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Bureau of Mines

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MINERAL INDUSTRIES OF

# AFRICA



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**UNITED STATES DEPARTMENT OF THE INTERIOR • Manuel Lujan, Jr., Secretary**

**BUREAU OF MINES • T S Ary, Director**

**As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.**

**U.S. GOVERNMENT PRINTING OFFICE**

**WASHINGTON : 1992**

# Preface

This edition of the Minerals Yearbook records the performance of the worldwide minerals industry during 1990 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. 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 and 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, Area Reports: International, contains the latest available mineral data on more than 160 foreign countries and discusses the importance of minerals to the economies of these nations. Volume III is presented as five area reports and one world overview: 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, Mineral Industries of the Middle East, and Minerals in the World Economy. This year's reports incorporate location maps, industry structure tables, and an outlook section previously incorporated in our Mineral Perspectives Series quinquennial regional books, which have been discontinued. The U.S. Bureau of Mines continually strives to improve the value of its publications to users. Constructive comments and suggestions by readers of the Yearbook are welcomed.

*T S Ary, Director*



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# Acknowledgments

The U.S. Bureau of Mines, in preparing these Volume III Minerals Yearbook Reports, 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 routine and special reports submitted by 10 Regional Resource Officers assigned to minerals and petroleum reporting and by economic and commercial officers and other officials of the U.S. Department of State in American 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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# Vitae

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George A. Morgan is Chief, Branch of Africa and the Middle East. He has worked as vanadium specialist for the Bureau and has covered the mineral industry of a number of countries in Africa and the Middle East, especially Iraq, Namibia, the Republic of South Africa, and Zaire.

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# THE MINERAL INDUSTRY OF AFRICA

By George A. Morgan and Staff, Branch of Africa and Middle East

## INTRODUCTION<sup>1</sup>

The 53 countries that constituted Africa in 1990 accounted for a significant portion of total world output of a number of mineral commodities. Among the most significant to be produced in Africa were 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. Several of these, chromite, cobalt, diamond, and manganese, were not produced in the United States.

Despite the underdevelopment of much of Africa, mineral raw materials play a very important part in the national economies of many of its 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. In several countries, one or two mineral commodities are dominant in a weakly diversified economy. Among these are petroleum and diamonds in Angola, petroleum in the Congo, 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. These centers of mineral exports developed years ago, and with the exception of petroleum, nearly all the hard-rock mines opened during the colonial period. Some, such as gold in Ghana, have recently been reactivated. In Botswana, Gabon, Namibia, the Republic of South Africa, and Zimbabwe, relatively successful diversification has grown from the central core of mineral development and its attendant infrastructure. In recent years, African countries have expanded or improved their mining, investment, and tax laws to further such activity. Privatization of Government-held mining enterprises is commonplace. With the exception of a marble quarry in Togo,

these privatization moves appear to have been successful. The move toward mineral development is happening despite the time lag for development and initial capital requirements for opening mines. The advantages of developing an economic mineral resource base in those countries with such identified wealth continue to be employment, education and training, improved health facilities, export earnings, and infrastructure development.

The most significant mineral economies in Africa in terms of diversity, volume, 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 exploration target for additional oil and gas resources. West coast countries currently producing crude petroleum were Angola, Benin, Cameroon, Congo, Côte d'Ivoire, Gabon, Morocco, Senegal, and Zaire. Exploration for natural gas continued in Namibia and the Republic of South Africa. 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. It was among the top world producers of andalusite, chromite, diamond, fluorspar, gold, manganese, platinum-group metals, pyrophyllite, titanium, uranium, vanadium, vermiculite, and zircon.

U.S. imports in 1990 from African nations were mainly raw materials. In the case

of mineral commodities, 10 countries were considered to be major import sources. Among these were: Gabon for manganese; Guinea for bauxite; Madagascar for graphite; Morocco for barite; Namibia for quartz crystal; the Republic of South Africa for andalusite, antimony, asbestos, chromium, diamond, fluorspar, gem stones, 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 total land area of Africa was 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 impede exploration.

Other large areas are subject to internal strife or legislation prohibitive to risk investment, which have set back the pace of mineral industry development and even exploration.

The population of Africa is about 677 million compared with 253 million for the United States. However, Africa's labor force is only about 190 million, or about 50% larger than 124 million for the United States, and 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. The combined gross domestic product (GDP) of the countries of Africa is estimated at about \$413 billion and is vastly outweighed by the \$5,465 billion gross national product of the United States. African countries have some of the lowest per capita GDP in the world and vary from about \$107 for Mozambique to \$4,286 for the island na-

tion of Seychelles. Average per capita GDP for the region is \$610. All tons are metric in this report unless otherwise specified.

<sup>1</sup>George A. Morgan, Chief, Branch of Africa and Middle East, Division of International Minerals.

### SELECTED GENERAL SOURCES OF REGIONAL INFORMATION

Africa Economic Digest London.

British Sulphur Corp. Ltd., London:

Nitrogen, bimonthly.

Phosphorus and Potassium, bimonthly.

Sulphur, bimonthly.

Bureau de Recherches Geologiques et Minieres, Paris:

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.

McGraw-Hill, Inc., New York: Engineering and Mining Journal, monthly.

Mining, Financial Mail Survey, Johannesburg.

Mining Journal Ltd., London:

Mining Magazine, monthly.

Mining Journal, weekly.

Mining Annual Review, July.

Penn Well Publishing Co., Tulsa, OK:

International Petroleum Encyclopedia.

Society of Economic Geologists, University of Texas, El Paso, TX: Economic Geology (and Bulletin), bimonthly.

Standard Bank, Johannesburg, South Africa:

Standard Bank Review, monthly.

United Nations Statistical Office, New York:

U.N. trade statistics.

U.S. Department of Commerce:

Bureau of the Census: trade statistics.

International Trade Administration: Foreign Economic Trends and Their Implications for the U.S., International Marketing Information Series.

U.S. Department of Energy.

U.S. Department of the Interior, Bureau of Mines:

Mineral Commodity Summaries.

Minerals Yearbook, v. I, Metals and Minerals;

v. III, Area Reports: International.

Minerals Facts and Problems.

Information Circular 8610; Summary of Mining and Petroleum Laws of the World (in five parts), part 4, Africa.

U.S. Joint Publications Research Service, Arlington, VA: Foreign Broadcast Information Service Regional Publications, weekly.

World Bank, Washington, DC: Bank news releases.

World Bureau of Metal Statistics, London:

World Metal Statistics, monthly.

TABLE 1

### AFRICA: PRODUCTION OF SELECTED MINERAL COMMODITIES, 1990

(Thousand metric tons unless otherwise specified)

|                          | Alumi-<br>num<br>metal | Ce-<br>ment | Chro-<br>mite | Cobalt,<br>mine<br>(tons),<br>Co<br>content | Copper,<br>mine,<br>content | Dia-<br>mond<br>(thou-<br>sand<br>carats) | Gold<br>(kilo-<br>grams) | Iron ore<br>(gross<br>weight) | Lead<br>mine,<br>Pb<br>content | Man-<br>ganese<br>ore | Petrol-<br>eum<br>crude<br>(thou-<br>sand<br>barrels) | Phos-<br>phate<br>rock<br>(gross<br>weight) | Steel,<br>crude  | Uran-<br>ium<br>(tons) | Zinc,<br>mine<br>content |
|--------------------------|------------------------|-------------|---------------|---|-----------------------------|---|--------------------------|-------------------------------|--------------------------------|-----------------------|---|---|------------------|------------------------|--------------------------|
| Algeria                  | —                      | 6,337       | —             | —   | —                           | —   | —                        | 2,941                         | 1                              | —                     | 290,175   | 1,128                                       | 767              | —                      | 6                        |
| Angola                   | —                      | 1,000       | —             | —   | —                           | 1,300                                     | —                        | —                             | —                              | 174,000               | —   | 10  | —                | —                      | —                        |
| Benin                    | —                      | 275         | —             | —   | —                           | —   | —                        | —                             | —                              | 1,415                 | —   | 8   | —                | —                      | —                        |
| Botswana                 | —                      | —           | —             | 206   | 25                          | 17,352                                    | 50                       | —                             | —                              | —                     | —   | —   | —                | —                      | —                        |
| Burkina Faso             | —                      | —           | —             | —   | —                           | —   | 7,800                    | —                             | —                              | —                     | —   | 3   | —                | —                      | —                        |
| Burundi                  | —                      | —           | —             | —   | —                           | —   | 9                        | —                             | —                              | —                     | —   | —   | —                | —                      | —                        |
| Cameroon                 | 93                     | 580         | —             | —   | —                           | —   | 8                        | —                             | —                              | —                     | 64,605  | —   | —                | —                      | —                        |
| Central African Republic | —                      | —           | —             | —   | —                           | 381                                       | 241                      | —                             | —                              | —                     | —   | —   | —                | —                      | —                        |
| Congo                    | —                      | 77          | —             | —   | 1                           | —   | 4                        | —                             | 1                              | —                     | 58,765  | —   | —                | —                      | 1                        |
| Cote d'Ivoire            | —                      | 500         | —             | —   | —                           | 12  | 20                       | —                             | —                              | —                     | 770   | —   | —                | —                      | —                        |
| Egypt                    | 179                    | 15,299      | —             | —   | —                           | —   | —                        | 2,405                         | —                              | —                     | 319,375   | 1,143                                       | 2,100            | —                      | —                        |
| Ethiopia                 | —                      | 340         | —             | —   | —                           | —   | 850                      | —                             | —                              | —                     | —   | —   | —                | —                      | —                        |
| Gabon                    | —                      | 115         | —             | —   | —                           | 1   | 80                       | —                             | —                              | 2,540                 | 100,000   | —   | —                | 828                    | —                        |
| Ghana                    | 174                    | 565         | —             | —   | —                           | 650                                       | 16,840                   | —                             | —                              | 247                   | —   | —   | 26               | —                      | —                        |
| Guinea                   | —                      | —           | —             | —   | —                           | 127                                       | 6,341                    | —                             | —                              | —                     | —   | —   | —                | —                      | —                        |
| Kenya                    | —                      | 1,512       | —             | —   | —                           | —   | 25                       | —                             | —                              | —                     | —   | —   | ( <sup>1</sup> ) | —                      | —                        |
| Liberia                  | —                      | 50          | —             | —   | —                           | 100                                       | 600                      | 4,050                         | —                              | —                     | —   | —   | —                | —                      | —                        |
| Libya                    | —                      | 2,700       | —             | —   | —                           | —   | —                        | —                             | —                              | 501,510               | —   | 500   | —                | —                      | —                        |
| Madagascar               | —                      | 35          | 73            | —   | —                           | —   | 216                      | —                             | —                              | —                     | —   | —   | —                | —                      | —                        |
| Malawi                   | —                      | 77          | —             | —   | —                           | —   | —                        | —                             | —                              | —                     | —   | —   | —                | —                      | —                        |
| Mali                     | —                      | 20          | —             | —   | —                           | —   | 5,200                    | —                             | —                              | —                     | —   | 10  | —                | —                      | —                        |
| Mauritania               | —                      | 90          | —             | —   | —                           | —   | —                        | 11,420                        | —                              | —                     | —   | —   | —                | —                      | —                        |
| Morocco                  | —                      | 4,200       | —             | 194   | 16                          | —   | —                        | 148                           | 69                             | 49                    | 144   | 21,396                                      | 7                | —                      | 19                       |

See footnotes at end of table.

TABLE 1—Continued

## AFRICA: PRODUCTION OF SELECTED MINERAL COMMODITIES, 1990

(Thousand metric tons unless otherwise specified)

