early 1993 partly due to a Russian export surge. In 1992 the Zaire and Zambia producer price was \$25 until November, when it was set at \$18.

ZCCM produced cobalt as a byproduct of copper. Ores from the Nkana, Chibuluma, Baluba, and Chingola Mines were the main sources of cobalt minerals. Content ranged from 0.08% to 0.14%

cobalt that was concentrated by flotation to 3% to 6% for feeding the two processing plants at Nkana and Chjambishi. Roasting converted the copper and cobalt sulfides to soluble sulfate form and the iron into oxide. The calcine produced was leached with sulfuric acid. Copper was selectively removed by electrowining, and the remaining solution was purified by pH control to remove copper, iron, and zinc. After drying into a cobalt hydrate and redissolution, plus an ion exchange step at Chambishi to remove nickel, the cobalt was electrowon from solution to produce cathode. For high-purity metal, some cathode from Chambishi was treated in a vacuum induction furnace at 1,600° C, which volatilizes impurity elements for removal in a distillation step.

Although recovery rates historically were rather poor, ZCCM said there were several process alternatives for increasing recovery that were being tested in 1992 and 1993. These include more efficient flotation concentration, extraction from tailings leach solutions, and retreating copper smelter slag. Such innovations were seen to result in additional production of about 600 mt/a of metal in the short term and ultimately more than 3,000 mt/a.

**Copper.**—Having successfully achieved reversal of the production decline and substantially increased net profit as well, ZCCM's management was still faced with problems in maintaining the desired output of 450,000 to 500,000 mt/a finished copper from 20 to 25 Mmt/a of ore beyond 1998. Cash operating costs for copper metal (presumably refined-grade fob refinery, excluding capital charges and including byproduct credits for cobalt, precious metals, and selenium) were said to have dropped to \$0.65 per pound in 1992 from \$0.73 in 1991. Further reductions were expected from a planned 20% cut in the work force in 1993, as well as the introduction of new technology and equipment. Some observers indicated excluded costs added \$0.25 or more. The net profit for the year ending

March 1993 announced in the press in July 1993 was \$174 million (apparently converted at about K239 per US\$) with an equivalent operating profit of \$452 million.

Capital requirements were substantial but not completely clear from public announcements. In December 1992, a company official stated normal annual reinvestment needs were \$150 million in hard currency and \$120 million in equivalent local money. About the same time, other company releases said preliminary estimates of new capital investment needed to maintain desired production totaled \$1.4 billion over about 15 years starting in 1993. Peak expenditures apparently were several hundred million dollars per year in the first 6 years. An immediate requirement was for deepening and expanding the Konkola Mine. That project was estimated to cost \$500 million to \$600 million over 6 years starting in 1994 to produce at least 6 Mmt/a of ore from resources estimated at more than 420 Mmt averaging more than 3.5% copper.

Outside observers of the situation appeared to focus on three groups of concerns: the adequacy of ore resources, production plans, and costs; the suitability of the operating organization and management; and the privatization concepts. During 1993 two organizations became involved in World Bank funded studies aimed at examining those matters. In January 1993, SRI International of the United States, which had been providing some technical-economic services to ZCCM at various times in past years, commenced developing a business plan concentrating on the first two points. Kienbaum Development Services of Germany was to begin working in September 1993 on evaluating strategic financial and ownership options in regard to privatization. The studies were not expected to be completed before the end of 1993.

Ore reserves at operating mines were sufficient for almost 20 years at 1992's mining rate, according to data

in ZCCM annual reports, which are generally considered reliable. However, management believed that without outside investment, production will begin to decline when the Nchanga open pit output begins to fall in about 1998. Apparently the heavy \$700 million debt interest and capital payments were expected to reduce earnings below reinvestment needs to maintain the desired metal production.

Of the several major international mining organizations that showed some interest in the privatization offer, Anglo American Corp. seemed to have a preferred position. It had a long history of involvement in Zambian mining, and in addition to controlling a 27.3% share in the company, it held preemptive rights to 50% of the Government's 60.3% share. It appeared advantageous for the Government to retain some interest in the new company for domestic political reasons as well as to accede to the preferences of some major potential investors. One alternative approach of splitting the company into smaller production units was reportedly opposed by at least one large company.

After separation of the Konkola Mine and concentrator into a new division, apparently during 1991, the ZCCM production units consisted of five copper divisions and one lead-zinc-pyrite division. A power division and corporate support groups complemented them. Operating components included more than 10 mines (9 underground, 1 large open pit, several smaller pits; plus 1 underground idle), 11 concentrators (plus 2 idle), 2 copper smelters (plus 1 idle) and 1 lead-zinc smelter, 2 copper leach-electrowin plants, 2 electrolytic copper refineries (plus 1 idle), 2 electrolytic zinc plants, 2 roast-leach-electrowin cobalt plants, and a precious-metal plant. Rather comprehensive descriptions of the operations and critical considerations were presented in *Engineering and Mining Journal* of March 1992 and *Mining Journal* of October 9, 1992.

**Zinc.**—At ZCCM's Kawabe lead-

zinc mine, about 110 km north of Lusaka, the ore types in the remaining reserves were changing from sulfides to oxides. As a consequence, the zinc leach plant was rehabilitated and reopened in early 1993 with an annual capacity reported as 10,000 tons of zinc. The Imperial Smelting furnace was to be closed. Ore was delivered to the mill at a rate of 150,000 to 180,000 mt/a in the 3 years ending March 1992.

## Industrial Minerals

**Cement.**—Plants operated by Chilanga Cement Ltd. were at Lusaka, originally started up in 1951, and at Ndola on the Copperbelt, started up in 1969. Apparently both were subsequently enlarged, and capacities in 1992 were rated at 200,000 mt/a and 300,000 mt/a, respectively. Output went primarily to domestic customers but in 1991, latest information available indicated 20% was exported, mostly to Burundi. Reportedly having little debt and being marginally profitable, the company was to be privatized late in 1993 and a study was in progress to determine how best to accomplish it.

**Fluorspar.**—A unit of Agip SpA, of Italy, reportedly discussed with the Government the possible development of a fluorspar deposit in the Sianoyo area, about 120 km south of Lusaka. Significant infrastructure costs were said to be a restraint on exploitation. Maps showed Agip had an exploration licence in the area 25 years ago but it was for radioactive minerals.

**Gemstones.**—Theft of hundreds of thousands of dollars worth of emeralds from a safe at Zambian Emerald Industries Ltd. was reported in January 1993, possibly the country's largest ever gemstone theft. They had not yet been valued by the state-run organization, and the monetary loss was considered a possible hinderance to future purchases from miners. An accusation of laxity helped further the demands for early privatization of the

company.

As one of Zambia's most important mineral commodities, gemstones had an attractive potential for foreign investment in mining, processing, and marketing. In value, emeralds were estimated to normally comprise about 80% of total gemstone production; but in volume, amethyst output usually was the largest reported. Aquamarine, garnet, and tourmaline also were mined.

Of 30 to 40 registered gemstone operations reported, 2 were said to be larger-size, mechanized mines that were joint ventures with the Government. From 200 to several thousand small, unregistered mining operations were estimated to be operational. Government policies on gemstone operations were liberalized in 1990, and miners were becoming more open.

**Talc.**—A presumably private company formed in 1989, called Talc Zambia Ltd., was reported to be working the Mushishi deposit identified as being near Ndola on the Copper Belt. Reserves were given as 2 Mmt containing 33% steatite. Initial output rate was about 30,000 mt/a of several grades for sale domestically as well as to buyers in Zimbabwe and the Republic of South Africa.

The Lilayi talc deposit, just south of Lusaka, was mined by Government-owned Crushed Stone Sales Ltd., which was listed for privatization early in 1992. Operations were not considered very efficient.

### Mineral Fuels

**Coal.**—Improvements at the Maamba Collieries Ltd. strip mine in southern Zambia apparently continued although no specific details were reported. A World Bank funded study to determine the long-term viability of the mine before committing major funds was started by consultant John T. Boyd Co. of Pennsylvania in October 1992. The company had been an unprofitable

parastatal that was considered reasonably well-managed but needing improved productivity for which investment was required.

**Petroleum.**—Ground seismic results from a survey planned in mid-1991 by Mobil Oil Corp. for both the Zambian and Zimbabwean sides of the Zambezi River valley, if completed, remained unavailable. Four-year exploration agreements were completed in late 1989 covering an area about 50 km on each side of the border from east of Victoria Falls to Mozambique. In 1990 airborne gravity and magnetic surveys were carried out. The drilling decision, not expected until late 1992 at the earliest, was apparently still pending.

### Reserves

Copper ore reserves of ZCCM were ample for at least 15 years of continued full-scale operation according to ZCCM officials. As given in ZCCM's annual report, on March 31, 1992, a total of ore reserves at seven mines was 366.22 Mmt calculated as having an average content of 3.03% copper. Additional mineral resources of ZCCM were huge, 1.25 billion tons at 2.4% copper. There were other known copper deposits outside of ZCCM's license area as well. The major one was considered to be Lumwana, northwest of the Copper Belt, with resources of more than 1 billion tons at 0.7% copper.

Cobalt reserves associated with the copper ore were substantial. From ZCCM's annual report, on March 31, 1992, 154.52 Mmt of copper ore reserves had 0.18% contained cobalt. Additional resources include a total of more than 14 Mmt of copper ore at more than 0.28% cobalt and 133 Mmt at 0.11% to 0.12% plus smelter slag dumps of 24 Mmt with 0.40% to 0.65% cobalt.

Gold ore resources were being studied by several groups and appeared to be rather extensive.

Lead-zinc reserves at existing operations were limited, but additional resources were known at several

locations. Kwabe reserves as of March 31, 1992, totaled 1.24 Mmt at 15.2% zinc and 2.4% lead. Large resources were projected at Kabwe, but most were low grade or not immediately accessible.

Nickel reserves at the Munali sulfide deposit, 65 km southwest of Lusaka, were 11.7 Mmt at 1.04% nickel with minor copper, gold, silver, and platinum-group metal content, according to a 1989 announcement by a private company, Appolo Mining (Pty.) Ltd., before its consultant's investigation was complete.

A large variety of other metallic minerals deposits were also known but needed further exploration. Most work has been done on iron, molybdenum, and tin.

Industrial mineral resources that were being studied or exploited by commercial groups included: clays for brick and tile, and for refractories; fluorspar; gemstones; gypsum; limestone for cement and lime manufacture; magnetite and phyllite probably for cement manufacture; marble; silica presumably for glassmaking; and talc. Phosphate resources were known, but only of low grade, one of which was a carbonatite in the northeast, which was the subject of continuing studies by Government agencies.

Mineral fuel resources were reported as 250 Mmt of bituminous coal but details of the classification were not available. Petroleum resources remained conjectural with no further work known to be planned.

### INFRASTRUCTURE

A fairly extensive truck road and railway network existed within the country and externally for access to ocean and lake ports for international trade. Major highways generally paralleled the rail lines. The principal rail routes were: northeast to and from Dar es Salaam, Tanzania—nearly 2,000 km from Ndola in the Copper Belt—mostly on the Tanzania Zambia Railways Authority (Tazara) line; and

south through Zimbabwe to and from South African ports—more than 2,500 km from Ndola—using the Zambia Railways Ltd. line in Zambia. The roughly 2,000-km rail link southeast to Beira, Mozambique, through Zimbabwe, became generally available after a long hiatus due to civil war in the port country, but ship availability apparently was limited. The more than 2,200-km rail link north into Zaire and west to Lobito, Angola, remained unavailable because of political unrest in the port country. A southeasterly route involving trucks to Grootfontein in Namibia and then rail to port at Walvis Bay on the South Atlantic Ocean was tested with copper shipments starting in 1990 but apparently was of limited advantage. In general, the railroad system still had rolling stock shortages, and track maintenance on internal routes was of concern. However, donor aid programs were helping to improve the situation. Some railcars were being rented from Swaziland.

A crude oil pipeline, Tazama Pipelines Ltd., a joint venture between the Zambia and Tanzania Governments, ran from Dar es Salaam about 1,700 km southeast to a refinery in Ndola. International and domestic air transport were generally considered excellent.

Electric power capacity was adequate, furnished about 70% from hydroelectric, 20% from oil, and 10% from coal plants. Expansion of hydro sources was planned. However, the drought caused some concern in the fall of 1992 and resulted in some limitation on consumption. Zaire furnished some extra power needed in the Copper Belt during the year. The energy source for mobile equipment continued to be petroleum, a significant amount of which was from imported crude that was refined in the state-owned Indeni Petroleum Refinery Co. facility at Ndola, but other needs were met by imports of appropriate products. The household energy source was wood, which thus continued to be the country's largest single source of energy.

Telecommunications also were considered very good, both internally and externally.

## OUTLOOK

Zambia's economic difficulties could remain a problem for some time because of the many impediments to the reform program that was so essential to eventual resolution of the difficulties. But much promise of success could be found in the availability of good agricultural, mineral, and water resources; the new open political environment; and a firmly market oriented Government; together with the continued reasonable personnel and financial assistance from international sources. With political stability and improved investment and mining policies, the international mining community could be expected to act on the opportunities. Even in the short term, a number of minerals were considered ripe for development, and copper output had a good probability for at least a small improvement. In the longer term, without some outside financing in the next few years, copper production can be expected to decrease as long as earnings are required for debt reduction rather than future operating needs.

<sup>1</sup>Where necessary, values have been converted from Zambia kwachas (K) to U.S. dollars at the rate of K160=US\$1.00 for 1992 values and K61.73=US\$1.00 for 1991 values. The 1991 value was the official year average quoted by the Bank of Zambia, which also quoted yearend rates for 1991 at K89.29=US\$1.00. The 1992 value was the approximate official midyear rate. In early December 1992 the Government adopted the free commercial rate for future transactions at K247=US\$1.00, but at yearend 1992 the commercial rate was reported more than K300=US\$1.00.

## OTHER SOURCES OF INFORMATION

### Agencies

Ministry of Mines  
P.O. Box 31969  
Lusaka, Zambia  
Telephone: 227-653  
Mines Development Department  
P.O. Box 31969  
Lusaka, Zambia

Telephone: 227-653  
Geological Survey Department  
P.O. Box 50135  
Lusaka, Zambia  
Telephone: 250-174/212-553

### Publications

Survey of Development Potential of Mineral Industry in SADCC, Sept. 1989, by R. Marjonen and J. Huta. UN Revolving Fund for Natural Resources Exploration  
No. 1, UN Plaza  
New York, NY 10017  
ZCCM: The Way Forward, Supplement to the Mining Journal, Oct. 9, 1992, London.

TABLE I  
ZAMBIA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992 <sup>*</sup>
<b>METALS</b>					
Beryllium: Beryl kilograms	1,343	880	<sup>1</sup> 1,633	<sup>2</sup> 836	<sup>3</sup> 504
<b>Cobalt:<sup>4</sup></b>					
Mine output:					
Ore milled: <sup>5</sup>					
Gross weight thousand tons	6,634	6,596	6,505	<sup>6</sup> 6,311	6,300
Co content	10,687	10,590	10,870	10,967	10,800
Concentrate:					
Gross weight	268,662	274,989	258,698	243,504	250,000
Co content	7,090	7,255	<sup>6</sup> 6,999	<sup>6</sup> 6,994	7,000
<b>Metal:</b>					
Materials treated:					
Gross weight	313,897	299,811	261,608	282,927	285,000
Co content	7,519	7,075	6,666	7,104	7,100
Refined electrolytic cathode	4,871	4,447	4,674	4,741	<sup>4</sup> 4,797
<b>Copper:<sup>4</sup></b>					
Mine output: <sup>6</sup>					
Ore milled:					
Gross weight thousand tons	24,040	23,640	22,952	<sup>2</sup> 21,502	23,000
Cu content	540,701	538,115	519,400	<sup>4</sup> 475,870	520,000
Concentrate:					
Gross weight	1,507,632	1,487,749	1,343,642	<sup>1</sup> 1,101,833	1,300,000
Cu content	394,122	419,080	400,221	<sup>3</sup> 343,647	400,000
<b>Metal:</b>					
<b>Electrowon:</b>					
From tailings leachate	97,690	78,716	67,774	70,614	<sup>3</sup> 80,371
From copper concentrate leachate	20,041	16,857	12,418	11,108	—
From cobalt concentrate leachate	29,986	25,233	24,379	28,214	<sup>3</sup> 27,321
Total electrowon	147,717	120,806	104,571	109,936	<sup>3</sup> 107,692
Smelter output, blister/anode <sup>7</sup>	308,928	<sup>3</sup> 345,478	331,739	300,329	<sup>3</sup> 356,367
Total electrowon and blister	456,645	<sup>4</sup> 466,284	436,310	410,265	<sup>4</sup> 464,059
<b>Refined:</b>					
Electrorefined <sup>8</sup>	311,983	342,735	334,878	<sup>3</sup> 314,125	<sup>3</sup> 376,059
Shapes <sup>9</sup>	85,728	75,383	50,546	42,938	<sup>3</sup> 52,436
Subtotal	397,711	418,118	385,424	<sup>3</sup> 357,063	<sup>4</sup> 428,495
Electrowon <sup>10</sup>	51,848	45,444	52,660	45,390	<sup>3</sup> 43,712
Total refined grade	449,559	463,562	438,084	<sup>4</sup> 402,453	<sup>3</sup> 472,207
Gold <sup>4 11</sup> kilograms	227	129	129	136	<sup>3</sup> 271
<b>Lead:<sup>4</sup></b>					
Mine output, ore milled:					
Gross weight	133,000	111,000	158,000	177,000	110,000
Pb content	12,118	8,807	9,638	9,084	5,000
<b>Metal:</b>					
Smelter bullion, gross weight	11,720	6,912	5,339	4,999	3,500
Refined, gross weight <sup>12</sup>	6,345	3,653	3,670	2,637	<sup>3</sup> 3,033

See footnotes at end of table.



TABLE 1—Continued  
ZAMBIA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992 <sup>3</sup>
<b>METALS—Continued</b>					
Manganese concentrate (48% Mn), gross weight	502	351	712	662	<sup>3</sup> 292
Selenium, refined, gross weight <sup>4 13</sup> kilograms	24,083	20,861	21,692	21,858	<sup>3</sup> 31,785
Silver <sup>4 11</sup> do.	24,093	19,719	17,031	13,657	<sup>3</sup> 20,972
<b>Tin concentrate:</b>					
Gross weight (65% to 72% Sn)	2	2	2	9	<sup>3</sup> 3
Sn content	1	1	1	6	<sup>3</sup> 2
<b>Zinc:<sup>4 14</sup></b>					
Mine output, Zn content of ore milled	25,169	22,853	32,074	19,825	15,000
Metal, refined, gross weight <sup>15</sup>	18,343	12,351	9,717	6,339	<sup>3</sup> 7,288
<b>INDUSTRIAL MINERALS</b>					
Cement, hydraulic	404,600	385,937	<sup>1</sup> 437,421	366,914	347,000
<b>Clays:</b>					
Brick <sup>16</sup>	<sup>5</sup> 5,000	5,126	3,732	2,817	3,000
Building, not further specified <sup>8</sup>	2,000	2,000	2,000	2,000	2,000
China and ball	367	<sup>3</sup> 350	<sup>2</sup> 250	120	200
Feldspar	120	20	60	<sup>1</sup> 70	<sup>3</sup> 113
<b>Gemstones:</b>					
Amethyst kilograms	4,701	6,275	18,130	168,220	<sup>3</sup> 479,252
Aquamarine do.	56	89	166	65	<sup>3</sup> 254
Emerald do.	1,039	334	619	265	<sup>3</sup> 453
Gypsum <sup>17</sup>	15,000	15,000	<sup>1</sup> 14,000	<sup>1</sup> 14,000	13,000
Lime, hydrated and quick thousand tons	239	<sup>2</sup> 230	<sup>2</sup> 214	184	<sup>2</sup> 212
Limestone for cement and lime <sup>18</sup> do.	<sup>8</sup> 90	<sup>9</sup> 80	<sup>8</sup> 60	<sup>7</sup> 50	770
Magnetite, gross weight <sup>19</sup>	445	318	576	400	<sup>3</sup> 417
Nitrogen: N content of ammonia	16,200	11,700	3,900	4,700	5,000
Sand and gravel, construction thousand tons	200	226	<sup>1</sup> 500	<sup>1</sup> 500	500
<b>Stone, construction:</b>					
Limestone, crushed aggregate do.	999	775	772	739	750
Other <sup>8</sup> do.	<sup>1</sup> 1,600	<sup>1</sup> 1,000	<sup>7</sup> 00	<sup>7</sup> 00	700
<b>Sulfur:<sup>4</sup></b>					
<b>Pyrite concentrate:</b>					
Gross weight (42% S)	74,952	70,828	72,060	73,483	74,000
S content <sup>8</sup>	31,500	29,700	<sup>3</sup> 30,200	<sup>3</sup> 30,600	31,000
<b>In sulfuric acid:<sup>8 20</sup></b>					
From pyrite roaster gas, S content	<sup>2</sup> 7,000	<sup>1</sup> 8,000	<sup>1</sup> 5,000	<sup>2</sup> 0,000	20,000
From smelter gas, S content	<sup>8</sup> 3,000	<sup>7</sup> 8,000	<sup>7</sup> 1,000	<sup>6</sup> 9,000	75,000
Total, S content	<sup>1</sup> 110,000	<sup>9</sup> 6,000	<sup>8</sup> 6,000	<sup>8</sup> 9,000	95,000
Talc	73	114	160	89	<sup>3</sup> 366
<b>MINERAL FUELS AND RELATED MATERIALS</b>					
Coal, bituminous thousand tons	524	395	382	345	<sup>3</sup> 422
<b>Petroleum, refinery products:<sup>4</sup></b>					
Liquefied petroleum gas thousand 42-gallon barrels	84	43	<sup>1</sup> 100	<sup>1</sup> 100	100
Motor gasoline do.	1,149	1,237	<sup>1</sup> 1,300	<sup>1</sup> 1,300	1,300
Jet fuel <sup>8</sup> do.	<sup>3</sup> 520	540	<sup>5</sup> 00	<sup>5</sup> 00	500
Kerosene <sup>8</sup> do.	<sup>3</sup> 318	323	<sup>3</sup> 00	<sup>3</sup> 00	300

See footnotes at end of table.