|                                  | Alumi-<br>num<br>metal | Ce-<br>ment | Chro-<br>mite | Cobalt,<br>mine<br>(tons),<br>Co<br>content | Copper,<br>mine,<br>content | Dia-<br>mond<br>(thou-<br>sand<br>carats) | Gold<br>(kilo-<br>grams) | Iron ore<br>(gross<br>weight) | Lead<br>mine,<br>Pb<br>content | Man-<br>ganese<br>ore | Petrol-<br>um<br>crude<br>(thou-<br>sand<br>barrels) | Phos-<br>phate<br>rock<br>(gross<br>weight) | Steel,<br>crude | Uran-<br>ium<br>(tons) | Zinc,<br>mine<br>content |
|----------------------------------|------------------------|-------------|---------------|---|-----------------------------|---|--------------------------|-------------------------------|--------------------------------|-----------------------|--|---|-----------------|------------------------|--------------------------|
| Mozambique                       | —                      | 80          | —             | —   | ( <sup>1</sup> )            | —   | 63                       | —                             | —                              | —                     | —  | —   | —               | —                      | —                        |
| Namibia                          | —                      | —           | —             | —   | 26                          | 1,000                                     | 2,000                    | —                             | 25                             | —                     | —  | —   | —               | 3,700                  | 35                       |
| Niger                            | —                      | 27          | —             | —   | —                           | —   | —                        | —                             | —                              | —                     | —  | —   | —               | 3,000                  | —                        |
| Nigeria                          | —                      | 3,500       | —             | —   | —                           | —   | 374                      | ( <sup>1</sup> )              | —                              | 669,393               | —  | 133   | —               | —                      | —                        |
| Rwanda                           | —                      | 60          | —             | —   | —                           | —   | 700                      | —                             | —                              | —                     | —  | —   | —               | —                      | —                        |
| Senegal                          | —                      | 470         | —             | —   | —                           | —   | —                        | —                             | —                              | —                     | 8  | 7,252                                       | —               | —                      | —                        |
| Sierra Leone                     | —                      | —           | —             | —   | —                           | 78  | 32                       | —                             | —                              | —                     | —  | —   | —               | —                      | —                        |
| Somalia                          | —                      | 75          | —             | —   | —                           | —   | —                        | —                             | —                              | —                     | —  | —   | —               | —                      | —                        |
| South Africa, Republic of        | 166                    | 8,700       | 4,951         | 300   | 182                         | 9,116                                     | 607,500                  | 29,958                        | 78                             | 4,884                 | —  | 2,963                                       | 8,973           | 3,472                  | 97                       |
| Sudan                            | —                      | 167         | 13            | —   | —                           | —   | 100                      | —                             | —                              | —                     | —  | —   | —               | —                      | —                        |
| Swaziland                        | —                      | —           | —             | —   | —                           | 42  | —                        | —                             | —                              | —                     | —  | —   | —               | —                      | —                        |
| Tanzania                         | —                      | 540         | —             | —   | —                           | 85  | 1,629                    | —                             | —                              | —                     | —  | 25  | —               | —                      | —                        |
| Togo                             | —                      | 399         | —             | —   | —                           | —   | —                        | —                             | —                              | —                     | 2,570  | —   | —               | —                      | —                        |
| Tunisia                          | —                      | 3,300       | —             | —   | —                           | —   | —                        | 291                           | 3                              | —                     | 36,500   | 6,258                                       | 200             | —                      | 13                       |
| Uganda                           | —                      | 14          | —             | —   | —                           | —   | —                        | —                             | —                              | —                     | —  | ( <sup>1</sup> )                            | —               | —                      | —                        |
| Zaire                            | —                      | 461         | —             | 20,000                                      | 372                         | 19,427                                    | 4,236                    | —                             | —                              | —                     | 10,597   | —   | —               | —                      | 50                       |
| Zambia                           | —                      | 375         | —             | 7,086                                       | 400                         | —   | 129                      | 1                             | 10                             | 1                     | —  | —   | —               | —                      | 32                       |
| Zimbabwe                         | —                      | 700         | 643           | 102   | 15                          | —   | 16,900                   | 1,259                         | —                              | —                     | —  | 148   | 580             | —                      | —                        |
| Total Africa                     | 612                    | 52,640      | 5,680         | 27,888                                      | 1,037                       | 48,099                                    | 671,573                  | 52,847                        | 187                            | 7,721                 | 2,227,257  | 42,896                                      | 13,304          | 11,000                 | 253                      |
| Share of world<br>total, percent | 3.5                    | 4.7         | 44.2          | 75.1  | 11.9                        | 48.5                                      | 33.2                     | 5.7                           | 5.5                            | 32.6                  | 10.4   | 27.8  | 1.7             | 37                     | 3.4                      |
| United States                    | 4,048                  | 71,310      | —             | —   | 1,587                       | —   | 266,000                  | 56,408                        | 495                            | —                     | 2,664,000  | 46,343                                      | 89,726          | 3,400                  | 543                      |

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

TABLE 2

## AFRICA: PRODUCTION OF SELECTED MINERAL COMMODITIES, 1989-REVISED

(Thousand metric tons unless otherwise specified)

|                          | Alumi-<br>num<br>metal | Ce-<br>ment | Chro-<br>mite | Cobalt,<br>mine<br>(tons),<br>Co<br>content | Copper,<br>mine,<br>content | Dia-<br>mond<br>(thou-<br>sand<br>carats) | Gold<br>(kilo-<br>grams) | Iron ore<br>(gross<br>weight) | Lead<br>mine,<br>Pb<br>content | Man-<br>ganese<br>ore | Petrol-<br>um<br>crude<br>(thou-<br>sand<br>barrels) | Phos-<br>phate<br>rock | Steel,<br>crude | Uran-<br>ium<br>(tons) | Zinc,<br>mine |
|--------------------------|------------------------|-------------|---------------|---|-----------------------------|---|--------------------------|-------------------------------|--------------------------------|-----------------------|--|------------------------|-----------------|------------------------|---------------|
| Algeria                  | —                      | 6,819       | —             | —   | —                           | —   | —                        | 2,748                         | 1                              | —                     | 253,675  | 1,124                  | 943             | —                      | 6             |
| Angola                   | —                      | 1,000       | —             | —   | —                           | 1,245                                     | —                        | —                             | —                              | —                     | 167,000  | —                      | 10              | —                      | —             |
| Benin                    | —                      | 150         | —             | —   | —                           | —   | —                        | —                             | —                              | —                     | 1,460  | —                      | 2               | —                      | —             |
| Botswana                 | —                      | —           | —             | 207   | 27                          | 15,252                                    | 66                       | —                             | —                              | —                     | —  | —                      | —               | —                      | —             |
| Burkina Faso             | —                      | —           | —             | —   | —                           | —   | 7,600                    | —                             | —                              | —                     | —  | 3                      | —               | —                      | —             |
| Burundi                  | —                      | —           | —             | —   | —                           | —   | 18                       | —                             | —                              | —                     | —  | —                      | —               | —                      | —             |
| Cameroon                 | 92                     | 580         | —             | —   | —                           | —   | 8                        | —                             | —                              | —                     | 58,648   | —                      | —               | —                      | —             |
| Central African Republic | —                      | —           | —             | —   | —                           | 415                                       | 328                      | —                             | —                              | —                     | —  | —                      | —               | —                      | —             |
| Congo                    | —                      | 77          | —             | —   | 1                           | —   | 4                        | —                             | 1                              | —                     | 55,000   | —                      | —               | —                      | 1             |
| Cote d'Ivoire            | —                      | 500         | —             | —   | —                           | 12  | 13                       | —                             | —                              | —                     | 771  | —                      | —               | —                      | —             |
| Egypt                    | 180                    | 9,507       | —             | —   | —                           | —   | —                        | 2,562                         | —                              | —                     | 310,980  | 1,347                  | 1,400           | —                      | —             |

See footnotes at end of table.

TABLE 2—Continued

## AFRICA: PRODUCTION OF SELECTED MINERAL COMMODITIES, 1989-REVISED

(Thousand metric tons unless otherwise specified)

|                                  | Alumi-<br>num<br>metal | Ce-<br>ment | Chro-<br>mite | Cobalt,<br>mine<br>(tons),<br>Co<br>content | Copper,<br>mine,<br>content | Dia-<br>mond<br>(thou-<br>sand<br>carats) | Gold<br>(kilo-<br>grams) | Iron ore<br>(gross<br>weight) | Lead<br>mine,<br>Pb<br>content | Man-<br>ganese<br>ore | Petrol-<br>eum<br>crude<br>(thou-<br>sand<br>barrels) | Phos-<br>phate<br>rock | Steel,<br>crude  | Uran-<br>ium<br>(tons) | Zinc,<br>mine |
|----------------------------------|------------------------|-------------|---------------|---|-----------------------------|---|--------------------------|-------------------------------|--------------------------------|-----------------------|---|------------------------|------------------|------------------------|---------------|
| Ethiopia                         | —                      | 370         | —             | —   | —                           | —   | 745                      | —                             | —                              | —                     | —   | —                      | —                | —                      | —             |
| Gabon                            | —                      | 115         | —             | —   | —                           | 1   | 81                       | —                             | —                              | 2,592                 | 75,819  | —                      | —                | 1,047                  | —             |
| Ghana                            | 169                    | 565         | —             | —   | —                           | 494                                       | 13,358                   | —                             | —                              | 279                   | —   | —                      | 18               | —                      | —             |
| Guinea                           | —                      | —           | —             | —   | —                           | 147                                       | 2,118                    | —                             | —                              | —                     | —   | —                      | —                | —                      | —             |
| Kenya                            | —                      | 1,216       | —             | —   | —                           | —   | 15                       | —                             | —                              | —                     | —   | —                      | ( <sup>1</sup> ) | —                      | —             |
| Liberia                          | —                      | 85          | —             | —   | —                           | 155                                       | 734                      | 11,700                        | —                              | —                     | —   | —                      | —                | —                      | —             |
| Libya                            | —                      | 2,700       | —             | —   | —                           | —   | —                        | —                             | —                              | —                     | 412,450   | —                      | 10               | —                      | —             |
| Madagascar                       | —                      | 35          | 63            | —   | —                           | —   | 45                       | —                             | —                              | —                     | —   | —                      | —                | —                      | —             |
| Malawi                           | —                      | 77          | —             | —   | —                           | —   | —                        | —                             | —                              | —                     | —   | —                      | —                | —                      | —             |
| Mali                             | —                      | 20          | —             | —   | —                           | —   | 3,000                    | —                             | —                              | —                     | —   | 10                     | —                | —                      | —             |
| Mauritania                       | —                      | 90          | —             | —   | —                           | —   | —                        | 12,110                        | —                              | —                     | —   | —                      | —                | —                      | —             |
| Morocco                          | —                      | 4,200       | —             | 121   | 16                          | —   | —                        | 176                           | 67                             | 32                    | 102   | 18,067                 | 7                | —                      | 19            |
| Mozambique                       | —                      | 80          | —             | —   | ( <sup>1</sup> )            | —   | —                        | —                             | —                              | —                     | —   | —                      | —                | —                      | —             |
| Namibia                          | —                      | —           | —             | —   | 27                          | 927                                       | 336                      | —                             | 24                             | —                     | —   | —                      | —                | 3,700                  | 42            |
| Niger                            | —                      | 27          | —             | —   | —                           | —   | —                        | —                             | —                              | —                     | —   | —                      | —                | 3,013                  | —             |
| Nigeria                          | —                      | 3,500       | —             | —   | —                           | —   | —                        | 300                           | —                              | —                     | 626,489   | —                      | 200              | —                      | —             |
| Rwanda                           | —                      | 68          | —             | —   | —                           | —   | 732                      | —                             | —                              | —                     | —   | —                      | —                | —                      | —             |
| Senegal                          | —                      | 380         | —             | —   | —                           | —   | —                        | —                             | —                              | —                     | 13  | 7,388                  | —                | —                      | —             |
| Sierra Leone                     | —                      | —           | —             | —   | —                           | 129                                       | 226                      | —                             | —                              | —                     | —   | —                      | —                | —                      | —             |
| Somalia                          | —                      | 100         | —             | —   | —                           | —   | —                        | —                             | —                              | —                     | —   | —                      | —                | —                      | —             |
| South Africa, Republic of        | 170                    | 8,000       | 4,618         | 350   | 179                         | 8,714                                     | 605,452                  | 30,291                        | 70                             | 4,402                 | —   | 3,165                  | 8,600            | 2,903                  | 75            |
| Sudan                            | —                      | 150         | 25            | —   | —                           | —   | 500                      | —                             | —                              | —                     | —   | —                      | —                | —                      | —             |
| Swaziland                        | —                      | —           | —             | —   | —                           | 55  | —                        | —                             | —                              | —                     | —   | —                      | —                | —                      | —             |
| Tanzania                         | —                      | 540         | —             | —   | —                           | 150                                       | 116                      | —                             | —                              | —                     | —   | 5                      | —                | —                      | —             |
| Togo                             | —                      | 389         | —             | —   | —                           | —   | —                        | —                             | —                              | —                     | —   | 3,355                  | —                | —                      | —             |
| Tunisia                          | —                      | 3,228       | —             | —   | —                           | —   | —                        | 280                           | 3                              | —                     | 37,595  | 6,610                  | 194              | —                      | 9             |
| Uganda                           | —                      | 14          | —             | —   | —                           | —   | —                        | —                             | —                              | —                     | —   | ( <sup>1</sup> )       | —                | —                      | —             |
| Zaire                            | —                      | 460         | —             | 25,000                                      | 471                         | 17,755                                    | 2,032                    | —                             | —                              | —                     | 10,119  | —                      | —                | —                      | 173           |
| Zambia                           | —                      | 386         | —             | 7,255                                       | 419                         | —   | 129                      | ( <sup>1</sup> )              | 9                              | ( <sup>1</sup> )      | —   | —                      | —                | —                      | 23            |
| Zimbabwe                         | —                      | 719         | 627           | 90  | 16                          | —   | 16,003                   | 1,143                         | —                              | —                     | —   | 134                    | 650              | —                      | —             |
| Total Africa                     | 611                    | 46,147      | 5,333         | 33,023                                      | 1,156                       | 45,451                                    | 653,659                  | 61,310                        | 175                            | 7,305                 | 2,010,121   | 41,208                 | 12,034           | 10,663                 | 348           |
| Share of world<br>total, percent | 3.4                    | 4.1         | 44.8          | 76.2  | 13.1                        | 47.9                                      | 33.1                     | 6.6                           | 5.1                            | 27.6                  | 9.3   | 25.2                   | 1.5              | 26.8                   | 4.9           |
| United States                    | 4,030                  | 72,200      | —             | —   | 1,498                       | —   | 265,500                  | 59,000                        | 419                            | —                     | 2,778,745   | 49,817                 | 97,900           | 6,210                  | 288           |

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

TABLE 3

## AFRICA: MINERAL INDICATORS OF SELECTED COUNTRIES

| Country                   | Mineral share of GDP <sup>1</sup> (percent) | Mineral share of exports <sup>1</sup> (percent) | Updated mining law | Updated investment/ tax code | Most significant mineral activity, in order of importance |
|---------------------------|---|---|--------------------|------------------------------|---|
| Algeria                   | NA  | 96  | X                  | X                            | Natural gas, petroleum.                                   |
| Angola                    | 34  | 99  | X                  | X                            | Petroleum, diamond.                                       |
| Benin                     | 5   | 11  |                    | X                            | Petroleum, cement.  |
| Botswana                  | 50  | 90  |                    |                              | Diamond, copper, nickel, soda ash.                        |
| Congo                     | 45  | 90  |                    |                              | Petroleum.  |
| Cote d'Ivoire             | 5   | 13  | In review          | In review                    | Petroleum.  |
| Gabon                     | 38  | 89  |                    | X                            | Petroleum, manganese, uranium.                            |
| Ghana                     | 5   | 36  | X                  | X                            | Gold, bauxite, diamond.                                   |
| Guinea                    | 25  | 90  | In review          | In review                    | Bauxite.  |
| Kenya                     | 1   | 17  |                    | X                            | Soda ash, refined petroleum.                              |
| Libya                     | More than 28                                | More than 95                                    |                    | X                            | Petroleum, natural gas.                                   |
| Madagascar                | 1   | 3   |                    | X                            | Chromite, graphite, gem stones.                           |
| Malawi                    | 1   | NA  | X                  | X                            | Cement, gem stones.                                       |
| Mali                      | 3   | 20  | X                  | In review                    | Gold.   |
| Morocco                   | 5   | 45  |                    | X                            | Phosphate.  |
| Mozambique                | ( <sup>2</sup> )                            | 3   | X                  | X                            | Gold.   |
| Namibia                   | 28  | 73  | X                  | In review                    | Diamond, uranium, copper.                                 |
| Niger                     | 7   | More than 75                                    |                    | X                            | Uranium.  |
| Senegal                   | 11  | 25  | X                  | X                            | Phosphate.  |
| Sierra Leone              | NA  | 90  |                    |                              | Titanium minerals, bauxite, diamond.                      |
| South Africa, Republic of | 11  | 41  | X                  | X                            | Gold, coal, platinum-group metals, diamond.               |
| Swaziland                 | 4   | 4   | X                  | X                            | Asbestos.   |
| Togo                      | 9   | 38  |                    | X                            | Phosphate.  |
| Zaire                     | 25  | 75  |                    |                              | Copper, diamond, cobalt.                                  |
| Zambia                    | 15  | 90  | In review          | X                            | Copper, cobalt.   |
| Zimbabwe                  | 7   | 42  |                    | X                            | Chromite, gold, nickel.                                   |

X New or recently updated mining, investment, or tax code.