TABLE 1—Continued  
**ZAMBIA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	1988	1989	1990	1991	1992 <sup>3</sup>
<b>MINERAL FUELS AND RELATED MATERIALS—Continued</b>					
<b>Petroleum, refinery products<sup>4</sup>—Continued:</b>					
Distillate fuel oil      thousand 42-gallon barrels	2,149	2,071	r 2,000	r 2,000	2,000
Residual-fuel oil      do.	564	623	r 700	r 700	700
Other, including refinery fuel and losses      do.	466	431	r 400	r 400	400
<b>Total</b> do.	<b>5,250</b>	<b>5,268</b>	<b>r 5,300</b>	<b>r 5,300</b>	<b>5,300</b>

<sup>1</sup>Estimated. <sup>2</sup>Revised.

<sup>3</sup>Table includes data available through Dec. 1, 1993.

<sup>2</sup>In addition to commodities listed, the following were probably produced but information is inadequate to reliably estimate output: fluorspar (reported in 1989 at 99 metric tons and in 1990 at 35 metric tons); tourmaline (reported for 1990 through 1992 as at least 1 kilogram per year); additional crude construction materials at artisanal operations (clays for brick and tile; sand, gravel, and stone for aggregate and fill; dimension stone; et al); and clay and/or shale normally used for cement manufacture (about 0.4 ton per ton of finished cement). Some "industrial sand" and minor amounts of "phylite" and "silicate" production was also reported but not further defined.

<sup>3</sup>Reported figure.

<sup>4</sup>Data are for year beginning Apr. 1 of year stated.

<sup>5</sup>Ores from which both a copper concentrate and a cobalt concentrate, or a cobalt concentrate only were produced.

<sup>6</sup>Includes ore and concentrate shown under cobalt entry above, all of which contain copper that was recovered, but separate quantitative data on copper content of cobalt concentrates are not available. In the Copper chapter of Volume I of the USBM Minerals Yearbook, copper content of mine production is considered to be the sum of the following entries from this table: "Smelter output" plus "Total electrowon" less any metal derived from imported ore included in either entry.

<sup>7</sup>Includes the following quantity of blister anodes produced on toll by Zambia Consolidated Copper Co. Ltd. (ZCCM) from Zairean (1988-92), South African (1991-92), and Indonesian (1992) concentrates, in metric tons: 1988—24,812; 1989—15,295; 1990—16,182; 1991—19,678; 1992—34,569. In the Copper chapter of the USBM Minerals Yearbook, "smelter production" is considered to be the sum of the following entries from this table: "Smelter output" plus "Total electrowon" less "Refined: Electrowon."

<sup>8</sup>Includes the following quantity of electrolytic cathodes (presumably refined grade) produced on toll by ZCCM from blister smelted from Zairean (1988-92), South African (1991-92), and Indonesian (1992) concentrates, in metric tons: 1988—28,886; 1989—15,094; 1990—16,494; 1991—15,690; 1992—40,001.

<sup>9</sup>Reported by ZCCM as "finished production, refined shapes," presumably billets and/or wirebars of refined grade produced from lower grade electrowon cathodes and/or blister anodes that were furnace- or fire-refined; although high-grade electrowon cathodes or even electrorefined cathodes could possibly have been used as well.

<sup>10</sup>Presumed to meet refined-grade specifications although reported by ZCCM only as "finished production, leach cathodes," apparently a portion of the total electrowon cathodes that were not further refined.

<sup>11</sup>From copper and cobalt refinery residue produced by ZCCM only. Additional production probably came from artisanal operations but information is inadequate to reliably estimate output. However, for calendar year 1992, total production presumably from artisanal and ZCCM operations, was reported as 218 kilograms of gold and 18,264 kilograms of silver. For year beginning Apr. 1, 1992, up to 250 kg of silver may have come from imported copper concentrates smelted and refined on toll.

<sup>12</sup>Reported by ZCCM as "finished production." Presumed to be primary in the absence of any reported use of scrap by ZCCM.

<sup>13</sup>Presumably recovered from copper and cobalt refinery mud/slimes processed at ZCCM's Ndola Precious Metal plant. A similar quantity may be contained in mud/slimes not processed in-country and possibly sold for treatment elsewhere, but information is inadequate to reliably estimate content.

<sup>14</sup>Gross weight of ore milled shown in "Lead" above.

<sup>15</sup>Includes output of both Imperial smelter and electrolytic zinc plant reported as "finished production" by ZCCM.

<sup>16</sup>Presumably weight of finished brick.

<sup>17</sup>Estimated for cement manufacture only, assuming no imports. Available information is inadequate to reliably estimate additional output for other uses (e.g., plaster). Only production officially reported was 82 metric tons for 1992.

<sup>18</sup>Estimated for cement and lime manufacture only. Also see "Stone, construction: Limestone, crushed aggregate."

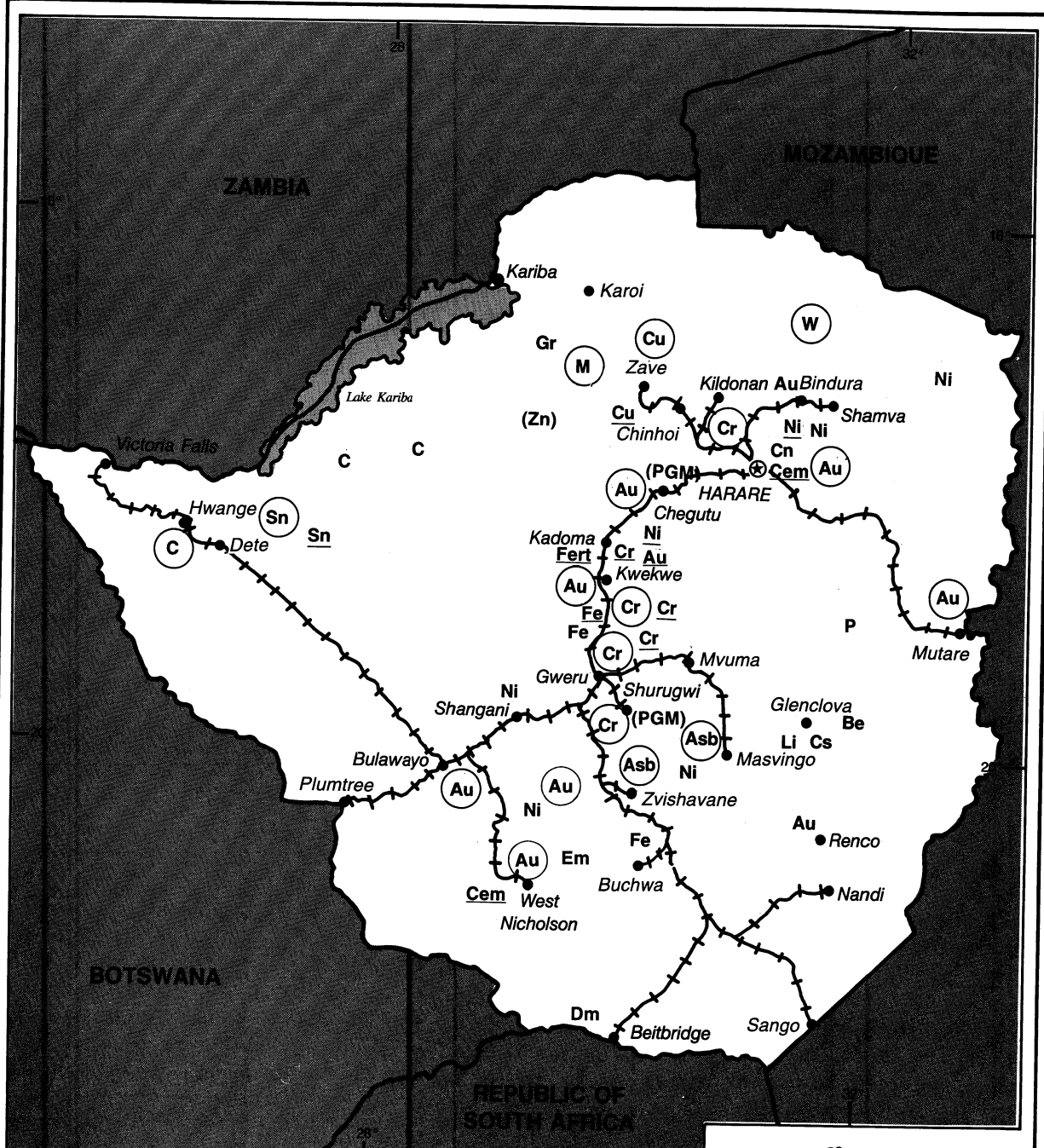
<sup>19</sup>Presumably for cement manufacture, dense media, electronic, or other special uses. Estimated 65% to 70% Fe.

<sup>20</sup>Additionally about 2,800 metric tons of sulfuric acid (containing about 900 metric tons of sulfur) was produced by burning imported sulfur mostly in 1988, only 19 tons of the total acid was made in 1987.

# ZIMBABWE

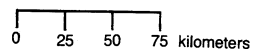
AREA 390,580 km<sup>2</sup>

POPULATION 11.0 million



- LEGEND**
- International boundary
  - Capital
  - City
  - Railroad
  - Group of producing mines or wells
  - Undeveloped significant resources

See table for mineral symbols.  
 Underlined symbol indicates plant.  
 The boundary representations and names shown for Latvia are not necessarily authoritative.



## THE MINERAL INDUSTRY OF

# ZIMBABWE

By Philip M. Mobbs

Zimbabwe played a major role in world supply of ferrochromium, chrysotile asbestos, and lithium minerals. More than one-half of the world's known reserves of high-grade chromium ore was in Zimbabwe. The country's most significant minerals produced in 1992 were, in order of value, gold, nickel, asbestos, coal, copper, chromite, iron ore, granite, phosphate, and limestone. The mining sector contributed about 7% of the GDP and approximately 45% of total foreign exchange earnings in 1992.

The severe drought that affected the region repeatedly buffeted the mining industry. Early in the year, the mining communities weathered shortages of grain and cooking oil. Then, water rights were reduced. The scarcity of potable water for the miners generated considerable concern about continuing industry operations, especially in the south. The lack of process water also inhibited production. Conservation and recycling of water, the drilling of new water wells, and withdrawing water from flooded shafts were some of the mechanisms the industry used to survive the crisis.

The lack of rain also contributed to the low water levels behind the Lake Kariba Dam, which, in turn, led to reduced generating capacity of the hydroelectric plant. The resultant power shortage forced companies to curtail operations.

As a result of the drought, Zimbabwe's GDP fell an estimated 8% to 10% in 1992. The economic recession coincided with the Government's tight money anti-inflationary policies, which produced 30% to 50% annual interest rates and a depreciating Zimbabwean dollar. The Government stuck to its Economic Structural Adjustment Program (Esap), despite the recession. The investment incentives intended to

stimulate the nation's exports, to give industry access to more foreign exchange, and to allow foreign investors to repatriate a higher percentage of their profits also were maintained.

Zimbabwe was self-sufficient in most minerals. More than 50 different mineral commodities were produced in the country. Mineral-related imports were primarily petroleum products and finished goods, as local resources satisfied a significant proportion of the nation's manufacturers' needs.