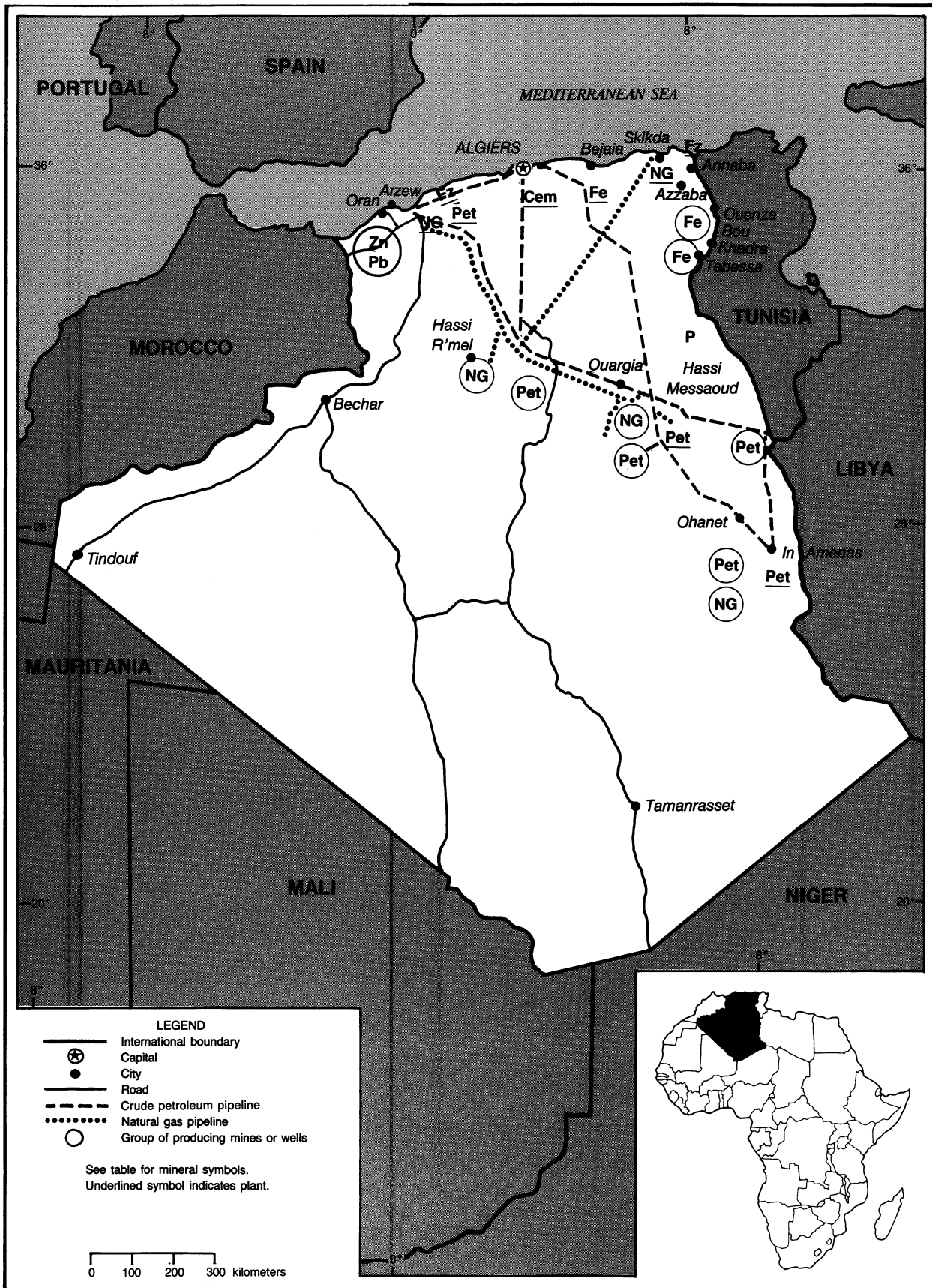
<sup>1</sup>Data on GDP at factor costs in current dollars is reported here for most countries. However, in many cases, underreporting has been found to occur owing to the exclusion of various minerals in both GDP and exports. Some minerals, such as cement, clays, and stone, may be considered industrial materials and included in manufacturing rather than mining. Others, such as fertilizers and salt, may be included in agriculture rather than mining. Still additional, at times substantial, amounts of smuggled minerals, particularly gem stones, are not included.

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

# ALGERIA

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

POPULATION 24.7 million



# THE MINERAL INDUSTRY OF ALGERIA

By Bernadette Michalski

**A**lgeria's mineral industry fosters a diverse but modest production of metals; however, hydrocarbons remained by far the leading mineral sector, accounting for the bulk of export earnings. The Government launched an aggressive policy to develop and market hydrocarbons, particularly natural gas. Included in the Government's priority list was the development of the Haoud el Hamra Gasfield, the refurbishing and expansion of natural gas gathering and processing facilities, and the negotiation of long-term natural gas export contracts.

## GOVERNMENT POLICIES AND PROGRAMS

Economic considerations prompted the Government decision to open hydrocarbon deposit development to foreign companies. The national 5-year plan covering 1990-94 emphasizes international cooperation in energy development and the removal of limitations on foreign equity. The stipulation that the Government's hydrocarbon agency, 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. The principle that SONATRACH should have only a minority interest in associations with foreign partners was applied for the first time in the licenses awarded Total CFP for the Hamra Sud-Est and Djebel Bottene perimeter.

Law 90-10, the money and credit law, was adopted in March 1990. Under this law, nonresidents of Algeria are permitted to bring in capital to finance all economic activities not specifically reserved to the state. Thus, import and distribution monopolies have been abolished. The law also states that foreign investor's capital, as well as profits, interest, dividends, and royalties, may be repatriated under conditions to be defined by the Council on Money and Credit. This law sets the parameters for a more open regime for foreign investment and a more dynamic and efficient financial sector.

## PRODUCTION

Algeria ranks 6th among the world's natural gas producers and 15th among the world's petroleum producers. Although petroleum production remains significant, the nation's more mature wells required gas reinjection to maintain pressures.

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. Mercury was produced entirely for export, and production remained dependant upon the price of this commodity in the world market. Phosphate rock production is exported.

The decline in lead and zinc production was attributed to the temporary closure of the Kherzet Youcef Mine where shaft deepening operations were being carried out.

## TRADE

Although hydrocarbons account for the bulk of Algeria's export earnings, crude oil contributed only 17.3% to the total hydrocarbon exports for 1990. Western Europe absorbed more than 90% of Algeria's crude oil exports in 1990. Depleting oil reserves were the cause for diverting marketing attention to natural gas, condensates, and refined products.

Oil and gas exports increased by 36% to \$12,300 million in 1990, accounting for more than 96% of total exports. The revenue improvement was partially attributable to more favorable crude oil prices. The surge in prices following the Iraqi invasion of Kuwait spurred a recovery in Algerian export earnings in the last 4 months of 1990. The average monthly spot price for Algerian Saharan Blend crude oil ranged from a low of \$15.03 per bbl in June to a high of \$37.97 per bbl in October. The annual average was \$24.22 per bbl compared with an annual average of \$18.52 in 1989 and \$15.15 in 1988. Increased revenues were additionally supported by the increase in natural gas

exports. Algeria's adoption of a more flexible price system that linked the price of natural gas to the price of crude oil improved market accessibility. Total export volumes of natural gas rose to 31.4 billion m<sup>3</sup>. More than 13 billion m<sup>3</sup> of natural gas were exported by pipeline to Italy and Tunisia. The bulk of natural gas exports were delivered to Western Europe. The largest consumer was Italy, which imported 11.4 billion m<sup>3</sup>, followed by France at 9 billion m<sup>3</sup>. Revenues from natural gas exports are expected to increase appreciably as traditional and new export markets respond to Algeria's introduction of a realistic market-based pricing formula.

## STRUCTURE OF THE MINERAL INDUSTRY

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 is no longer pursued. The nation's chronic cement shortages prompted the Government's invitation to private investors to enter the state-dominated cement industry. The 1990-94 plan was to be modified by legislation liberalizing private participation.

## COMMODITY REVIEW

### 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.

**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



TABLE 1

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

(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>                                    | 1986                 | 1987                 | 1988                | 1989 <sup>p</sup>    | 1990 <sup>e</sup>    |
|---|----------------------|----------------------|---------------------|----------------------|----------------------|
| <b>METALS</b>   |                      |                      |                     |                      |                      |
| Cadmium, refined  | 124                  | 102                  | 55                  | 46                   | 45                   |
| <b>Iron and steel:</b>                                    |                      |                      |                     |                      |                      |
| Iron ore, gross weight      thousand tons                 | 3,360                | 3,380                | 3,118               | 2,748                | <sup>3</sup> 2,941   |
| <b>Metal:</b>   |                      |                      |                     |                      |                      |
| Pig iron      do.   | 1,246                | 1,478                | 1,500               | 1,300                | <sup>3</sup> 1,037   |
| Steel, crude      do.                                     | 1,120                | 1,378                | 1,300               | 943                  | <sup>3</sup> 767     |
| Lead, concentrate, Pb content <sup>e</sup>                | <sup>2</sup> 900     | 1,600                | 1,900               | 1,400                | 1,000                |
| Mercury      kilograms                                    | <sup>7</sup> 64,000  | 758,400              | 662,000             | 587,000              | <sup>3</sup> 637,000 |
| Silver <sup>e</sup> do.                                   | 3,700                | 3,700                | 3,000               | 2,800                | 2,500                |
| <b>Zinc:</b>  |                      |                      |                     |                      |                      |
| Concentrate, Zn content                                   | <sup>1</sup> 13,573  | <sup>8</sup> 8,892   | <sup>6</sup> 6,348  | 6,263                | 6,300                |
| Metal, smelter output                                     | 30,300               | 21,000               | 26,492              | 16,800               | <sup>3</sup> 15,033  |
| <b>INDUSTRIAL MINERALS</b>                                |                      |                      |                     |                      |                      |
| Barite, crude   | 60,000               | 45,000               | 43,000              | 49,000               | <sup>3</sup> 53,078  |
| Cement, hydraulic      thousand tons                      | 6,460                | 7,541                | 7,195               | 6,819                | <sup>3</sup> 6,337   |
| <b>Clays:</b>   |                      |                      |                     |                      |                      |
| Bentonite   | 32,300               | 24,600               | <sup>2</sup> 25,600 | 39,000               | <sup>3</sup> 42,000  |
| Fuller's earth <sup>e</sup>                               | 3,500                | 3,500                | 3,500               | 3,500                | 3,500                |
| Kaolin  | 14,200               | 16,000               | 17,800              | 18,000               | 18,000               |
| Diatomite   | 4,000                | 3,300                | 3,087               | 4,400                | <sup>3</sup> 4,156   |
| Gypsum <sup>e4</sup> thousand tons                        | 275                  | 275                  | 275                 | 275                  | 250                  |
| Lime, hydraulic <sup>e</sup>                              | 40,000               | 40,000               | 40,000              | 40,000               | 40,000               |
| Nitrogen: N content of ammonia <sup>e</sup>               | 150,000              | 150,000              | 150,000             | 150,000              | 150,000              |
| Phosphate rock      thousand tons                         | 1,203                | 1,073                | 1,332               | 1,124                | <sup>3</sup> 1,128   |
| Salt      do.   | 190                  | 233                  | 237                 | 229                  | <sup>3</sup> 225     |
| Sodium compounds: Caustic soda <sup>e</sup> 700           | 700                  | 700                  | 700                 | 700                  |                      |
| Strontium minerals: Celestite, gross weight <sup>e</sup>  | 5,400                | 5,400                | 5,400               | 5,400                | 5,400                |
| Sulfur, elemental <sup>e</sup>                            | 20,000               | 20,000               | 20,000              | 20,000               | 20,000               |
| <b>MINERAL FUELS AND RELATED MATERIALS</b>                |                      |                      |                     |                      |                      |
| <b>Gas, natural:</b>                                      |                      |                      |                     |                      |                      |
| Gross      million cubic meters                           | 97,300               | 110,910              | 109,903             | 108,000              | 110,000              |
| Dry <sup>5</sup> do.                                      | 46,968               | 43,180               | 44,900              | 48,400               | 48,500               |
| Natural gas plant liquids      thousand 42-gallon barrels | 40,550               | 45,750               | 55,400              | 56,492               | 56,000               |
| <b>Petroleum:</b>   |                      |                      |                     |                      |                      |
| Crude      do.  | 248,675              | 239,200              | 236,800             | 253,675              | <sup>3</sup> 290,175 |
| Condensate from oil and gasfields      do.                | 160,000              | 170,000              | 175,000             | 170,000              | 175,000              |
| <b>Refinery products:</b>                                 |                      |                      |                     |                      |                      |
| Gasoline      thousand 42-gallon barrels                  | <sup>1</sup> 16,138  | <sup>1</sup> 17,360  | <sup>1</sup> 15,610 | 17,760               | 18,000               |
| Kerosene and jet fuel <sup>e</sup> do.                    | <sup>4</sup> 660     | <sup>4</sup> 530     | <sup>4</sup> 058    | <sup>3</sup> 903     | 4,000                |
| Distillate fuel oil      do.                              | 51,500               | 54,400               | 60,105              | 57,233               | 58,000               |
| Residual fuel oil <sup>e</sup> do.                        | <sup>3</sup> 7,760   | <sup>3</sup> 6,100   | <sup>4</sup> 0,050  | <sup>3</sup> 7,660   | 38,000               |
| Lubricants      do.                                       | <sup>8</sup> 82      | <sup>9</sup> 17      | <sup>7</sup> 35     | 959                  | 975                  |
| Other <sup>e</sup> do.                                    | 45,200               | 43,425               | 47,100              | 47,300               | 47,000               |
| Total      do.  | <sup>1</sup> 156,140 | <sup>1</sup> 156,732 | 167,658             | <sup>1</sup> 164,815 | 165,975              |

<sup>e</sup>Estimated. <sup>p</sup>Preliminary. <sup>r</sup>Revised.<sup>1</sup>Table includes data available through Sept. 30, 1991.<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 1990

(Thousand metric tons unless otherwise specified)

| Major commodity                     | Major operating companies  | Location of main facilities  | Annual capacity  |
|-------------------------------------|--|--|--|
| Cement                              | Entreprise des Ciments et Derives de L'Est   | Setif, near Bejaia   | 1,000.   |
|                                     |  | Batna, 60 km south of Skikda   | 1,000.   |
|                                     |  | Constantine, west of Skikda  | 1,000.   |
|                                     | Do.  | Entreprise des Ciments et Derives de L'Ouest   | 3 plants at Oran   |
| Do.                                 | Cimenterie de Oued Sly   | El-Asnam, 80 km west of Algiers<br>Djelfa  | 2,000.<br>500.   |
| Do.                                 | Entreprise des Ciments et Derives du Centre  | Blida, 5 km southwest of Algiers<br>Bouira, near Algiers<br>Algiers  | 1,000.<br>1,000.<br>500.   |
| Fertilizer                          | Entreprise Nationale des Engrais (Asmidal)   | Arzew  | 495 ammonium nitrate,<br>660 ammonia,<br>132 urea,<br>395 nitric acid.   |
| Do.                                 | Do.  | Annaba   | 330 ammonium nitrate,<br>330 ammonia,<br>254 nitric acid,<br>495 sulfuric acid,<br>165 phosphoric acid,<br>550 compound fertilizers. |
| Iron ore                            | Entreprise Nationale de Fer et de Phosphates   | Ouenza and Bou Khadra  | 4,000.   |
| Mercury kilograms                   | Entreprise Nationale des Nonferrous et Substances Utiles   | Azzeba   | 4,000.   |
| Natural gas million cubic meters    | Societe Nationale pour la Recherche, la Production, le Transport, la Transformation, et la Commercialisation des Hydrocarbures | Hassi R'Mel and Hassi Messaoud natural gas gathering center  | 112,000.   |
| Do.                                 | Do.  | Liquefaction plants at Arzew   | 22,900.  |
| Do.                                 | Do.  | Liquefaction plant at Skikda   | 7,900.   |
| Natural gas liquids million barrels | do.  | Hassi R'Mel  | 200.   |
| Petroleum, 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) | 438.   |
| Petroleum, crude                    | Do.  | Total, Compagnie Francaise des Petroles  |  |
| Do.                                 |  | Mereksen   | 2.   |
| Refinery product                    | Entreprise Nationale de Raffinage des Produits Petroliers  | Refinery at Skikda   | 118.   |
| Do.                                 | do.  | Refinery at Arzew  | 22.  |
| Do.                                 | do.  | Refinery at El Harrach, near Algiers   | 21.  |
| Do.                                 | do.  | Refinery at Hassi Messaoud   | 9.   |
| Do.                                 | do.  | Refinery at In Amenas  | 2.   |
| Iron and steel                      | Entreprise Nationale de Siderurgie   | El Hadjar, near Bejaia   | 1,500.   |

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.**—Raw steel was produced at the Entreprise Nationale de Siderurgie's El Hadjar steel complex, the nation's sole steelworks. Blast furnace modernization requiring a 3-month-shutdown was scheduled for mid-1990.

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 as of yearend 1990.

**Lead and Zinc.**—Enterprise Nationale de Recherche Miniere (EREM) has announced the discovery in 1990 of two lead-zinc ore deposits in the Oued Amizour mountain region. The most significant deposit was discovered at a depth of 250 m at Azrou Bechar, about 20 km southeast of Bejaia. The deposit is reported to contain 200 Mmt of ore grading 6% zinc. A second deposit in the region had estimated reserves of 22 Mmt containing 2.5% zinc and 1.13% lead. Lead-zinc mining operations were from two small mines until mid-1990, when the Kherzet Youcef Mine closed. The El Abed Mine near the Algerian-Moroccan border remained in production, averaging between 10,000 to 15,000 mt/a of zinc concentrates.

**Mercury.**—Algeria was 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.**—The state controlled the cement industry. However, in 1990, private-sector investors in the Oran region were authorized to purchase up to five works for \$200 million. The International Finance Corp. was to assist in identifying the plants and mobilize finance.

**Clay.—Kaolin.**—El Milia, 20 km north of Tamazert, was to be the site of a 50,000-mt/a-capacity kaolin plant. Most of the plant's output will be directed to the do-

mestic market. 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 openpit 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 1.2 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 overhauling and upgrading the complexes were awarded to the Bechtel Corp. and the M. W. Kellogg Co. of the United States and Sofregas of France.

In mid-1990, Gaz de France 49%, Sonatrach 36%, and Sonelgaz 15%, formed a joint venture under Safir. Based in Algeria, the company's primary responsibility will be to conduct engineering studies in the gas industry.

Total CFP signed an agreement in May to make investment in the development of the Hamra Gasfield in the East-Central Sahara in return for a specified amount of natural gas liquids. Details on the agreement were not disclosed.

Negotiations were renewed in 1990 for the construction of a helium plant at Arzew. The project entails setting up a joint venture involving Air Products of the United States and L'Air Liquide of France to process helium-rich waste gas from Sonatrach's natural gas facilities.

**Petroleum.—Exploration.**—Most of the exploration activity remains under SONATRACH, which holds the license for exploration on more than 450,000 km<sup>2</sup>. In November 1990, it was assigned 2- year exploration licenses for nine concessions totaling 138,838 km<sup>2</sup>. Total acreage being explored under terms of association con-

tracts with foreign firms in Algeria were reported at 82,945 km<sup>2</sup> by yearend.

**Production.**—Crude oil production averaged 795,000 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. Field condensate production averaged 410,000 bbl/d.

**Refining.**—SONATRACH operated four refineries with a combined distillation capacity of 465,000 bbl/d and 56,000-bbl/d of catalytic reforming capacity. Refined product output averaged more than 460,000 bbl/d. The 300,000-bbl/d-capacity Skikda refinery was closed in October for maintenance.

### Reserves

Hydrocarbon reserves as reported by the Ministry of Mines and Industry in January 1991 totaled 3.23 trillion m<sup>3</sup> of natural gas. Unassociated natural gas accounted for 85% of these reserves. Petroleum reserves were reported at 9.2 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

Natural gas was pumped from Hassi R'Mel by pipeline to the Mediterranean Ports of Arzew and Skikda. Nine lines carried dry gas. Four lines carried condensates and LPG. A gas line network totaling 1,500 km transported natural gas from Alrar, Rhourde Nouss, and Gassi Touil to Hassi Messaoud and Hassi R'Mel.

Port capacity at Skikda is limited to 90,000 m<sup>3</sup>-natural gas-carriers. Consideration is being given to the expansion of the port to accommodate 125,000 m<sup>3</sup> carriers.

Sonelgaz announced the completion of a 168-MW gas-fired unit at the Marsat el-Hadjadj powerplant. By mid-1991, when Marsat II is scheduled for operation, total electric power capacity at the powerplant will be 880 MW.

## OUTLOOK

Algeria's aging energy industries are operating at full capacity and can only ex-

pand if modernized. The 1990-94 economic plan recognizes that stimulating foreign investment interest is an essential element of the economic reform program. In pursuing this course of action, the Algerian Government plans to sell off a portion of production rights in existing oil and gasfields to private companies. According to the Algerian Ministry of Mines, by 1994, exports of natural gas are expected to exceed 57 billion m<sup>3</sup>, doubling the 1990 level. Expansion of the trans-Mediterranean pipeline alone should open markets in Austria, Czechoslovakia Hungary, and Yugoslavia. With sufficient foreign capital to refurbish the natural gas extraction and

processing facilities, as well as the transport infrastructure, Algeria should be positioned to take full advantage of anticipated price increases.

<sup>1</sup>Where necessary, values have been converted from Algerian dinars (AD) to U.S. dollars at the rate of AD.958=US\$1.00.

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

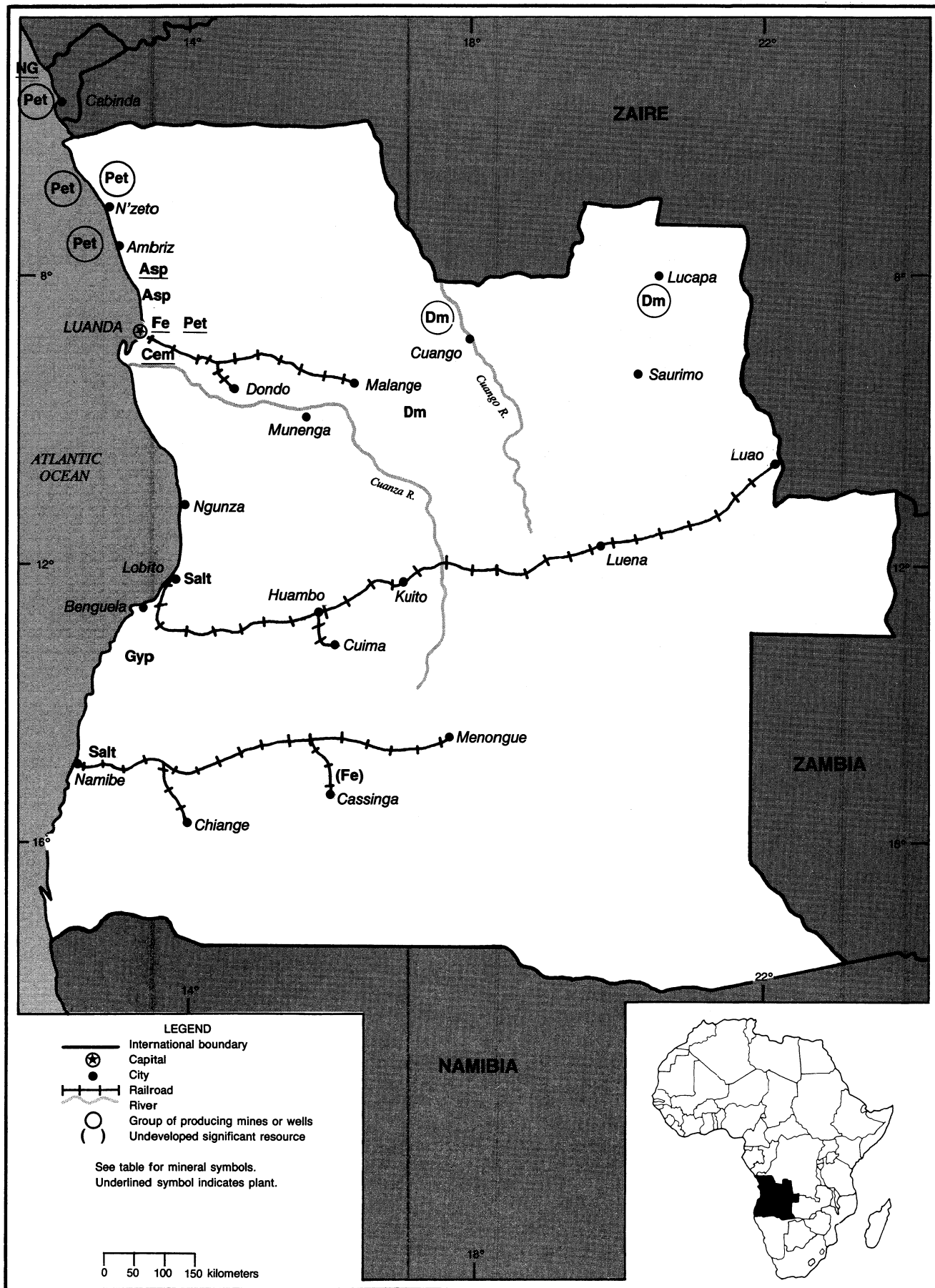
Ministry of Mines  
80 Avenue Ahmed Ghermoul  
Algiers, Algeria  
Ministry of Industry  
Le Colise Rue Ahmed-Bey de Constantine

Algiers, Algeria  
Société Nationale des Matériaux de  
Construction  
90 Rue Didouche Mourad  
Algiers, Algeria  
Société Nationale pour la Recherche, la  
Production, le Transport, la Transforma  
tion, et la Commercialisation des  
Hydrocarbures  
10 Rue du Sahara, Hydra  
Algiers, Algeria  
Société Nationale de Siderurgie  
Ravin Sidi Yahia  
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# ANGOLA

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

POPULATION 8.6 million



# THE MINERAL INDUSTRY OF ANGOLA

By Audie L. King

**T**he petroleum industry dominated the Angolan economy. Although data for 1990 were unavailable, in 1989, the mineral industry accounted for about 34% of the GDP of \$7.7 billion at factor cost. About 95% of the mineral sector's revenues were from crude petroleum. In 1989, about 53% of Government revenues and about 92% of total export earnings were generated from the petroleum sector. Beginning in August 1990, the value of Angola's crude oil production rose sharply as both output and prices increased following Iraq's invasion of Kuwait. Revenues derived from the state's participation in the petroleum industry and the taxation of foreign oil companies continued to be the Angolan Government's principal source of foreign exchange. Military expenditures accounted for about 40% of Government spending.