### GOVERNMENT POLICIES AND PROGRAMS

The Government was easing its intimate involvement with various sectors of the mineral economy, including foreign exchange policies, its strict regulation of private investment, price controls, and parastatal operations.

The surtax on capital goods destined for a project approved by the Zimbabwe Investment Center (ZIC) was suspended by January's Statutory Instrument 35 of 1992. Exemption of import taxes on similar goods also was granted during 1992. Modification of the Gold Trade Act was being considered. The Government imposed a 5% drought levy on companies for the 1992 and 1993 tax years.

In line with the Esap, the Government encouraged increased mineral production, as more exports would provide more foreign exchange and ease the balance of payments situation. Supplemental foreign exchange programs for the mining industry were instituted.

The Export Retention Scheme (ERS), which began in 1991, was an Esap program that provided companies with a percentage of foreign exchange earned by their exports. After appropriate

documentation had been filed, the Government allowed exporters access to foreign exchange for import of materials and capital equipment.

The percentage was increased from 5% to 7.5% and raised again to 15% during the first year of the program. During the first half of 1992, the rate was 25%, which was increased to 30% for the last 6 months of the year. At yearend, the rate was again increased to 35%, effective January 1993. ERS entitlements became tradable financial instruments at midyear when the associated import licenses became transferrable.

The original Minerals Marketing Corp. of Zimbabwe (MMCZ) foreign exchange facility (MMCZ1 facility), a \$75 million<sup>1</sup> loan from a consortium of banks in Britain and Europe to the Zimbabwean mining industry made in 1991, was administered jointly by the Ministry of Mines and the Chamber of Mines and disbursed during the year. During May 1992, the \$50 million MMCZ2 facility was initiated. ERS funding was somewhat favored over the MMCZ facilities because imported goods financed by the MMCZ facility were subject to an 8.5% commission on their f.o.b. value.

The Government ordered its parastatals to compete in the marketplace as commercial enterprises, as part of the Esap. Most parastatals responded to the Government's new profitability standards with price hikes, despite the recession.

### PRODUCTION

Gold accounted for 42% of the value of the nation's mineral industry production, followed by nickel (15%), asbestos (14%), coal (9%), copper (4%), and chromite (3%). Many commodities posted lower production in 1992 than in 1991, most notably barite, copper, and

magnesite. Commercial production of diamonds was initiated during the year. (See table 1.)

## TRADE

Most of the country's mineral industries were export oriented and thus exposed to world market fluctuations. The main export commodities, in order of importance, were tobacco, gold, ferroalloys, cotton, nickel, asbestos, iron and steel, coffee, sugar, and copper. Zimbabwe's leading trade partners were Germany, Japan, the Republic of South Africa, Switzerland, the United Kingdom, and neighboring African countries.

Most of the minerals produced were exported in beneficiated form, such as copper cathodes, ferrochromium, steel, and coke. Principal mineral exports to the United States were ferrochromium and nickel. Exports were handled by the MMCZ. (See tables 2 and 3.)

Investment guarantees were offered in Zimbabwe by the Overseas Private Investment Corp. and the Multilateral Investment Guarantee Agency.

## STRUCTURE OF THE MINERAL INDUSTRY

Mining in Zimbabwe was carried out by about 13 large companies, principally subsidiaries of international mining companies. (See table 4.) Mines belonging to these companies produced approximately 85% of the country's mineral output. The rest of the production was from relatively small mines.

At the beginning of the year, there were approximately 774 operating mines in Zimbabwe, of which 79% were gold mines, 4% were emerald mines, 4% were chromite operations, 2% were beryl mines, and 2% were black granite quarries.<sup>2</sup>

The drought stimulated the increase in gold panning in Zimbabwe. The Ministry of Mines estimated between 40,000 and 50,000 people were involved in informal gold panning, which was legalized in 1991. Much of their production was

going directly to the black market. The formal mining industry employed approximately 50,000 workers, about 5% of the national labor force.

The Government's mining company, Zimbabwe Mining Development Corp. (ZMDC), had interest in a number of mining operations. Refractory ores containing gold were treated at the state's oldest parastatal, The Roasting Plant. Doré was delivered to Fidelity Printers and Refiners (Pvt.) Ltd., a subsidiary of the Reserve Bank of Zimbabwe that officially purchased all gold produced in the country.

Most of Zimbabwe's exported minerals were beneficiated before being sold by the Government's MMCZ. Exports were usually shipped out of the country aboard state-owned National Railways of Zimbabwe.

## COMMODITY REVIEW

There were 56 fatal mining accidents in both 1991 and 1992. A number of the deaths were attributed to illegal operations in which laid off miners reentered abandoned mines.

The Small Scale Miners' Association of Zimbabwe, a confederation of alluvial gold panners, initiated a training and information campaign to combat environmental degradation of the nation's watercourses by the panners.

The Canadian International Development Agency completed its aeromagnetic survey of Zimbabwe.

Seventy-four Exclusive Prospecting Orders (EPO's) were issued by the Mining Affairs Board in 1991. Although only 47 EPO's were issued during 1992, given the rate that new applications were being filed, the number of EPO's granted was expected to rebound in 1993.

The Austrian Government arranged a \$10 million fund for small and medium miners. Nonexporting companies, such as small miners, refiners, and equipment suppliers, did not qualify for foreign exchange allocations under the ERS.

Nitro Nobel Zimbabwe inaugurated operations in March 1991. The 4,000 mt/a Kwekwe company, proposed in 1987, was slated to save the mining

industry foreign exchange formerly expended on imported explosives.

In response to the electric power reduction, a number of mining operations switched to a shorter (5-day) workweek. Gold thefts increased during the year as the recession lengthened.

The increased number of artisanal miners looking for a stretch of stream to pan challenged farmers, who were unwilling to allow access to their lands and risk damage to their crops and the local hydrology.

## Metals

**Chromite.**—The ferrochrome producers, Zimbabwe Alloys Ltd. (Zimalloys) and Zimbabwe Mining and Smelting Co. (Pvt.) Ltd. (Zimasco), were whipsawed by the drop in the world price of ferrochrome and the increase in local energy prices. The ferrochrome smelting industry earned approximately 8% of Zimbabwe's total foreign exchange earnings in 1992.

Zimasco continued its experimental mechanized mining of narrow seam chromite ore of the Great Dyke, and a Zimasco contractor started open pit operations at the Hornet Mine, a podiform deposit. However, as the year progressed, both Zimasco and Zimalloys cut back on production by their subsidiaries and contractor cooperatives. Negotiations concerning the sale of Zimasco to RTZ Corp. plc were called off in December.

Zimalloys continued its attempt to secure foreign exchange for emission control equipment for its refinery furnaces. Zimalloys' previous applications for foreign exchange had been disapproved by the ZIC. The refinery was ineligible for funds under the ERS, which was allocated for direct mineral production, not environmental undertakings. At yearend, Zimalloys sold a portion of its electric power allocation to Bindura Nickel Corp. which was also an Anglo American Corp. subsidiary.

**Copper.**—Mhangura Copper Mines Ltd. completed repairs on the collapsed

Miriam shaft to the 16-00 level. Rehabilitation of the shaft from the 16-00 level to the 24-00 level was proposed for 1993. The mine had produced 70% of the company's ore. The Norah shaft, which had contributed the other 30%, exhausted its reserves in September and was shut down. Smelter and refinery output was expected to be reduced in 1993 because of the mine problems and a scheduled 2- to 3-month maintenance shutdown.

Reunion Mining plc. of London, United Kingdom, reportedly initiated a feasibility study of the oxide ores in the Sanyati polymetallic deposit (formerly ZMDC's Copper Queen and Copper King zinc-copper-lead deposits).

**Gold.**—Most of the new gold operations were based on the application of new technology to old operations.

Cluff Resources Zimbabwe Ltd. continued the drilling program to define reserves at its Freda Rebecca Mine at Bindura as part of the continuing feasibility study of underground mining at Freda Rebecca. Near-surface oxides were exhausted at both the Freda and Rebecca pits. Additional oxides were obtained from the Topsman deposit. The Rebecca open pit was projected to be mined out in 1993, while the sulfide ore at the Freda open pit was projected to last until 1998.

Cluff opened the Peach Tree Mine near Filabusi at the end of the year, after depleting heap-leachable reserves at the nearby Royal Family Mine during July. Retreatment of the dumps at the Royal Family and the remainder of the Marvel complex continued.

Trillion Resources Ltd. of Canada entered into a joint-venture agreement with the ZMDC. The venture plans to expand operations at the Jena Mines, a complex of 2 current producers and 10 former gold operations near Silobena.

In November, Falcon Gold Zimbabwe Ltd. started up the Antelope Mine sands retreatment. The facility was designed to process 300,000 mt/a and projected to yield 210 kg/a.

Masasa Mines completed the sampling program at its Makaha Prospect in

northeast Zimbabwe.

Union Carbide planned to heap leach the oxide deposits at the Motapa Mine, 100 km north of Bulawayo.

The Roasting Plant near Kwekwe requested Government approval of its proposal to replace its roasters with a pressure oxidation plant. The Canadian International Development Agency had funded the feasibility studies. Potential customers included a number of mines whose refractory ore was not amenable to roasting.

The Roasting Plant also replaced its extended three-payment system to ore suppliers with a single payment plan.

**Iron and Steel.**—Zimbabwe Iron and Steel Corp. (Zisco) proposed to significantly increase its continuous casting capability from its present 20%. Zisco also intended to reduce the diverse steel product line that it had developed during the Unilateral Declaration of Independence and sanctions period. The company was authorized to charge competitive prices for local sales at the end of 1991. The price controls of the 1980's had eroded the company's ability to remain competitive, and it was unable to recoup its domestic losses with higher export prices, given the state of the world steel market.

The company undertook rehabilitation of the No. 4 blast furnace during the year. Planned plant improvements included a 2-Mmt/a sinter plant and a dedicated thermal power station.

A Zisco subsidiary, Zimchem Refiners (Pvt.) Ltd., was proposed to refine coke oven byproducts, such as benzole and tar, into products such as benzene, toluene, and xylene.

**Nickel.**—Rio Tinto Zimbabwe (RTZ) extended its toll refining agreement with BCL Ltd. of Botswana. RTZ's Empress nickel refinery has been dependent on matte from BCL's Selebi-Phikwe smelter since reopening in 1985.

Bindura Nickel Corp. Ltd. expected that production at the Madziwa Mine would be extended for an estimated 2 years with the discovery of additional

reserves. Deepening of the Trojan shaft continued through the year. Bindura also received ISO 9002 accreditation, an international quality assurance standard.

Bindura's BSR Ltd. installed a new electrostatic precipitator and a new sodium sulfate crystallizer at the smelter. The Na<sub>2</sub>SO<sub>4</sub> was expected to substitute for up to 50% of the Na<sub>2</sub>SO<sub>4</sub> presently being imported into Zimbabwe.

**Platinum-Group Metals.**—Exploration continued along the Great Dyke. A number of companies were searching for exploitable nickel-copper sulfides with high gold and platinum values.

The feasibility study was being prepared for the Hartley Project, a platinum prospect of Delta Gold NL and BHP Minerals Ltd., a subsidiary of The Broken Hill Proprietary Co., Ltd. Underground exploration continued at the trial mine. Zimasco completed a feasibility study of the Mimosa Prospect, its Great Dyke platinum prospect.