Revenues from official diamond mining accounted for about 2% of the GDP and about 7.6% of total export earnings. Official production of diamond increased for the eighth consecutive year to about 1.3 million carats. This was still only about two-thirds of the production level achieved before the civil war began in 1975. Illegal, small-scale mining continued to be a problem as an estimated 0.5 million carats of diamond was smuggled across the border into Zaire. The state diamond mining company, Empresa Nacional dos Diamantes de Angola (Endiama), signed an agreement with De Beers to reestablish its marketing relationship. The deal, signed in January 1991, would provide Endiama with a \$50 million loan to increase production from the Cuango area. In return, Endiama agreed to sell its entire production from the Cuango area to De Beers' Central Selling Organization (CSO). De Beers also agreed to spend at least \$50 million on the evaluation of the Camutue kimberlite in northeastern Angola and to prospect for new primary diamond sources.

## GOVERNMENT POLICIES AND PROGRAMS

To prepare for membership in the world's financial community, Angola began to lib-

eralize its economic policies and move to a more market-oriented economy. Membership in the World Bank and the International Monetary Fund (IMF) came after the Government implemented some of the key points of its ambitious reform program, the Programa de Saneamento Economico e Financeiro (SEF), launched in 1988. The SEF planned to substantially devalue the local currency, the kwanza; privatize small- and medium-sized state companies; revise legislation to make foreign investment more attractive; reduce the size of the public sector; and improve revenue collection methods. It also became a full member of the Multinational Investment Guarantee Agency, a World Bank affiliate that provides political risk insurance to companies operating in its member countries.

Some of the SEF reforms affected the mining laws that had been in effect since 1979. Though the Government continued to consider all mineral resources to be property of the state, new laws allowed foreign companies to participate in exploration and mining. Provisions in the law that required a majority ownership by Angolan nationals were repealed. This effectively allowed the mining industry to enjoy the same freedom of operations that the highly successful petroleum industry had enjoyed for many years. A newly formed Ministry of Geology and Mines would oversee the changes in the mining laws. Since Angola's independence, the Geological Survey Department and the National Department of Mines, the latter of which controlled the state mining companies, had been under the Ministry of Industry.

Monetary reforms under the SEF would free price controls that had caused the cost of some goods on the parallel market to be more than 60 times that of regulated prices. In September, the Government announced that it intended to devalue the Angolan currency from 30 kwanzas to 60 kwanzas to the dollar. Further devaluations in the kwanza were anticipated and were expected to cause hardship for a large number of people. The banking industry would be revamped to encourage foreign investment, make international business transactions easier, and to lessen the importance of for-

ign currency in Angola's domestic economy.

The Office of Foreign Investment was established to centralize and speed up the Government's approval of new foreign investment projects. Foreign companies were guaranteed the right to repatriate profits.

Angola's Finance Minister identified 17 public enterprises that could be privatized once a reorganization of state-owned enterprises was completed in May 1991. Revenues from the sales of publicly held companies could be used to cover subsequent budget deficits and to create an unemployment fund. Enterprises such as the Benguela railroad and the Angolan airlines would only sell a part of their holdings. Plans called for the Government to maintain a majority status in any company that holds a monopoly status.

Other Government austerity measures, under the SEF, included tax reforms designed to increase Government revenue and measures to cut state expenditures by 15%. Tax incentives for hard currency shops were removed, and custom duties based on the value of imported items were introduced. Duty on certain items such as cars and alcohol was increased by between 30% and 100%. Tax incentives were offered for certain projects that were deemed necessary for the rebuilding of the infrastructure or training the labor force.

## PRODUCTION

The production of Angola's principal mineral commodities increased during 1990 despite continued disruptions from the civil war. After maintaining a constant output during the first 6 months of the year, Angola increased petroleum production sharply following the outbreak of hostilities in the Middle East. Overall, petroleum production was up by about 4.2% in 1990 compared with increases of less than 1% in 1989 and more than 25% in 1988. Diamond production increased for the fourth consecutive year.

Clay, granite, marble, and quartz were reportedly mined at a number of localities throughout the country, but information on

production and mine locations was sparse and unreliable.

## TRADE

Petroleum products accounted for about 92% of Angola's export earnings. Diamond exports accounted for most of the rest of the country's exports. Angola also exported minor quantities of coffee and timber. In 1990, about 50% of exports, nearly all of which was petroleum, went to the United States. Other recipients of Angolan exports included the U.S.S.R., Cuba, Portugal, France, Brazil, Spain, and the United Kingdom. During 1990, France and Portugal significantly increased oil imports from Angola to make up for lost markets in the Middle East.

Angola's principal imports were food, clothing, instruments and optical goods, paper, minerals, chemicals, plastics, metals, and electrical and transport equipment. The main suppliers were the U.S.S.R., Cuba, Portugal, France, the United States, and Brazil.

## STRUCTURE OF THE MINERAL INDUSTRY

During 1990, the Angolan industrial sector, with the significant exception of the petroleum industry, was dominated by state enterprises. In most cases, private foreign oil companies operated on the basis of joint ventures or production-sharing agreements with Sociedade Nacional de Combustiveis de Angola (Sonangol), the state-run oil company. Diamonds were mined by the state-run company, Endiama, which like the petroleum companies, was considered an enclave enterprise. Enclave enterprises were free from most Government oversight and regulation. All other minerals were mined or processed by Government enterprises. Additional state companies were responsible for mineral deposits that were not currently being mined but were potentially valuable. For example, Cia. de Fosfatos de Angola (Fosfang) was accountable for a large phosphate deposit in northwestern Angola. Companhia de Ferro de Angola (Ferrangol), another state company, intended to bring the Cassala-Kitunga iron ore mine near Cassinga into operation and oversaw numerous other prospective iron deposits.

While the Government moved ahead with plans to privatize many state-run enterprises, the future status of Angola's mining

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

| Commodity <sup>2</sup>  | 1986    | 1987    | 1988    | 1989 <sup>a</sup> | 1990 <sup>a</sup> |
|---|---------|---------|---------|-------------------|-------------------|
| Asphalt and bitumen, natural <sup>c</sup> metric tons                                       | 10,000  | 11,000  | 13,000  | 13,000            | 13,000            |
| Cement, hydraulic <sup>c</sup> thousand metric tons   | 350     | 350     | 1,000   | 1,000             | 1,000             |
| Diamond: <sup>c,3</sup>   |         |         |         |                   |                   |
| Gem thousand carats   | 240     | 675     | 950     | 1,165             | 1,215             |
| Industrial do.  | 10      | 75      | 50      | 80                | 85                |
| Total do.   | 250     | 750     | 1,000   | 1,245             | 1,300             |
| Gas, natural: <sup>c</sup>  |         |         |         |                   |                   |
| Gross million cubic meters  | 3,917   | 4,780   | 6,297   | 6,353             | 6,602             |
| Marketed do.  | 300     | 370     | 510     | 520               | 538               |
| Gypsum <sup>c</sup> metric tons   | 20,000  | 20,000  | 57,000  | 57,000            | 57,000            |
| Iron and steel: Steel, crude <sup>c</sup> do.   | 10,000  | 10,000  | 10,000  | 10,000            | 10,000            |
| Natural gas plant liquids,<br>propane and butane <sup>c</sup><br>thousand 42-gallon barrels |         |         |         |                   |                   |
|   | 2,320   | 2,320   | 2,790   | 2,480             | 2,500             |
| Petroleum:  |         |         |         |                   |                   |
| Crude do.   | 102,930 | 131,190 | 165,000 | 167,000           | 174,000           |
| Refinery products do.   | 9,855   | 9,490   | 9,855   | 10,800            | 11,700            |
| Salt <sup>c</sup> metric tons   | 55,000  | 60,000  | 70,000  | 70,000            | 70,000            |

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

<sup>1</sup>Table includes data available through Jan. 24, 1992.

<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>Reported figure.

companies was uncertain. Recent agreements between Endiama and De Beers, for example, suggest that the Government intends to retain control of the nation's diamond deposits while contracting out certain aspects of its operations. The Government announced that it intended to modify existing laws to allow private Angolans and foreign companies to own the right to exploit mineral deposits. Companies considered by the Government to be strategic public monopolies would, however, remain under state control, but would be made autonomous and decentralized. Nonviable public enterprises would be required to present a program for closing down and liquidating their assets.

## COMMODITY REVIEW

### Industrial Minerals

After 5 years of independently marketing its own diamond output, Endiama reestablished its relationship with De Beers. Endiama agreed to sell current diamond production from the Cuango area through the Luzern Switzerland-based De Beers Centenary AG, set up in May 1990, to deal

with all of De Beers non-Republic of South African assets and earnings. Since 1985, when De Beers pulled out of the country because of the civil war, Angola was the world's largest diamond-producing country to sell outside the CSO. Once the final details of the agreement are worked out, Angola expects to market a significant portion of its output through De Beers. At first, De Beers would market diamonds mined in the Cuango region, which amounted to about 80% of the country's output in 1990. In exchange for diamond marketing rights, De Beers would supply Endiama with a \$50 million loan to increase placer production in the Cuango area and build and equip a diamond sorting operation in Luanda. De Beers would spend an additional \$50 million over 5 years to develop other diamond deposits, including some very large kimberlites in the Lucapa area. To date, all of Angola's diamond production has come from alluvial deposits. Production from the kimberlite deposits was not expected to start until the mid-1990's. Endiama was also negotiating with the U.S.S.R. for the bulk sampling of the Catoca deposit near Lucapa, which is considered to be the most promising of the undeveloped kimberlite deposits.

TABLE 2  
**ANGOLA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990**

(Thousand metric tons unless otherwise specified)

| Major commodity                    | Major operating companies                              | Location of main facilities                                   | Annual capacity |
|------------------------------------|--|---|-----------------|
| Cement                             | Empresa de Cimento de Angola (Cimangol)                | Luanda  | *2,000          |
| Diamond thousand carats            | Empresa Nacional dos Diamantes (Endiama)               | Luanda Norte Province, Cuango and Lucapa areas                | *1,300          |
| Petroleum, crude million barrels   | Chevron-operator<br>Cabinda concession                 | Offshore Cabinda  | *90             |
| Do.                                | Texaco-operator<br>block 2                             | Offshore Zaire Province between the Zairian border and N'zeto | *29             |
| Do.                                | Société National ELF Aquitaine (ELF)-operator, block 3 | Offshore, 30 kilometers off the coast, near N'zeto            | *59             |
| Do.                                | Petrofina S.A. (Fina)-operator                         | Onshore, Cabinda<br>Onshore Cabinda, Areas A and B            | *15             |
| Petroleum, refined million barrels | Cia. de Petroleos de Angola (Petrangol)                | Luanda  | *12             |
| Iron and steel                     | Siderurgia Nacional                                    | do.   | 30              |

\*Estimated.

Throughout 1990, Angola's diamond mining areas were not well protected, and the transport routes remained dangerous. Working conditions remained arduous, with little food or other consumer goods. Key supplies of fuel and equipment had to be flown in. It was estimated that during 1990, about \$100 million worth of diamonds was smuggled over Zaire's border to the buying offices in Tshikapa, Zaire, or through Lisbon, Portugal. Endiama signed an agreement with Sociedade Portuguesa de Empreendimentos (SPE) and Zaire's parastatal diamond company in Kinshasa on April 20. The agreement aimed at halting illegal diamond trafficking around the River Cuango region. It would regulate the flow of certain goods, typically bartered on the black market for diamonds, across international boundaries.

Endiama signed an agreement with Brazil's Construtora Norberto Odebrecht for the joint diamond prospecting along the Cuango River on the border with Zaire.

Endiama announced another contract with the Portuguese state company, SPE, to mine alluvial diamond deposits in the Lucapa area. Under a 2-year contract, SPE would explore a 700-km<sup>2</sup> region in the same area. It was hoped that at the end of the 2-year contract SPE and Endiama would form a joint venture for further exploration.

Endiama signed a prospecting agreement with Portugal's Sociedade Portuguesa de Investimentos (SPI) and private Zairian

group Saicam to explore an area along the Cuango River near the Zaire border. Prospecting was expected to begin in the last quarter of 1991.

#### Mineral Fuels

As of 1990, the Government had divided Angola's offshore area into 31 petroleum exploration concessions. Of these, 14 were near shore, shallow water concessions defined as being less than 500 feet (152 m) in depth. These occupy a 20- to 50-km-wide strip along the entire Angolan coast. Paralleling the shallow water concessions were 17 deep water concessions, defined as occupying depths from 500 to 2,000 feet (152 m to 609 m). The shallow water concessions comprised, from north to south, blocks 1 through 13 and the offshore Cabindan Concession. The deep water concessions were similarly designated Blocks 14 through 30. Blocks 1 through 3, occupying the shallow water area between the Zaire River and N'zeto, are, however, labeled anomalously. Block 2 occupied a 120-km stretch about 25 km wide nearest the coast, while blocks 1 and 3 occupied the rest of the shallow water area further offshore.

The Cabinda Concession and blocks 2 and 3 and were producing, while blocks 1, 4, and 5, were being explored. Following a Government-sponsored promotional meeting in mid-1989, blocks 6, 7, and 8 were allocated to foreign investors.

Sonangol was expected to offer blocks 9 through 13 under a similar production-sharing agreement used for the Cabindan Concession and other blocks. Interest in these blocks was high because of geological similarities of the area to the oil-rich Campos Basin in Brazil. Negotiations were also underway for the north and central onshore areas in Cabinda. Chevron's predecessor, Gulf Oil Corp., made many oil and gas finds in the area before Angola's independence in 1975.

Sonangol recently decided to offer all of the country's deep water concessions for oil exploration. Most major international petroleum companies have asked to bid on the 17 virtually unexplored blocks. Contracts will be on production-sharing terms similar to those that Angola used to open up its nearshore blocks 20 years ago. The contractor would be called upon to pay for all exploration expenses, with recovery of these expenses paid for from a "cost oil" share of production from successful finds. The remaining "profit oil" would go largely to the Government, its take starting at 70% and rising to 95% in line with cumulative production. A controversial aspect of the old agreement has been the price cap that has prevented oil companies from benefiting from oil price rises after an exploration contract is signed. This cap will likely be omitted in consideration of the higher risks of deep water work. It was anticipated that interest would be strongest in the northern



blocks, offshore Cabinda and northern Angola.

Angola began importing LPG from Nigeria following UNITA's November 29, 1990, attack on the Cia. de Petroleos de Angola (Petrangol) oil refinery in Luanda. This attack effectively shut down operations. Repairs began immediately, and plans called for expansion of the facility's canister filling capacity from 2,500 to 9,000 canisters per day for domestic use.

ELF Aquitaine (ELF) proceeded to bring on-line some of its numerous block 3 discoveries. Production was established at the Palanca, Pacassa, Bufalo, and Impala Southeast Fields, with oil piped to offshore loading facilities. A fifth field, Impala, was under development and scheduled for startup in the first part of 1991, while a sixth field, Cobo, was slated for development. When all of these new fields become fully operational by the mid-1990's, ELF's production capacity will have increased from the present 162,000 bbl/d to a projected 200,000 bbl/d. ELF controlled other promising fields that have yet to be developed: the Caco, Cefo, Golungo, Kuma, Palanca Northeast, Pambi, and Quissama. The Pambi Field was described by ELF as a major accumulation. Overall ELF says that 13 out of 26 exploratory wells drilled in block 3 during 1990 yielded significant commercial discoveries.

Chevron was still showing good finds in the offshore Cabinda Concession, that already accounted for more than one-half of Angola's total production. The 3 largest of 14 active fields, the Takula, Numbi and Wamba, which together accounted for 70% of Cabinda's production, continued to be the focus of current development work. Chevron was predicting that production would continue to increase in these fields until the mid-1990's. Water injection facilities were placed onstream at the Takula and Numbi Fields. Three additional production platforms were installed in 1990. Chevron's producing wells are all in the near-offshore area designated A, but work was underway to bring discoveries in areas B and C, to the west and south, respectively, into production by 1994. Plans called for four fields, two in area B and two in area C, to be developed in the first phase of expansion. These four fields would yield an additional 50,000 to 100,000 bbl/d.

Braspetro, the overseas subsidiary of the parastatal Brazilian oil company, Petrobras, was negotiating to become the operator in a consortium that would explore block 9. Meanwhile, the company announced the

discovery of three new offshore petroleum deposits in block 2: the Espadarte, Albacore, and Calafate fields. These have combined resources estimated at 7.5 Mbbl. Braspetro planned to begin production from the Espadarte Field by the end of 1991. The Espadarte Field is conveniently near currently operating facilities.

An international consortium led by Texaco made a string of new discoveries, including the Bagre, Estrela, and Savelha fields in the northern part of block 2, and the Morsa and Califate Fields in the southern part of the block.

### Reserves

Sonangol reported petroleum reserves of about 2 billion bbl. Proven natural gas reserves were reported to be almost 60 billion m<sup>3</sup>. It was estimated, however, that natural gas resources exceeded 140 billion m<sup>3</sup>.

According to the Government, Angola had proven diamond resources of about 82 million carats in deposits grading a minimum of 0.6 carats/m<sup>3</sup>. About two-thirds of these diamonds were in kimberlites as yet unmined. Estimates of the resource base ranged from 220 to 350 million carats.

The Cassinga iron ore deposit had resources of 100 Mmt, grading more than 63% iron, when it closed in 1975 because of the outbreak of the civil war. An additional 1 billion tons of material, grading between 35% and 63% iron, was indicated. Ferrangol also claimed to have extensive iron deposits 70 km northeast of Dondo and a potentially economic manganese deposit about 150 km east of Dondo.

There was reportedly about 10 Mmt of commercial-grade phosphate ore at Kindonacaxa near N'zeto. In a 1981 test, using a 15,000 mt/a pilot plant, it was shown that crushed phosphate produced from the deposit was suitable for domestic consumption. The possibility of using the ore to produce phosphoric acid was still being investigated by Fosfang. The deposit has yet to be exploited on a commercial basis because of war-related transport difficulties. There are also large phosphate deposits at Mongotando, about 45 km north of Cabinda.

Other known resources included natural asphalt, barite, bauxite, beryllium, copper, gold, granite, gypsum, kaolin, lead, marble, mica, quartz, rare earths, talc, tungsten, uranium, and zinc.

## INFRASTRUCTURE

The basic transportation infrastructure in Angola was developed before Independen-

dence in 1975. Surface transport infrastructure consisted of 3 east-west-trending rail-port systems. There are the northern Luanda Railroad, the central Benguela Railroad, and southern Namibe Railroad, as well as a mostly north-south-trending feeder road network. The rail system consisted of 2,879 km of 1.067-m-gauge and 310 km of 0.600-m-gauge track. Most of the route has been damaged during the civil war, and even undamaged sections were threatened by security problems. Trains that did run routinely pushed a ballast car in front to absorb the blast of explosives that were often placed on the tracks. Most of the railroad's physical assets had fallen into disrepair or had been destroyed. As a result, by 1990, freight shipments had fallen to a small fraction of what they were before Independence. The flow of goods had also reversed, with imports currently dominating the freight business.

Plans formulated by the Southern African Development Coordination Conference (SADCC) and a group of Western and Arab donors to rehabilitate the entire 1,350 km of track of the Benguela Railroad were delayed owing to continued military operations in the area. While the prospect of restoring the Benguela Railroad to its former status as a major transport link in Southern Africa was appealing, some foreign government officials doubted the economic wisdom of such a massive undertaking. Rehabilitation could take almost a decade to complete and would cost an estimated \$600 million. Proponents of the project contended that it would be especially important to Zaire, a leading producer of copper and cobalt. Zaire once transported one-half of its trade on the Benguela line. Detractors felt that by the time the project could be completed, in the late 1990's, the value of exports, including copper and cobalt mined in Zaire and Zambia, would not justify the cost of reconstruction. In the near term, the most likely portion of the route to be restored would link Angola's coastal Ports of Lobito and Benguela to the inland cities of Huambo and Kuito. The Provincial government of Bié approved an emergency program to renovate the railway between Kuito and Huambo.

Angola had about 73,828 km of roads, 8,577 km of which was paved. The road system, however, has not been maintained since Independence and was in severe need of repair. It was estimated that more than 200 bridges and 5,400 km of paved roads needed rehabilitation or reconstruction. The Government estimated that the renovation

of the nation's roads would take 30 years to complete.

The Italian Government was planning to sponsor the construction of a sea terminal in Cabinda Province. It also financed the construction of the Lobito sea terminal, completed in 1986.

The total installed capacity of Angola's electrical supply system was about 506 MW in 1989, the last year for which data were available. Of this total, only 60% was available because much of the system had fallen into disrepair since 1974, when Angola's power generation peaked at 1,029 GW·h. Following Independence, the nation's demand for power fell dramatically, but has since recovered to about 770 GW·h. In 1986, Angola generated 754 GW·h of electricity, 97.6% of which was from hydroelectric plants. More recently, however, Angola's hydroelectric power distribution network had come under increasingly frequent rebel attacks. For example, between 1984 and 1990, UNITA destroyed 217 pylons on the power lines that supply Luanda. As a result, Angola has been forced to increasingly rely on more expensive thermal plants.

Work on the Capanda Dam and associated 520-MW hydroelectric project con-

tinued during the year even though the country's present power-generating facilities, if fully rehabilitated, could meet projected demand. The \$920 million project experienced financial difficulties when the Banco do Brazil canceled \$75 million worth of credit on the grounds that the risk was unacceptable. Brazil's Construtora Norberto Odebrecht was the main contractor for the Capanda scheme. The company was the lead partner in Consortio Capanda, a joint venture also including Technopromoeexport of the U.S.S.R. and Furnas Centrais Electricas (FCE) of Brazil. Work at the dam site 148 km southeast of Luanda began in December 1986. It was still on schedule for the first turbine to open in December 1992. Three other turbines would be on-line by 1994. The Cuanza River was diverted through a 320-m-long relief tunnel early in 1989. Excavators in the dry bed had already removed all of the earth and most of the rock scheduled to be moved. Work on the dam wall started in October 1989. Completion of the dam was due in January 1991, with a final height of 110 m and a width of 1,120 m. There were 2,500 workers on-site, of whom 2,050 were Angolan.

## OUTLOOK

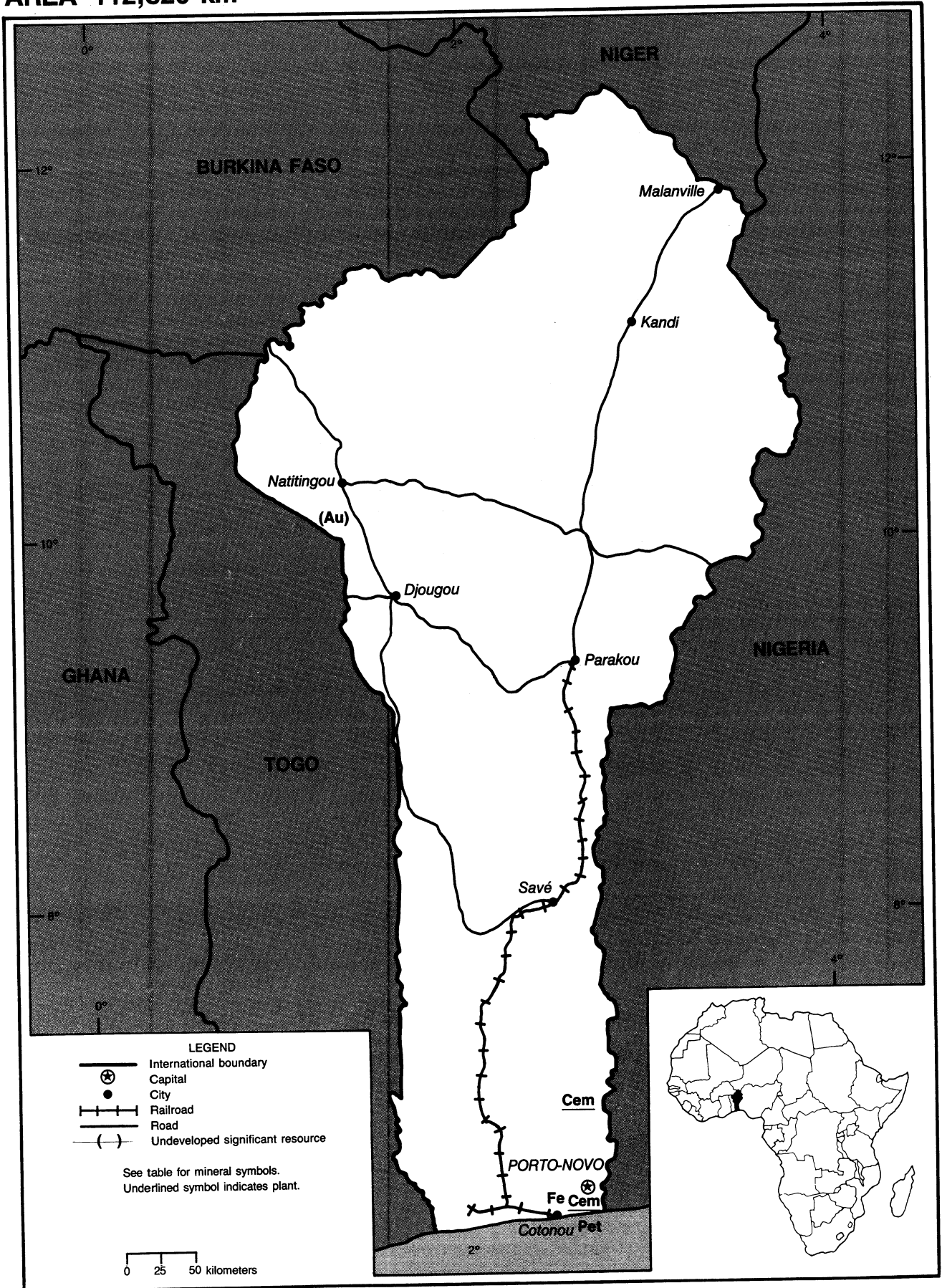
The economy will continue to be heavily dependent on the petroleum industry for the foreseeable future. The stagnating minerals industry can be expected to revive once transportation and security problems are resolved. Recent changes in the Angolan Government's attitude toward a free market economy and a multiparty political system may help stabilize the economy. Renewed mineral exploration would follow if appropriate mining policies were established. Within a few years, new commodities such as gold, iron ore, kaolin, and phosphate rock could be added to Angola's list of export commodities. Exploration rights for the higher risk onshore oil concessions and deep water offshore concessions will likely be awarded in the near future.

The prospect of mining the country's massive kimberlite deposits opened up the potential of Angola becoming one of the world's top diamond producers in terms of both value and volume. The future role of the former U.S.S.R. in Angola's mineral industry is uncertain, but will likely diminish as the 15 new republics struggle with continuing economic and political difficulties.