## Industrial Minerals

**Emerald.**—During 1991, RTZ reached a preliminary agreement to sell its Sandawana operation, the country's largest emerald mine. The Government granted its approval during 1992; however, conclusion of the deal was not expected until 1993.

**Diamond.**—Cornerstone Investments and the Australian operator, Auridam Consolidated NL, began mining at their River Ranch kimberlite property in March. Auridam reported that 60% of the output is of gem quality. The mine was projected to have a 10- to 15-year life. Kimberlitic Searches Ltd., a De Beers company, had discovered the property in the 1970's; however, the Ministry of Mines rescinded De Beers' River Ranch claims in March 1991. The Government had wanted its MMCZ to market production, while De Beers proposed to handle the output itself. Negotiations failed to resolve this distribution impasse.

Auridam was also studying the

Shigwizi pipe with Cluff.

Quest Exploration (Pvt.) Ltd., a subsidiary of Reunion Mining, concluded a second year of exploration in western Zimbabwe, primarily in the Zambezi Valley and the Gwaai and Hurange areas.

**Granite.**—The Mines and Minerals Act was amended during May 1990 to reclassify exports of clay, sand, and stone as minerals. Granite production for 1992 was valued at \$8.6 million, ranking the dimension stone sector eighth in terms of value. The reclassification eliminated the royalty payments that dimension stone quarriers had been paying the rural councils and effectively mandated that MMCZ market the stone. A number of problems have since arisen. Quarriers continued to be restricted to renewable special grants for their operations, not mining titles as miners received. The Ministry of Finance refused to grant tax relief to dimension stone quarriers similar to that enjoyed by mine operators. Following the national strategic objective of natural resources beneficiation, the Government indicated that it wanted the granite industry to set up a polishing industry, despite the lack of equipment, funding, and local labor force skills. The Government also indicated that it would institute a levy on dimension stone producers payable to the rural councils to replace the lost royalties.

### Mineral Fuels

**Coal.**—The drought and the recession adversely affected the Wankie Colliery. The agricultural industry required less coal, Zaire's coke orders declined with that nation's mineral industry activity, and domestic coal and coke orders dropped with the mineral industry's slowdown.

Wankie was awarded a 45% price increase in March and an additional 27% increase in September and initiated austerity measures to survive the recession.

RTZ continued work on the Sengwa Colliery during 1992. Preliminary sales contracts were entered into with local

agricultural and industrial concerns. Metallurgical-grade coal was undergoing testing at the Zimasco smelter in Kwekwe. The operation's future remained nebulous as the project's economics had been based on sales to the country's faltering ferrochrome industry.

**Petroleum.**—Petrozim (Pvt.) Ltd., a joint venture between the Zimbabwe National Oil Company (50%) and Lonrho plc (50%), began construction of a 203-km pipeline from the Beria pipeline terminal at Feruka, near Mutare, to Harare.

### INFRASTRUCTURE

Most of Zimbabwe's bulk imports and exports were moved by rail, making it the backbone for the country's agricultural and industrial development. All major cities and industrial centers were linked by the rail network. The Government's National Railways of Zimbabwe was one of the largest in Africa, consisting of 4,304 km of track.

Electrical generating capacity nosedived during the year with the effects of the drought on the Lake Kariba hydroelectric power station and the breakdowns at the Hwange thermal powerplant. Zambia's Kafue Gorge hydroelectric power station also reduced the amount of electricity it sold to Zimbabwe. The Zimbabwe Electricity Supply Authority (ZESA) responded by requesting a 20% reduction in power consumption by its minerals industry customers, who consumed between 30% and 40% of the electricity sold by ZESA. During April, ZESA signed an agreement to begin a project that should eventually enable it to import power generated by the Cabora Bassa hydroelectric power station in Mozambique.

ZESA increased its rates by 25% in September and raised prices again in December, in line with the Government's wish that parastatals become self-sufficient.

### OUTLOOK

Zimbabwe is beginning to recover from its recent history of inadequate

availability of foreign currency. The ERS and MMCZ facilities provided a means to obtain foreign exchange to replace aging plants and obsolete equipment, enabling the industry to attempt to regain lost competitive advantages. Given the intensity of exploration, new mineral deposits were likely to be discovered. However, the recession, continued high interest rates, and low commodity prices will adversely affect the viability of many of the country's marginal mineral operations.

Asbestos, chromite, gold, and nickel should remain the mainstays of the Zimbabwean mineral economy through the turn of the century. A slow recovery in mine production could be expected for the near term, with increases mainly in the production of diamonds, gold, and platinum-group metals. The updated investment regulations should encourage further local and foreign participation in the mineral industry and eventually increase output. The Government is expected to remain wary of any significant influx of funding swamping local private interests.

<sup>1</sup>Where necessary, values have been converted from Zimbabwe dollars (ZD) to U.S. dollars (US\$) at the rate of ZD5.00=US\$1.00.

<sup>2</sup>Chamber of Mines Journal (Harare), V. 35, No. 1, Jan. 1993, page 2.

### OTHER SOURCES OF INFORMATION

#### Agencies

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National Resource Board  
Head Office, Block 1  
Makombe Building  
Box 8070, Causeway  
Harare, Zimbabwe

#### **Publications**

Bartholomew, D.S., Base Metal and Industrial Mineral Deposits of Zimbabwe. Zimbabwe Geological Survey Mineral Resources Series No. 22, Harare, 1990, 154 pp.

Bartholomew, D.S., Gold Deposits of Zimbabwe. Zimbabwe Geological Survey Mineral Resources Series No. 23, Harare, 1990, 75 pp.

The Chamber of Mines Journal, Harare, monthly.



TABLE 1  
ZIMBABWE: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1988	1989	1990	1991	1992
<b>METALS</b>					
Antimony, mine output, concentrate, Sb content	165	210	101	160	254
Beryllium: Beryl concentrate, gross weight	33	46	28	29	23
Chromium: Chromite, gross weight	561,477	627,424	643,098	563,634	522,013
Cobalt: <sup>2</sup>					
Mine output, Co content <sup>o</sup>	104	90	102	105	80
Metal	126	112	127	130	100
Columbium and tantalum: Tantalite concentrate:					
Gross weight kilograms	66,000	32,000	35,000	111,000	94,000
Cb content <sup>o</sup> do.	9,900	4,800	5,200	16,650	14,100
Ta content <sup>o</sup> do.	23,100	11,200	12,200	38,850	32,900
Copper:					
Mine output, concentrate, Cu content <sup>o</sup>	16,900	16,400	14,698	14,420	10,100
Metal:					
Smelter output, blister/anode, primary <sup>o 3</sup>	16,300	15,800	14,100	13,830	9,690
Refinery output, refined/cathode, primary	16,116	15,659	14,080	13,811	9,673
Gold kilograms	14,191	16,003	16,900	17,820	18,278
Iron and steel:					
Mine output, iron ore:					
Gross weight thousand tons	1,020	1,143	1,259	1,136	1,179
Fe content <sup>o</sup> do.	632	686	730	660	710
Metal:					
Pig iron <sup>o</sup> do.	600	520	521	535	507
Steel, crude do.	500	650	580	581	547
Ferroalloys:					
Ferrochromium	224,000	173,000	222,102	186,774	190,994
Ferrosilicon chromium	29,000	25,000	16,612	27,755	20,282
Ferromanganese	2,000	—	—	—	—
Total	255,000	198,000	238,714	214,529	211,276
Nickel:					
Mine output, concentrate, Ni content <sup>o</sup>	13,500	13,600	13,490	12,371	11,300
Refinery output, refined metal <sup>4</sup>	11,490	11,633	11,426	11,297	10,349
Platinum-group metals:					
Palladium kilograms	46	43	31	30	19
Platinum do.	28	25	21	19	9
Total do.	74	68	52	49	28
Selenium	3,272	3,000	2,300	2,549	1,736
Silver do.	21,953	22,305	21,221	19,380	16,930
Tin:					
Mine output, Sn content <sup>o</sup>	1,140	1,130	1,120	1,060	950
Smelter output, metal	855	848	838	796	716
Tungsten, concentrate:					
Gross weight	1	(°)	(°)	(°)	—
W content <sup>o</sup>	1	1	1	1	—
<b>INDUSTRIAL MINERALS</b>					
Asbestos	186,581	187,006	160,861	141,697	150,158
Barite	3,400	1,900	320	866	232

See footnotes at end of table.

TABLE 1—Continued  
ZIMBABWE: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1988	1989	1990	1991	1992
<b>INDUSTRIAL MINERALS—Continued</b>					
Cement, hydraulic	775,736	719,469	700,000	865,000	*900,000
Clays:					
Bentonite (montmorillonite)	113,157	104,865	99,854	*99,900	82,956
Fire clay	16,171	19,100	19,914	23,304	15,954
Kaolin	95	17	—	65	83
Diamond carats	—	—	—	—	40,654
Feldspar	3,730	2,697	2,197	3,820	2,696
Gemstones, precious and semiprecious: Emerald kilograms	6,380	6,300	13,010	*13,000	46
Graphite	11,441	18,147	16,383	12,903	12,346
Kyanite	1,795	1,869	160	*160	1,990
Lithium minerals, gross weight	15,073	20,647	19,053	9,186	12,837
Magnesium compounds: Magnesite	30,121	33,423	32,639	23,295	8,973
Mica	1,797	1,471	1,301	506	495
Nitrogen: N content of ammonia	64,400	*61,500	62,500	*66,000	*60,000
Phosphate rock, marketable concentrate thousand tons	125	134	148	117	142
Pigments, iron oxide	363	287	416	*400	538
Stone, sand and gravel:					
Granite	*50,000	*60,000	*70,000	79,907	90,694
Limestone thousand tons	1,408	1,370	1,252	1,428	1,366
Quartz <sup>6</sup> do.	55	62	63	70	77
Sulfur:					
Pyrite:					
Gross weight	39,659	47,561	66,571	69,851	66,345
S content <sup>*</sup>	17,500	20,900	29,300	30,734	29,200
Byproduct acid, metallurgical and coal process gas <sup>*</sup>	5,000	5,000	5,000	5,000	4,500
Total	22,500	25,900	34,300	35,734	33,700
Talc	976	1,513	1,787	1,676	2,203
Vermiculite	*1,000	*1,000	*1,000	2,319	4,300
<b>MINERAL FUELS AND RELATED MATERIALS</b>					
Coal, bituminous thousand tons	4,900	5,111	5,505	5,616	5,547
Coke, metallurgical <sup>7</sup> do.	600	600	565	560	500

\*Estimated. \*Revised.

<sup>1</sup>Table includes data available through Aug. 31, 1993.

<sup>2</sup>"Mine output" figures are calculated from "metal" figures. "Metal" may include metal content of compounds/salts and may include cobalt recovered from nickel-copper matte imported from Botswana for toll refining.

<sup>3</sup>Smelter copper includes impure cathodes produced by electrowinning in nickel processing.

<sup>4</sup>May include nickel content of nickel oxide.

<sup>5</sup>Less than 1/2 unit.

<sup>6</sup>Includes rough and ground quartz as well as silica sand.