# BENIN

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

POPULATION 4.7 million



# THE MINERAL INDUSTRY OF BENIN

By Hendrik G. van Oss

**B**enin's mineral industry in 1990 was dominated by the production of crude petroleum and cement. There was also a modest production of steel semimanufactures and of salt. Sales of mineral commodities in 1990 are estimated to have amounted to about 4.8% of the country's GDP of \$1.05 billion.<sup>1</sup> Of this, sales of crude petroleum were worth about \$24 million and made up virtually all of Benin's exports of primary minerals and an estimated 65% of total mineral commodity exports. Cement sales are estimated to have been worth about \$20 million, of which only about 5% represented exports. Overall, exports of mineral commodities are estimated to have accounted for almost 11% of Benin's total 1990 exports of \$263 million. As in years past, Benin's economy was dominated by agriculture; about 35% of GDP was from that sector in 1990. Approximately 50% of Government revenues were derived from taxes on the legal transshipment of goods to Nigeria; however, smuggled trade with that country remained a problem.

Imports of energy, dominantly refined petroleum products, made up approximately 25% of Benin's total 1990 imports of about \$428 million. Benin relies on electricity imports, all from Ghana, to meet almost 90% of its electricity needs.

A significant development in 1990 was the official switch to a market economy system early in the year. This move, although spurred by labor unrest at yearend 1989, followed recent trends toward liberalization of the country's investment climate and the 1987 adoption of a World Bank structural adjustment program. A major goal of this program is the privatization of state-run industries, especially the country's largest cement company. The Government was also soliciting international assistance in revising the country's mining law. The Office Béninoise des Mines (OBEMINES), under the Ministry of Industry, Mines, and Energy, oversees mineral developments in Benin.

Output of crude oil was all from the Sèmè Field, about 15 km south of Cotonou. The operator, Williams Brothers Engineering Co. of the United States, brought an eighth

well into production during the year. Recoverable reserves at Sèmè, about 20% of the measured resources, were reported by the Government to be about 41 Mbbl, of which 25 Mbbl is as condensate. Onshore exploration rights covering about 4,350 km were held by Trilogy Resources Corp. of Canada. Trilogy conducted an aeromagnetic survey in 1989 and planned a seismic survey of the ground in 1991. The company had an option to drill an exploration well in 1992. Offshore exploration rights covering 2,960 km were held by a joint venture between International Petroleum Corp. of Canada and Hardy Oil and Gas Co. of the United Kingdom. In 1990, the company reprocessed and interpreted about 500 line-km of seismic data and planned a followup seismic survey in 1991. The venture had a commitment to drill an exploration well in 1992.

Benin's three cement plants operated well below capacity during the year. The largest, Société des Ciments d'Onigbolo (SCO), is a joint venture largely between the Governments of Benin and Nigeria, and is the only integrated plant in the country. The plant, far larger than can be accommodated by the domestic market, was constructed to sell into the much larger Nigerian market. Reportedly, the plant has never produced in excess of 200,000 mt/a, and cement sales to Nigeria have been minor. As a result, the plant has had to sell on the Benin market to a larger degree than had been anticipated,

and this has hurt the sales of the country's other two cement mills. These other cement mills import their clinker, despite below-capacity utilization by SCO of its own calcining facilities. The two clinker-grinding plants were recently privatized, but the Government was having trouble finding buyers for its share in SCO, largely because of the joint ownership with the Government of Nigeria. SCO controls limestone reserves reported by the Government to be adequate for at least 100 years of operation of the cement mill at full capacity.

A small steel mill was operated by Société Béninoise de Siderurgie. The mill, which remelts scrap steel to produce rebar, wire, and roofing iron, was inaugurated in 1989. Original capacity was in two production lines, of 4,000-mt/a and 7,000-mt/a capacity, respectively. A 3,000-mt/a line was due on-stream at yearend 1990.

Benin has the potential for the development of significant additional reserves of oil and of natural gas. The country has large reserves of limestone near the cement facility at Onigbolo, north of Cotonou. A number of gold occurrences are known in Precambrian terrane in northwest Benin. None of the known occurrences is large, but there may be potential for the development of semi-industrial-scale gold mining in that region. Benin has deposits of brick and china clay near the Nigerian border; development of the clay deposits would likely depend on market conditions in Nigeria.

TABLE 1

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

(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>                    | 1986    | 1987    | 1988    | 1989 <sup>3</sup> | 1990 <sup>3</sup> |
|---|---------|---------|---------|-------------------|-------------------|
| Cement, hydraulic <sup>c</sup>            | 300,000 | 300,000 | 200,000 | 250,000           | 275,000           |
| Iron and steel: Steel, crude <sup>c</sup> | —       | —       | —       | 2,000             | 8,000             |
| Petroleum, crude                          |         |         |         |                   |                   |
| thousand 42-gallon barrels                | 2,800   | 2,555   | 1,825   | 1,460             | 1,415             |
| Salt, marine <sup>c</sup>                 | 100     | 100     | 100     | 100               | 100               |

<sup>c</sup>Estimated. <sup>p</sup>Preliminary. <sup>r</sup>Revised.

<sup>1</sup>Includes data available through Jan. 20, 1992.

<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 estimate output levels.

<sup>3</sup>Reported figure.

TABLE 2

**BENIN: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990**

(Metric tons unless otherwise specified)

| Major commodity                   | Major operating companies       | Location of main facilities  | Annual capacity                |
|-----------------------------------|---------------------------------|--|--------------------------------|
| Cement                            | CIMBENIN                        | Clinker-grinding plant near Cotonou  | 200,000 cement.                |
| Do.                               | Société des Ciments du Bénin    | do.  | 150,000 cement.                |
| Do.                               | Société des Ciments d'Onigbolo  | Integrated cement plant and limestone quarry about 80 kilometers north of Porto Novo | 500,000 cement.                |
| Petroleum, crude thousand barrels | Williams Bros. Engineering Co.  | Sèmè Field, 15 kilometers offshore Cotonou   | 1,460.                         |
| Salt, marine                      | Artisanal producers only        | Various coastal sites  | NA.                            |
| Steel                             | Société Béninoise de Siderurgie | Remelting plant in Cotonou   | 14,000 rebar and roofing iron. |

NA Not available.

<sup>1</sup>Where necessary, values have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF272.27=US\$1.00.

**Other Sources of Information**

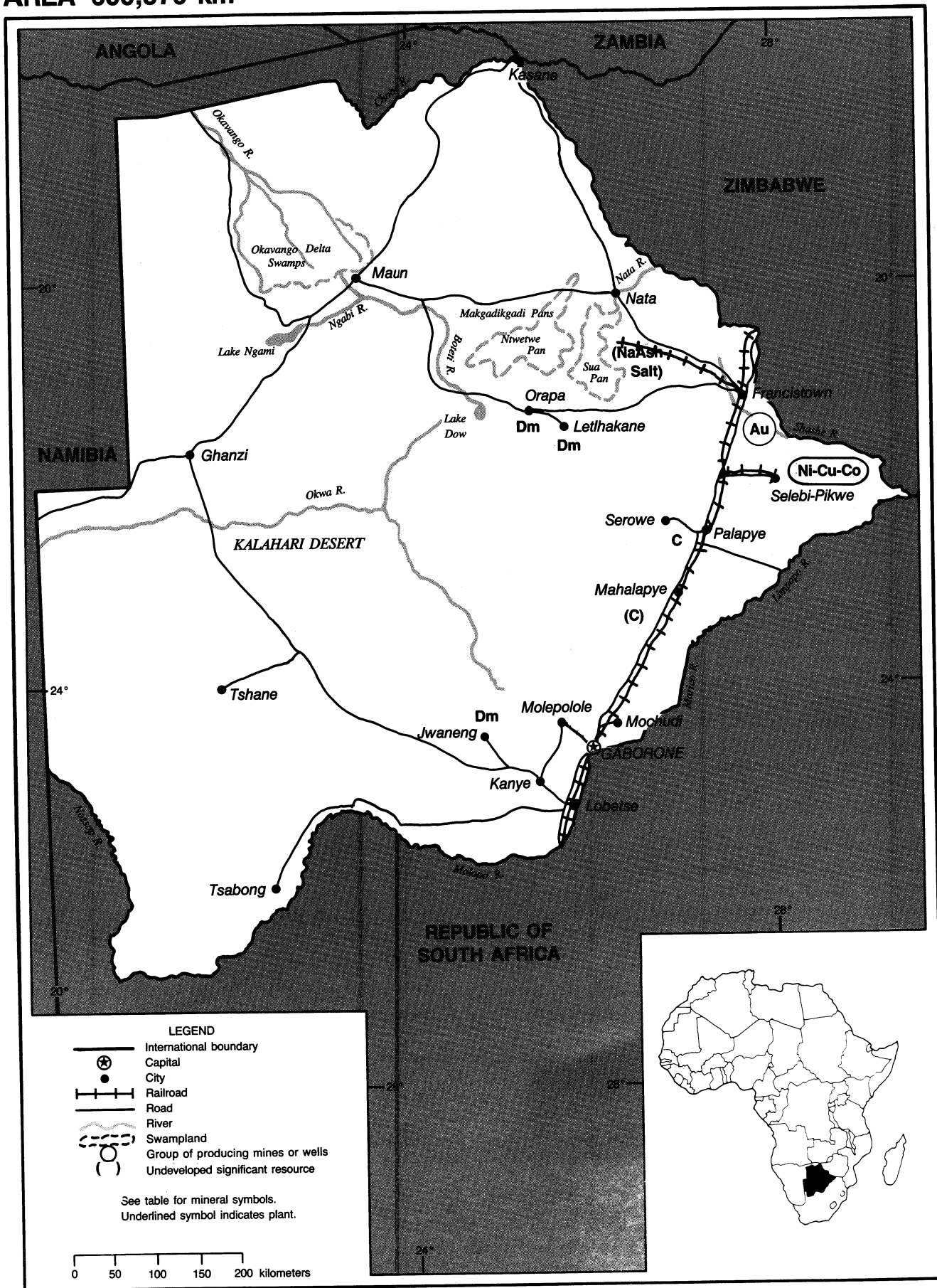
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# BOTSWANA

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

POPULATION 1.2 million



# THE MINERAL INDUSTRY OF BOTSWANA

By Lloyd E. Antonides and George A. Morgan

**T**he mineral industry continued to be the most important aspect of the nation's economy in 1990. It accounts for about 50% of GDP. The mining sector grew at an average annual rate, in real terms, of 16% during the past decade. Botswana has a surplus balance of payments, with foreign currency reserves equivalent to about \$3 billion.<sup>1</sup> This was mainly due to high production and strong sales for diamond. By early 1991, the surplus declined as the Government increased expenditures for various sectors, and imports also increased.

The mineral industry was the main source of revenue for the Government in its social and infrastructure development programs. In recent years, mining revenue made up about 59% of total Government revenues.

Total exports fell to \$1.79 billion in 1990 from \$1.89 billion in 1989, owing to the first decline in the mining sector in 10 years. Total imports increased to \$1.6 billion from \$1.37 billion in the same period.

Diamond reportedly accounted for most of the mining sector's contribution to Government revenue. Diamonds alone made up 40% of GDP and 78% of foreign exchange. Real growth in GDP was about 8.3% in the 1990-91 fiscal year. The contribution made by diamonds is expected to level off as production and sales stabilize.

At yearend 1989, the latest data available, there were 257 active prospecting licenses compared with 139 in 1988. Exploration, in order of importance focused on copper and nickel, gold, platinum group metals, and precious stones. A 4,000-m-deep drill hole was completed by Petro Canada Ltd. in midyear 1990 in the Nosop-Ncojane basin in western Kalahari. Drilled to determine sedimentary sequences, data from the drill hole are available to interested oil companies.

## GOVERNMENT POLICIES AND PROGRAMS

The Ministry of Mineral Resources and Water Affairs had responsibility for the mining sector. Royalties were collected on certain mineral sales. A 5% royalty was received on gold sales.

The Government pursued policies to increase the private sector's participation in the economy and to diversify away from diamond. Measures taken include improved training, education, and health; increased availability of capital; and expansion of the Botswana's Development Corp.'s role in the economy. New export incentives may be made to help local companies expand sales. The strong Pula inhibited the current effort to expand exports.

The Confederation of Commerce, Industry and Manpower signed a \$6.2 million agreement with the U.S. Agency for International Development. The funds are to increase employment by increasing the number of small, private enterprises, including small mining projects.

The Government's seventh national development plan, 1991-92 to 1995-96, included programs to reduce the economy's dependence on mining. This was expected to be difficult owing to the small domestic market, arid climate, and unskilled work force.

## PRODUCTION

Botswana's mining industry was dominated by diamond, production of which was stabilizing. It was one of the world's leading producers of high-quality gem diamond. Other mining activity was increasing, particularly by small local companies. Several local companies having foreign participation were reported to be opening mines. The Monarch Mine, near Francistown, is to produce gold and silver. Copper and silver are to be produced by Thakadu Mining Co. at Matsitama. Reportedly, the Jarcomar Co. is to produce manganese near Kgwakgwe. Total employment for these three mines is estimated at 350.

Total employment in the mining sector was about 13,000. This is about 7% of total formal-sector employment. Agriculture employs 80% of the working population. The largest private-sector employers were DeBeers Botswana Mining Co. (Debswana), 6,000; BCL Ltd. (BCL), 5,000; Morupule Colliery, 322; and Soda Ash Botswana Ltd. (SAB), about 560 when full production is reached. About 1,000 expan-

trates worked in the mining sector in 1989, the latest year data were available. Labor issues continue to surface as union representation increased. Small work stoppages and strikes have occurred and involved mainly salary disputes.

## TRADE

Botswana remains a member of the South African Customs Union, which includes Lesotho, Namibia, the Republic of South Africa, and Swaziland.

A 5.5% decline in exports and 15% increase in imports occurred in 1990. Export activity is based mainly on the mining sector, which declined owing to lower commodity prices. The country also remains dependent upon food imports owing to erratic rainfall. Most food imports are from Zimbabwe.