<sup>7</sup>Data represent output by the Wankie Colliery Co. Ltd.; additional output by the Redcliff plant of Zisco Ltd. may total 250,000 mt/a of metallurgical coke and coke breeze.

TABLE 2  
ZIMBABWE: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1990	Sources	
		United States	Other (principal)
<b>METALS</b>			
<b>Aluminum:</b>			
Ore and concentrate	6,632	—	All from Mozambique.
Oxides and hydroxides	74	21	India 55; Republic of South Africa 21; United Kingdom 11.
<b>Metal including alloys:</b>			
Scrap	7,474	—	All from Malawi.
Unwrought	18,067	(?)	Republic of South Africa 17,258; Australia 749.
Semimanufactures	8,109	257	Republic of South Africa 5,282; Brazil 1,244; China 391.
Antimony: Metal including alloys, all forms	3	—	China 2; Republic of South Africa 1.
Bismuth: Metal including alloys, all forms			
value, thousands	\$3	—	West Germany \$1; Republic of South Africa \$1.
Cadmium: Metal including alloys, all forms	do.	\$23	—
			Japan \$9; West Germany \$7; Republic of South Africa \$4.
<b>Chromium:</b>			
Oxides and hydroxides	55	—	West Germany 21; U.S.S.R. 17; Poland 16.
Metal including alloys, all forms	value, thousands	\$1	—
			All from Republic of South Africa.
<b>Cobalt:</b>			
Oxides and hydroxides	3	—	Republic of South Africa 2; United Kingdom 1.
Metal including alloys, all forms	value, thousands	\$2	—
			All from United Kingdom.
Columbium and tantalum: Ore and concentrate	1		All from Republic of South Africa.
<b>Copper:</b>			
Ore and concentrate	13,430	—	Republic of South Africa 13,084; Mozambique 346.
Matte and speiss including cement copper	982	—	All from Republic of South Africa.
<b>Metal including alloys:</b>			
Scrap	12	—	All from Malawi.
Unwrought	125	—	United Kingdom 106; Republic of South Africa 12.
Semimanufactures	3,238	10	Republic of South Africa 1,818; Italy 1,110; Zambia 54.
Gold: Metal including alloys, unwrought and partly wrought	kilograms	12	—
			United Kingdom 6; Zambia 6.
<b>Iron and steel:</b>			
Iron ore and concentrate excluding roasted pyrite	586	—	All from Republic of South Africa.
<b>Metal:</b>			
Scrap	36	NA	Republic of South Africa 1; unspecified 35.
Pig iron, cast iron, related materials	7,343	—	Republic of South Africa 7,335; Canada 18.
<b>Ferroalloys:</b>			
Ferromanganese	3	—	All from United Kingdom.
Ferromanganese	546	—	Republic of South Africa 534; United Kingdom 12.
Ferronickel	1	—	All from Republic of South Africa.
Ferrosilicomanganese	59	—	Do.
Ferrosilicon	102	5	Republic of South Africa 96; France 1.
Silicon metal	111	—	All from Republic of South Africa.
Unspecified	112	4	Republic of South Africa 79; United Kingdom 23.
Steel, primary forms	value, thousands	\$147	\$76
			Sweden \$68.

See footnotes at end of table.

TABLE 2—Continued  
ZIMBABWE: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1990	Sources	
		United States	Other (principal)
<b>METALS—Continued</b>			
<b>Iron and steel:</b>			
<b>Metal:</b>			
<b>Semimanufactures:</b>			
<b>Flat-rolled products:</b>			
<b>Of iron or nonalloy steel:</b>			
Not clad, plated, coated	138,353	3	Republic of South Africa 122,550; East Germany 7,396; Yugoslavia 2,255.
Clad, plated, coated	23,554	—	Republic of South Africa 17,652; United Kingdom 2,733.
Of alloy steel	2,796	—	Republic of South Africa 1,774; West Germany 576; Belgium-Luxembourg 141.
Bars, rods, angles, shapes, sections value, thousands	\$9,066	\$11	Republic of South Africa \$7,715; West Germany \$400.
Rails and accessories	11,918	—	Republic of South Africa 11,893; United Kingdom 17.
Wire	4,889	( <sup>c</sup> )	Republic of South Africa 4,179; United Kingdom 396; China 185.
Tubes, pipes, fittings	1,718	13	Republic of South Africa 1,468; France 87; United Kingdom 86.
<b>Lead:</b>			
Oxides	252	—	Republic of South Africa 174; Mauritius 53; Zambia 25.
<b>Metal including alloys:</b>			
Scrap	29	—	All from Malawi.
Unwrought	682	—	Republic of South Africa 534; Malawi 101; Zambia 47.
Semimanufactures	48	—	Zambia 25; Republic of South Africa 23.
Magnesium: Metal including alloys, semimanufactures	1	—	All from Republic of South Africa.
<b>Manganese:</b>			
Ore and concentrate, metallurgical-grade	8,896	—	Republic of South Africa 8,494; Gabon 194; Zambia 180.
Oxides	98	—	Belgium-Luxembourg 54; Republic of South Africa 44.
Metal including alloys, all forms	20	—	All from Republic of South Africa.
<b>Molybdenum:</b>			
Ore and concentrate	18	—	Do.
Metal including alloys, semimanufactures	1	—	Mainly from Australia.
<b>Nickel:</b>			
Matte and speiss	752	—	All from Republic of South Africa.
<b>Metal including alloys:</b>			
Unwrought	7	—	Republic of South Africa 6; United Kingdom 1.
Semimanufactures	6,113	9	France 2,808; Netherlands 2,316; Republic of South Africa 511.
<b>Platinum-group metals:</b>			
Waste and sweepings value, thousands	\$8	—	All from United Kingdom.
Metals including alloys, unwrought and partly wrought do.	\$113	—	Republic of South Africa \$52; United Kingdom \$41; West Germany \$13.
Selenium, elemental <sup>†</sup>	12	—	West Germany 8; Republic of South Africa 4.
Silver: Metal including alloys, unwrought and partly wrought value, thousands	\$62	—	Canada \$24; Republic of South Africa \$17; United Kingdom \$16.
Tin: Metal including alloys, semi-manufactures	77	—	All from Republic of South Africa.
<b>Titanium:</b>			
Ore and concentrate	132	—	Do.
Oxides	1,192	82	Republic of South Africa 662; Brazil 206; West Germany 112.

See footnotes at end of table.

TABLE 2—Continued  
ZIMBABWE: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1990	Sources	
		United States	Other (principal)
<b>METALS—Continued</b>			
<b>Titanium—Continued:</b>			
<b>Metal including alloys:</b>			
Unwrought	value, thousands	\$1	— All from United Kingdom.
Semimanufactures	do.	\$9	— All from Republic of South Africa.
<b>Tungsten, metal including alloys:</b>			
Unwrought	do.	\$11	— Do.
Semimanufactures	do.	\$2	— Republic of South Africa \$1; United Kingdom \$1.
Uranium: Metal including alloys, all forms	do.	\$23	— All from Norway.
<b>Zinc:</b>			
Ore and concentrate	do.	\$2	— All from Republic of South Africa.
<b>Metal including alloys:</b>			
Scrap		88	— Malawi 58; Zambia 30.
Unwrought		6,884	— Republic of South Africa 4,803; Zambia 1,315; Zaire 658.
Semimanufactures		42,214	171 Zambia 30,195; Republic of South Africa 11,204; United Kingdom 644.
<b>Zirconium:</b>			
Ore and concentrate		6,623	— Republic of South Africa 6,622.
Metal including alloys, semimanufactures	value, thousands	\$4	— All from Republic of South Africa.
<b>Other:</b>			
Ores and concentrates		14	— Do.
Ashes and residues	value, thousands	\$701	— Republic of South Africa \$517; Malawi \$113.
<b>INDUSTRIAL MINERALS</b>			
<b>Abrasives, n.e.s.:</b>			
Natural: Corundum, emery, pumice, etc.		367	(?) Turkey 266; United Kingdom 42; Republic of South Africa 32.
Artificial: Corundum		121	— United Kingdom 113; Republic of South Africa 8.
Dust and powder of precious and semiprecious stones including diamond	value, thousands	\$8	— United Kingdom \$7; Republic of South Africa \$1.
Grinding and polishing wheels and stones		316	13 West Germany 94; Republic of South Africa 79; India 65.
Barite and witherite		1	— All from Republic of South Africa.
<b>Boron materials:</b>			
Crude natural borates		29	— Do.
Oxides and acids		72	2 Netherlands 18; United Kingdom 18; Republic of South Africa 7.
Bromine, iodine, fluorine		7	— West Germany 5; Japan 1.
Cement		210,800	— Republic of South Africa 195,150; Zambia 15,541.
Chalk		2	— All from Republic of South Africa.
<b>Clays, crude:</b>			
Bentonite		1,075	— Republic of South Africa 894; Mozambique 160.
Kaolin		501	246 Republic of South Africa 187; United Kingdom 63.
Unspecified		13,008	— Sweden 7,650; United Kingdom 3,001; Republic of South Africa 2,357.
Cryolite and chiolite		10	— All from Denmark.
<b>Diamond, natural:</b>			
Gem, not set or strung	value, thousands	\$26	— Republic of South Africa \$22; United Kingdom \$3.
Industrial stones	do.	\$122	\$64 Republic of South Africa \$64; United Kingdom \$36; Zaire \$14.

See footnotes at end of table.

TABLE 2—Continued  
ZIMBABWE: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1990	Sources	
		United States	Other (principal)
<b>INDUSTRIAL MINERALS—Continued</b>			
Diatomite and other infusorial earth	970		France 536; Republic of South Africa 193; Kenya 187.
Feldspar	16	—	West Germany 15; United Kingdom 1.
Fluorspar	380		All from Republic of South Africa.
<b>Fertilizer materials: Manufactured:</b>			
Ammonia	113,945	102,076	Republic of South Africa 11,853.
Nitrogenous	24,476	—	Republic of South Africa 22,490; Netherlands 581; Saudi Arabia 415.
Phosphatic	8,100	—	Republic of South Africa 8,099.
Potassic	69,934	—	Israel 44,018; West Germany 13,725; Belgium-Luxembourg 6,436.
Unspecified and mixed	value, thousands	\$29	\$2 Republic of South Africa \$26; Norway \$1.
Graphite, natural	636	19	Republic of South Africa 439; West Germany 152.
Gypsum and plaster	1,389	1	United Kingdom 1,006; Republic of South Africa 321.
Lime	thousand tons	2,058	— All from Republic of South Africa.
Magnesium compounds: Oxides and hydroxides	330	—	Republic of South Africa 259; United Kingdom 40; West Germany 27.
<b>Mica:</b>			
Crude including splittings and waste	19	—	All from Republic of South Africa.
Worked including agglomerated splittings	4	—	Switzerland 1; United Kingdom 1.
Nitrates, crude	5,491	—	Chile 5,216; West Germany 215.
Pigments, mineral: Iron oxides and hydroxides, processed	17	—	Republic of South Africa 15; Hong Kong 2.
<b>Precious and semiprecious stones other than diamond:</b>			
Natural	value, thousands	\$213	— Republic of South Africa \$195; United Kingdom \$16.
Synthetic	do.	\$54	— United Kingdom \$32; Zaire \$17; Republic of South Africa \$4.
Pyrite, unroasted	47	—	Republic of South Africa 39; United Kingdom 8.
Salt and brine	54,415	—	Republic of South Africa 53,776; Kenya 253.
<b>Sodium compounds, n.e.s.:</b>			
Soda ash, natural and manufactured.	11,460	—	Kenya 3,668; Republic of South Africa 3,267; Bulgaria 1,342.
Sulfate, manufactured	1,128	—	Republic of South Africa 536; West Germany 280; Belgium-Luxembourg 108.
<b>Stone, sand and gravel:</b>			
<b>Dimension stone:</b>			
Crude and partly worked	375	—	Republic of South Africa 200; Switzerland 175.
Worked	63	—	All from Republic of South Africa.
Dolomite, chiefly refractory-grade	59	—	Do.
Gravel and crushed rock	457	—	Australia 340; Republic of South Africa 117.
Limestone other than dimension	4,102	—	All from Republic of South Africa.
Quartz and quartzite	12	NA	Republic of South Africa 10; unspecified 2.
Sand other than metal-bearing	947	22	Republic of South Africa 889; West Germany 20.
<b>Sulfur:</b>			
<b>Elemental:</b>			
Crude including native and byproduct	31,109	—	Republic of South Africa 17,623; Canada 13,438.
Colloidal, precipitated, sublimed	22	—	All from Republic of South Africa.
Sulfuric acid	77	—	Do.
Talc, steatite, soapstone, pyrophyllite	457	—	Zambia 397; Republic of South Africa 32.

See footnotes at end of table.

TABLE 2—Continued  
**ZIMBABWE: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

Commodity	1990	Sources	
		United States	Other (principal)
<b>INDUSTRIAL MINERALS—Continued</b>			
Vermiculite	8	—	All from Republic of South Africa.
Other: Crude	751	—	Republic of South Africa 750; Ireland 1.
<b>MINERAL FUELS AND RELATED MATERIALS</b>			
Asphalt and bitumen, natural	2,181	26	Zambia 1,484; Republic of South Africa 527; Trinidad and Tobago 108.
Carbon black	4,583	34	Mexico 2,848; Republic of South Africa 1,088; China 479.
<b>Petroleum:</b>			
Crude	barrels	350	— All from Republic of South Africa.
<b>Refinery products:</b>			
Liquefied petroleum gas	thousand 42-gallon barrels	1	— Do.
Gasoline	do.	2,206	NA Republic of South Africa 372; unspecified 1,830.
Mineral jelly and wax	do.	22	( <sup>2</sup> ) Republic of South Africa 10; Mauritius 3; West Germany 2.
Kerosene and jet fuel	do.	964	NA Republic of South Africa 23; unspecified 941.
Distillate fuel oil	do.	4,076	NA NA.
Lubricants	value, thousands	\$23,396	\$312 United Kingdom \$5,813; Netherlands \$2,965; unspecified \$8,551.
Residual fuel oil	thousand 42-gallon barrels	2,698	( <sup>3</sup> ) All from Zambia.
Bitumen and other residues	do.	5	— All from Republic of South Africa.
Bituminous mixtures	do.	179	NA Zambia 10; unspecified 169.

NA Not available.

<sup>1</sup>Comparable data for 1989 are not available. Table prepared by Virginia A. Woodson.

<sup>2</sup>Unreported quantity valued at \$1,000.

<sup>3</sup>Unreported quantity valued at \$10,000.

<sup>4</sup>May include phosphorus.

<sup>5</sup>Less than 1/2 unit.

TABLE 3  
ZIMBABWE: EXPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1990	Sources	
		United States	Other (principal)
<b>METALS</b>			
<b>Aluminum: Metal including alloys:</b>			
Scrap	16	—	All to United Kingdom.
Semimanufactures	381	1	Malawi 336; Zambia 38; Mozambique 6.
<b>Antimony: Metal including alloys, all forms</b>			
	17	—	All to Republic of South Africa.
<b>Chromium: Metal including alloys, all forms</b>			
	5	—	All to Malawi.
<b>Cobalt:</b>			
Oxides and hydroxides	78	—	All to Republic of South Africa.
Metal including alloys, all forms	99	—	Mozambique 40; United Kingdom 40; Switzerland 19.
<b>Columbium and tantalum: Ore and concentrate<sup>2</sup></b>			
	76	—	All to Mozambique.
<b>Copper:</b>			
Matte and speiss including cement copper	1,224	—	Republic of South Africa 1,172; West Germany 32; Netherlands 20.
<b>Metal including alloys:</b>			
Scrap	682	—	Republic of South Africa 554; United Kingdom 128.
Unwrought	11,899	—	United Kingdom 5,739; Republic of South Africa 2,903; West Germany 2,623.
Semimanufactures	value, thousands	\$931	\$2 United Kingdom \$674; Republic of South Africa \$225; Netherlands \$18.
<b>Gold: Metal including alloys, unwrought and partly wrought</b>			
	kilograms	6,850	— All to United Kingdom.
<b>Iron and steel: Metal:</b>			
Scrap	8,779	—	Republic of South Africa 8,778.
Pig iron, cast iron, related materials	89	—	Republic of South Africa 77; Zambia 8.
<b>Ferroalloys:</b>			
Ferrochromium	195,699	52,259	West Germany 40,124; Japan 27,677; Italy 19,692.
Ferromanganese	1	—	All to Kenya.
Ferrosilicochromium	22,084	6,562	West Germany 6,676; Japan 3,226.
Ferrosilicon	4	—	All to Zambia.
Unspecified	250	—	All to Kenya.
Steel, primary forms	210,814	—	Kenya 58,263; Hong Kong 55,808; Italy 34,005.
<b>Semimanufactures:</b>			
<b>Flat-rolled products:</b>			
<b>Of iron or nonalloy steel:</b>			
Not clad, plated, coated	thousands	\$5,017	— Kenya \$1,811; Republic of South Africa \$1,146; Malawi \$906.
Clad, plated, coated		6,654	— Zambia 6,486; Mozambique 70.
Of alloy steel		154	— Republic of South Africa 152; Mozambique 2.
Bars, rods, angles, shapes, sections	value, thousands	\$4,586	— Republic of South Africa \$2,223; Zambia \$1,164; Malawi \$827.
Rails and accessories		75,342	— Mozambique 57,366; Zambia 17,902.
Wire	value, thousands	\$983	— Zambia \$425; Republic of South Africa \$277; Malawi \$183.
Tubes, pipes, fittings		2,538	— Republic of South Africa 1,035; Zambia 996; Malawi 362.
<b>Lead:</b>			
Oxides	14	—	All to Republic of South Africa.
<b>Metal including alloys:</b>			
Scrap	57	—	All to United Kingdom.
Semimanufactures	value, thousands	\$3	— All to Malawi.

See footnotes at end of table.



TABLE 3—Continued  
ZIMBABWE: EXPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1990	Sources	
		United States	Other (principal)
<b>METALS—Continued</b>			
<b>Manganese:</b>			
Oxides	78	—	All to Republic of South Africa.
Metal including alloys, all forms	27	—	All to Zambia.
Mercury	value, thousands	\$1	— Do.
<b>Nickel:</b>			
Ore and concentrate	38	—	All to Republic of South Africa.
<b>Metal including alloys:</b>			
Scrap	1,800	—	All to Japan.
Unwrought	13,740	2,571	Japan 3,076; Italy 2,664; West Germany 1,738.
Semimanufactures	20	—	All to Republic of South Africa.
Platinum-group metals: Waste and sweepings	value, thousands	\$1,122	— West Germany \$1,113; Republic of South Africa \$9.
Silver: Metal including alloys, unwrought and partly wrought	value, thousands	\$7	\$3 Republic of South Africa \$2; Belgium-Luxembourg \$1.
Tin: Metal including alloys, semimanufactures	do.	\$15	— Republic of South Africa \$10; Zambia \$5.
Titanium: Metal including alloys, unwrought	6	—	All to United Kingdom.
<b>Zinc:</b>			
Ore and concentrate	1	—	All to West Germany.
Metal including alloys, semimanufactures	213,805	18	United Kingdom 213,635; Mozambique 51.
Other: Ashes and residues	3,742	—	Republic of South Africa 3,702; Netherlands 20; United Kingdom 20.
<b>INDUSTRIAL MINERALS</b>			
<b>Abrasives, n.e.s.:</b>			
Natural: Corundum, emery, pumice, etc.	811	—	Republic of South Africa 785; United Kingdom 26.
Grinding and polishing wheels and stones	19	—	All to Republic of South Africa.
Asbestos, crude	172,206	633	Japan 37,682; Spain 12,401; India 12,083.
Barite and witherite	value, thousands	\$3	— All to Republic of South Africa.
Cement	150,922	—	Republic of South Africa 96,642; Mozambique 54,133.
<b>Clays, crude:</b>			
Bentonite	81	—	Zambia 80; Malawi 1.
Kaolin	5,517	—	All to Republic of South Africa.
Unspecified	340	—	Republic of South Africa 283; Zambia 30; United Kingdom 27.
Diatomite and other infusorial earth	361	—	All to West Germany.
<b>Fertilizer materials: Manufactured:</b>			
Ammonia	845	—	Mozambique 500; Republic of South Africa 345.
Nitrogenous	value, thousands	\$310	— Burundi \$151; Zaire \$88; Mozambique \$58.
Phosphatic	2,002	—	All to Malawi.
Potassic	12,065	—	Zambia 6,500; Republic of South Africa 3,001; Malawi 2,541.
Unspecified and mixed	value, thousands	\$778	— Malawi \$535; Mozambique \$243.
Graphite, natural	16,082	1,925	West Germany 6,086; Republic of South Africa 3,501; Mozambique 2,152.
Gypsum and plaster	2,233	—	Malawi 2,130; Mozambique 103.
Lime	119	—	Mozambique 78; Republic of South Africa 41.
Magnesium compounds: Oxides and hydroxides	46	—	All to Republic of South Africa.

See footnotes at end of table.

TABLE 3—Continued  
ZIMBABWE: EXPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	1990	Sources	
		United States	Other (principal)
<b>INDUSTRIAL MINERALS—Continued</b>			
Mica: Crude including splittings and waste	708	—	Republic of South Africa 703; Malawi 5.
Nitrates, crude	86	—	Mozambique 81; Zambia 5.
Precious and semiprecious stones other than diamond:			
Natural	value, thousands	\$2,143	— Switzerland \$1,344; India \$739.
Salt and brine	1,075	—	Republic of South Africa 977; Ireland 95.
Sodium compounds, n.e.s.: Sulfate, manufactured	3	—	All to Netherlands.
Stone, sand and gravel: Dimension stone:			
Crude and partly worked	106,444	29	Switzerland 52,562; United Kingdom 15,644; Hong Kong 14,500.
Worked	60,931	495	Mozambique 59,983; Malawi 200.
Gravel and crushed rock	23,182	—	Mozambique 11,542; Republic of South Africa 11,460.
Limestone other than dimension	547	—	Republic of South Africa 497; Malawi 50.
Quartz and quartzite	308	—	Switzerland 300; Republic of South Africa 8.
Sand other than metal-bearing	1,719	—	Republic of South Africa 1,292; Bangladesh 360; Malawi 33.
Sulfur: Sulfuric acid	14	—	Republic of South Africa 13.
Talc, steatite, soapstone, pyrophyllite	7	—	All to Republic of South Africa.
Vermiculite	2,937	—	Do.
Other: Slag and dross, not metal-bearing	40	—	All to Mozambique.
<b>MINERAL FUELS AND RELATED MATERIALS</b>			
Asphalt and bitumen, natural	37	—	All to Republic of South Africa.
Carbon black	2	—	All to Mozambique.
Coal:			
Anthracite	59,369	—	Zaire 38,222; Mozambique 15,582; Republic of South Africa 3,589.
Unspecified	395	—	Mozambique 394.
Coke and semicoke	111,747	—	Zaire 86,642; Zambia 25,050.
Petroleum refinery products:			
Liquefied petroleum gas	42-gallon barrels	58	— All to Mozambique.
Gasoline	do.	5,389	— Malawi 4,182; Zaire 1,207.
Mineral jelly and wax	do.	1,582	— Malawi 1,078; West Germany 299; Republic of South Africa 181.
Kerosene and jet fuel	do.	2,372,151	— All to Malawi.
Distillate fuel oil	do.	425	— Zaire 283; Mozambique 142.
Bituminous mixtures	do.	800	— All to Mozambique.

<sup>1</sup>Comparable data for 1989 are not available. Table prepared by Virginia A. Woodson.

<sup>2</sup>May include vanadium.

TABLE 4  
ZIMBABWE: STRUCTURE OF THE MINERAL INDUSTRY FOR 1992

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Asbestos	Shabanie and Mashaba Mines (Pvt.) Ltd. (T & N plc, 100%)	Shabanie Mine, Zvishavane; Gaths and King Mines, Mashava	
Coal	Wankie Colliery Co. Ltd. (Government, 40%)	Hwange	5,000
Cobalt tons	Bindura Nickel Corp. (Anglo American Corp., 100%)	Shangani Mine, NW of Shangani; Madziwa Mine, 50 kilometers northeast of Bindura; Trojan Mine, Bindura; Epoch Mine, Filabusi	150
Copper	Mhangura Copper Mines Ltd. (Zimbabwe Mining Development Corp. (ZMDC))	Miriam & Norah Shafts, Mhangura	16
Do.	do.	Smelter at Alaska	35
Do.	do.	Refinery at Alaska	28
Diamond, carats	Joint venture between Auridam Consolidated NL, 50%, and Cornerstone Investments, 50%	River Ranch Mine, near Beitbridge	50,000
Gold, kilograms	Rio Tinto Zimbabwe Ltd. (RTZ Corp. plc., 56%)	Renco Mine, 75 kilometers southeast of Masvingo; Patchway Mine, Kadoma; Brompton Mine, Kadoma; and Cam and Motor dump, Kadoma	2,800
Do.	Cluff Resources Zimbabwe Ltd. (Cluff Resources plc, 82.4%, and private investors, 17.6%)	Freda Rebecca Mine, Bindura	2,500
Do.	Independence Mining (Pvt.) Ltd. (Lonrho plc, 100%)	How Mine, Bulawayo; Athens Mine, Mvuma; Tiger Reef Mine, Kwekwe; and Anzac Mine, Kwekwe	2,000
Do.	Falcon Gold Zimbabwe Ltd. (Falcon Mines plc, 71%)	Dalny Mine, Chegutu; and Venice Mine, Kadoma	1,650
Do.	Joint venture between ZMDC (Government, 100%), 60%, and African Gold Zimbabwe (Pvt.) Ltd., 40%	Sabi Mine, south of Zvishavane	500
Do.	Jena Mines Ltd. (ZMDC, 50%, and Trillion Resources (Pvt.) Ltd. Zimbabwe, 50%)	Jena Group, Kwekwe area	400
Do.	ZMDC	Elvington Gold Mine, near Chegutu	300
Do.	Masasa Mines (Delta Gold NL, 100%)	Giant tailings dump, near Chegutu	100
<b>Iron and steel:</b>			
Crude steel	Zimbabwe Iron and Steel Co. (Zisco) (Government, 92%)	Redcliff, near Gweru	1,000
Iron ore, gross weight	Buchwa Iron Mining Co (Zisco, 100%)	Buchwa West, Buchwa; Ripple Creek Mine, near Redcliff	1,400
<b>Ferroalloys:</b>			
Ferrochromium, high-carbon	Zimbabwe Mining and Smelting Co. (Pvt) Ltd. (Zimasco) (Union Carbide Corp., 100%)	Smelter at Kwekwe	178
Ferrochromium, low-carbon	Zimbabwe Alloys Ltd. (Zimalloys) (Anglo American Corp., 100%)	Smelter at Gweru	35
Ferrochromium-silicon	do.	do.	28
Lithium	Bikita Minerals (Pvt.) Ltd	Bikita Mine, 60 kilometers east of Masvingo	33
Nickel	Trojan Nickel Mines (Bindura Nickel Corp., 100%)	Shangani, Madziwa, Trojan, and Epoch Mines	17
Do.	BSR Ltd. (Bindura Nickel Corp., 100%)	Smelter and refinery at Bindura	16
Nickel	Rio Tinto Zimbabwe Ltd.	Empress Nickel Refinery, Eiffel Flats, northeast of Kadoma	9
Phosphate	Dorowa Minerals (Pvt.) Ltd. (Chemplex Corp. Ltd, 100%)	Dorowa Mine, 90 kilometers west of Mutare	155
Tin	Kamativi Tin Mines Ltd. (Government, 91%; Private, 9%)	50 kilometers north of Dete	1

## MAP SYMBOLS

Commodity	Symbol
Alunite	Alu
Alumina	<u>Al</u>
Aluminum	<u>AL</u>
Andalusite	And
Antimony	Sb
Arsenic	As
Asbestos	Asb
Asphalt	Asp
Barite	Ba
Bauxite	Bx
Bentonite	Bent
Beryllium/beryl	Be
Bismuth	Bi
Bitumen (natural)	Bit
Boron	B
Bromine	Br
Cadmium	Cd
Calcium/calcite	Ca
Carbon black	<u>CBl</u>
Cement	<u>Cem</u>
Cesium	Cs
Chromite	Cr
Clays	Clay
Coal	C
Cobalt	Co
Columbium (niobium)	Cb
Copper	Cu
Corundum	Cn
Cryolite	Cry
Diamond	Dm
Diatomite	Dia
Dolomite	Ds
Emerald	Em
Emery	E
Feldspar	Feld
Ferroalloys	<u>FA</u>
Ferrochrome	<u>FeCr</u>
Ferromanganese	<u>FeMn</u>
Ferronickel	<u>FeNi</u>
Ferrosilicon	<u>FeSi</u>
Fertilizer	<u>Fz</u>
Fluorspar	F
Gallium	Ga
Garnet	Gt
Gemstones	Gm
Germanium	Ge
Gold	Au
Graphite	Gr
Gypsum	Gyp
Indium	In
Iron and steel	<u>Fe</u>
Iron ore	Fe

Jade	Jade
Kaolin	Kao
Kyanite	Ky
Lapis lazuli	Laz
Lead	Pb
Lignite	Lig
Lime	<u>Lime</u>
Limestone	Ls
Liquefied natural gas	<u>LNG</u>
Liquefied petroleum gas	<u>LPG</u>
Lithium	Li
Magnesite	Mag
Magnesium	<u>Mg</u>
Manganese	Mn
Marble and alabaster	Marb
Marl	Ma
Mercury	Hg
Mica	M
Molybdenum	Mo
Natural gas	NG
Natural gas liquids	<u>NGL</u>
Nepheline syenite	Neph
Nickel	Ni
Nitrates	Nit
Nitrogen (ammonia plants)	<u>N</u>
Ochre	Oc
Oil sands	OSs
Oil shale	OSH
Olivine	Ol
Opal	Opal
Peat	Peat
Perlite	Per
Petroleum, crude	Pet
Petroleum refinery products	<u>Pet</u>
Phosphate	P
Pig iron	<u>Pig</u>
Pigments, iron	Pigm
Platinum-group metals	PGM
Potash	K
Pozzolana	Pz
Pumice	Pum
Pyrite	Py
Pyrophyllite	Pyrp
Quartz or quartzite	Qtz
Rare earths	RE
Rhenium	Re
Salt	Salt
Sand and gravel	S/Gvl
Sandstone	Ss
Selenium	Se
Sepiolite, meerschaum	Sep
Serpentine	Serp
Shale	Sh
Silicon	<u>Si</u>
Sillimanite	Slm

Silver	Ag
Soapstone	So
Soda ash, trona	NaAsh
Sodium sulfate	NaSO <sub>4</sub>
Stone	St
Strontium	Sr
Sulfur	S
Talc	Tc
Tantalum	Ta
Tellurium	Te
Thorium	Th
Tin	Sn
Titanium (rutile or ilmenite)	Ti
Titanium dioxide (processed)	<u>TiO<sub>2</sub></u>
Tungsten	W
Umber	Um
Uranium	U
Vanadium	V
Vermiculite	Vm
Wollastonite	Wo
Yttrium	Y
Zinc	Zn
Zircon	Zr

## MAP LEGEND

Symbol =	Mine, including beneficiation plants, wells
Circled Symbol =	Group of producing mines or wells
Underlined Symbol =	Processing plant or oil refinery, including smelters and metal refineries
(Symbol) =	Undeveloped significant resource

**UNITS OF MEASURE  
AND ABBREVIATIONS**

**Unit of Measure**

a = year  
 ° API = American Petroleum Institute gravity  
 bbl = barrel(s)  
 cal = calorie(s)  
 c = centi (prefix)  
 cm = centimeter(s)  
 m<sup>3</sup> = cubic meter(s)  
 d = day(s)  
 dwt = ton(s), deadweight  
 G = giga (prefix)  
 GW = gigawatt(s)  
 GW • h = gigawatt hour(s)  
 g = gram(s)  
 g/mt = gram(s) per metric ton  
 ha = hectare(s)  
 k = thousand  
 kcal = kilocalorie(s)  
 kg = kilogram(s)  
 kL = kiloliter(s)  
 km = kilometer(s)  
 km<sup>2</sup> = square kilometer(s)  
 kmt = thousand metric ton(s)  
 kV = kilovolt(s)  
 kW = kilowatt(s)  
 kW • h = kilowatt hour(s)  
 L = liter(s)  
 M = mega (prefix)  
 MW = megawatt(s)  
 MW • h = megawatt hour(s)  
 m = meter(s)  
 M = million  
 Mmt = million metric ton(s)  
 m<sup>2</sup> = square meter(s)  
 mt = ton(s), metric  
 SCE = standard coal equivalent  
 V = volt  
 W = watt  
 W • h = watt hour

**Abbreviation**

ADB = African Development Bank  
 API = American Petroleum Institute  
 EC = European Community  
 EFTA = European Free Trade Association  
 FTA = Free Trade Agreement  
 GATT = General Agreement on Tariffs and Trade  
 GDP = gross domestic product  
 GNP = gross national product  
 LNG = liquefied natural gas (methane)  
 LPG = liquefied petroleum gas (propane-butane)

OECD = Organization for Economic Cooperation and Development  
 OPEC = Organization of Petroleum Exporting Countries  
 SADC = Southern Africa Development Conference  
 UN = United Nations  
 UNDP = United Nations Development Program

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