Total exports in 1990 were \$1.79 billion, and total imports were \$1.6 billion. Diamond exports were \$1.4 billion. Copper and nickel exports in the 10-month period through October 1990 were \$113 million. Copper and nickel exports were down by 40% over those of 1989. Beef exports, the main commodity exported after minerals, were \$52 million in the same period.

## STRUCTURE OF THE MINERAL INDUSTRY

The large diamond and copper-nickel mining operations were primarily privately owned, with minor Government participation. The Botswana Development Corp. provided funding and guidance to small nascent enterprises, including mining enterprises. Its role in this regard was to expand. Mining was concentrated in the southeastern part of the country, along the main railroad and road route.

## COMMODITY REVIEW

### Metals

**Copper-Nickel.**—BCL operated the Selebi Phikwe mining complex. The Government owns 15%, and Botswana RST



TABLE 1  
**BOTSWANA: PRODUCTION OF SELECTED MINERAL  
 COMMODITIES FOR 1990<sup>1</sup>**

(Metric tons unless otherwise specified)

| Commodity  | 1986    | 1987    | 1988    | 1989 <sup>P</sup> | 1990 <sup>P</sup> |
|--|---------|---------|---------|-------------------|-------------------|
| Coal, not further described                            | 499,373 | 579,409 | 612,873 | 663,045           | 800,000           |
| Cobalt: Co content of smelter product <sup>2</sup>     | 163     | 181     | 291     | 207               | 206               |
| <b>Copper:</b>   |         |         |         |                   |                   |
| Mine output, Cu content of ore milled <sup>3</sup>     | 27,499  | 27,888  | 27,303  | 27,353            | 25,000            |
| Cu content of smelter product <sup>3</sup>             | 21,336  | 18,933  | 24,428  | 21,709            | 19,561            |
| <b>Diamond:</b>  |         |         |         |                   |                   |
| Gem and near gem <sup>c</sup> thousand carats          | 9,590   | 9,368   | 10,660  | 10,676            | 12,146            |
| Industrial stones <sup>c</sup> do.                     | 3,500   | 3,840   | 4,569   | 4,576             | 5,206             |
| Total do.  | 13,090  | 13,208  | 15,229  | 15,252            | 17,352            |
| Gem stones, semiprecious, rough <sup>4</sup> kilograms | 4,900   | 40,103  | 38,600  | 146,000           | 140,000           |
| Gold <sup>5</sup> do.                                  | 25      | 31      | 21      | 66                | 50                |
| Lime   | 225     | 325     | 226     | —                 | —                 |
| <b>Nickel:</b>   |         |         |         |                   |                   |
| Mine output, Ni content of ore milled <sup>3</sup>     | 25,558  | 25,920  | 25,971  | 23,684            | 21,500            |
| Smelter product, gross weight                          | 47,930  | 43,238  | 57,530  | 49,754            | 45,000            |
| Ni content of smelter product <sup>2</sup>             | 18,974  | 16,528  | 22,539  | 19,759            | 17,880            |
| Sand and gravel cubic meters                           | 129,181 | 122,203 | 179,936 | 147,300           | 175,000           |
| Stone, crushed, not further described do.              | 177,792 | 225,362 | 337,677 | 458,900           | 475,000           |

<sup>P</sup>Estimated. <sup>P</sup>Preliminary.

<sup>1</sup>Table includes data available through Jan. 21, 1992.

<sup>2</sup>Figures also used for recoverable mine output in world production tables appearing in Volume 1 of the Minerals Yearbook.

<sup>3</sup>Calculated from reported tonnage and head grade of ore milled.

<sup>4</sup>Principally pink carnelians and agates.

<sup>5</sup>Includes minor amounts of silver.

TABLE 2  
**BOTSWANA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990**

(Metric tons unless otherwise specified)

| Commodity                 | Major operating companies   | Location of main facilities       | Annual capacity                  |
|---------------------------|-----------------------------|-----------------------------------|----------------------------------|
| Coal                      | Anglo American Corp.        | Morupule                          | 800,000                          |
| Cobalt                    | BCL Ltd.                    | Selebi Phikwe                     | 300 <sup>e</sup><br>in matte.    |
| Copper                    | do.                         | do.                               | 25,000 <sup>e</sup><br>in matte. |
| Diamond<br>million carats | DeBeers Botswana Mining Co. | Orapa, Letlhakane,<br>and Jwaneng | 17.4                             |
| Nickel                    | BCL Ltd.                    | Selebi Phikwe                     | 23,000 <sup>e</sup><br>in matte. |

<sup>e</sup>Estimated.

Ltd. owns 85%. Botswana RST Ltd. is owned by Amax Corp., Anglo American Corp. (AAC), and public shareholders. BCL's output and sales declined in 1990 owing to weak metal prices, lower grade, and sharp wage and cost increases. For maximum smelter utilization, ore requirements are about 60,000 mt/a, or nearly full capacity. Additional

drilling and ore reserve delineation continued to meet these requirements. Despite an accumulated debt of \$0.7 billion, the operation is unlikely to close owing to the unemployment problem that would result.

Falconbridge Corp., in conjunction with G.S.E. Mining Co. of the Republic of South Africa, planned to develop an open pit cop-

per mine. The mine would develop the Thakadu and Makala deposits in the Matsitama District, west of Francistown. The deposits have about 8 Mmt of ore grading 3.5% copper, with some silver. Falconbridge was also negotiating with another partner to drill and assess the vein-type Bushman deposit, which had a smaller reserve but higher grade.

The Selkirk Mine, east of Francistown, commenced output in January 1989. Output for 1989, the latest available, was 57,159 tons of ore grading 2.4% nickel and 2.0% copper. Tati Nickel Mining Co. was the owner, with AAC holding a majority share. BCL operated the mine. Ore is shipped by truck to Selebi Phikwe for toll smelting, and the resulting matte is sold to Centametail (Pty.) Ltd. of Switzerland.

The Phoenix deposit, near the Selkirk Mine, is being studied for development. Also owned by Tati, it could support an open pit mine producing about 300,000 mt/a of ore grading 2% nickel and 0.8% copper. Startup could occur in 1994.

**Gold.**—Output was by a number of small local companies mining surface deposits in the vicinity of Francistown. The Map Nora Mine, 8 km south of Francistown, closed in early 1991 owing to low gold prices and insufficient reserves. It was put into production by Sashe Mines Ltd. in March 1989. Sashe was owned by Phelps Dodge Corp. of the United States, 85%, and the Government, 15%. One of 14 formerly worked gold occurrences in a 52-km<sup>2</sup> prospect area, reserves at Map Nora were 440,000 tons of sulfide ore grading 8 g/mt. The ore had high arsenic content. Antimony content was about 0.5% to 0.7%. Capacity was 6,600 mt/month. However, only 3,500 mt/month was produced owing to various start up problems. Both mine and roaster capacity were to be increased as additional nearby ore became available. Roaster production was 1,000 mt/month of concentrate, expandable to 1,500 mt/month. Gold recovery was 70% compared with an expected 88.5%. Byproduct production of 1 mt/m of arsenic trioxide, recovered from the baghouse, was stockpiled for sale. Gold bullion was 85% gold and 5% silver. Output was 36.5 kg of gold in 1990 and was sold to the Rand refinery in the Republic of South Africa via the Bank of Botswana. A 5% royalty was paid to the Government. Operating costs were \$370 per ounce, about one-third of which were for wages. Employment at the mine was about 350, and labor turnover was about 20%.

Morex Botswana was reported producing gold at Rainbow, near Matsiloje, in northern Botswana.

The Monarch Mine was reopened by the Mining and Development Co. Ltd., owned by the Republic of South Africa. Production capacity was about 7,000 mt/month for the underground mine. No ore grade was given for the mine.

Falconbridge Gold Corp.'s plan to develop the Signal Hill gold deposit was at an advanced stage. The ore would be heap leached at a rate of 150,000 to 250,000 mt/a. Reserves would last about 5 years.

**Iron and steel.**—A small iron foundry, Reliance Foundry (Pty.) Ltd., operated in Palapye. Domestically generated scrap iron was the company's source of supply. Scrap iron is also exported to the Republic of South Africa by local mining companies with long-term supply commitments.

**Platinum-Group Metals.**—Exploration continued along the Molopo River near the southern border region of Botswana. Grades of 1 g/mt of combined platinum-group metals were found earlier. Although no longer believed to be an extension of the Bushveld Complex in the Republic of South Africa, the area continues to generate exploration interest.

### Industrial Minerals

**Cement.**—Pretoria Portland Cement Co. of the Republic of South Africa may invest in a company to construct and operate a 250,000-mt/a cement plant at Morupule. Cement produced could include up to 25% fly ash from the nearby powerplant.

**Clays.**—A \$12 million project to produce bricks from clay found at Lobatse suffered a setback owing to health-related concerns. Emissions from the kiln and clay dust arising from digging are a concern of the Ministry of Health. The project is a joint venture between the Botswana Development Corp. and Interkiln Corp. of the United States. The Botswana Parliament had approved a special tax concession for the project.

**Diamond.**—Output stabilized as Debswana completed several projects to improve overall efficiency. Sales were expected to be lower owing to reduced demand in industrialized countries, and some production may be stockpiled. A new mine was being opened by Debswana near Serowe. Currently, three mines are operational, the Jwaneng, Letlhakane, and Orapa Mines. Total output from 16.3 Mmt of ore

was 17.341 million carats. Debswana also began training of 100 diamond cutters for its diamond-cutting venture at Serowe.

Agreement was reached between the Government, Debswana, and DeBeers to renew a 5-year contract to market diamonds through the Central Selling Organization. A feasibility study may also be commissioned to expand the Jwaneng Mine's capacity by 33%. Additionally, reserves at the mine were to include the DK-7 kimberlite pipe.

Ampal Ltd., an exploration company, and Corona Corp. of Canada agreed to a joint venture to drill for diamond. About 30 to 50 kimberlites would be drilled on Ampal's lease area in the southern Kalahari. Project cost was \$2 million.

**Soda ash.**—SAB inaugurated soda ash operations at Sua Pan in June 1991, at about 50% of capacity. SAB had 48 wells to pump underground brine into solar ponds. The company's sodium carbonate recovery plant is expected to be operating at 60% of capacity by yearend 1991. Output was slated for shipment to the Republic of South Africa via 34-car bulk trains. Markets have been found for about two-thirds of byproduct salt output. Output should reach 300,000 mt/a of soda ash valued at \$40 to \$45 million and 650,000 mt/a of salt. Total cost of the operation was \$510 million, of which \$370 million was capital costs and \$140 million was for infrastructure. Labor costs are about \$5.35 million per year. SAB applied for a 10% duty on imported soda ash to prevent dumping. Employment by SAB was 500, of whom 12% were expatriates.

**Stone.**—Kgale Quarries (Pvt.) Ltd. completed a \$2.7 million expansion program to increase the supply of aggregate. It was spurred by the building and construction industry, which is experiencing strong growth. The Botswana Development Corp. was a partner in Kgale through its subsidiary Kwena Concrete Products (Pty.) Ltd.

An asphalt plant is operational 25 km west of Gaborone. Plant throughput is from a local quarry. It is owned by Asphalt Botswana (Pty.) Ltd., which is 45% controlled by the Botswana Development Corp. Other shareholders are the Netherlands Development Finance Co., 30%, Volker Steven Ltd. of the Netherlands, 10%, and several local companies.

### Mineral Fuels

Capacity of the Morupule coal mine, the only producer, was about 600,000 mt/a. An

increase in capacity to 800,000 mt/a was being investigated. Output is primarily to the Botswana Power Corp. A new mine near Mmamabula was planned to meet increased energy long-term requirements.

### Reserves

Proven and indicated reserves of coal 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 million carats. Official reserve data were not reported for BCL's copper nickel operation; however, the company continued to replace depleted reserves.

## INFRASTRUCTURE

The Botswana Railways took delivery of 10 diesel locomotives. They are to be used on the new Sua Pan branch line, mainly for SAB's soda ash operations. However, several small deposits may now be economic with the opening of the line.

Several powerplants exist to generate electricity and rely mainly on domestically produced coal. Completion of phase two at the Morupule power station in 1989 brought total generating capacity in Botswana to 201 MW. The Morupule plant has a capacity of 132 MW. The Gaborone power station had a capacity of 9 MW and used fuel oil. The station is being dismantled and its components sold. A power station at Selebi Phikwe is rated at 60 MW. About 15 MW of this capacity is from waste steam heat from BCL. Concessionary rates are extended to BCL to maintain mining operations and increase production. SAB also expected to have a 22-MW generating plant using steam from its boilers for the production of sodium carbonate. About 6% of Botswana's electricity needs are imported from the Republic of South Africa. Electric power is exported to Zimbabwe. A feasibility study was underway to determine the viability of exporting electricity, mainly to the Republic of South Africa, from a large coal-fired plant. Capacity would be about 2,000 MW, and capital requirements were estimated at \$850 per kW.

The Botswana Power Corp. (BPC) reported that 65% of its electricity sales were to the mining industry in 1989-90. Of this, 43% was to BCL, and 22% was to the Orapa and Jwaneng Mines. About 43% of BPC's revenue is from the mining industry.

Water availability is a major issue in Botswana. A proposal to tap water from the

Okavango Delta for use by villages downstream was abandoned. The mining sector uses both mine water and drilled wells for its water needs. A number of studies have been made or are underway to assess supply and demand for water. The Joint Permanent Technical Committee on Water Matters, made up of Botswana and the Republic of South Africa, agreed to a \$700,000 study of the Limpopo and Shashe Rivers.

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## OUTLOOK

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The Government predicted little growth in mineral revenues over the next 5 years owing to a leveling off of diamond produc-

tion and sales. Debswana planned to stabilize diamond output to about 15 million carats per year. However, the high value of diamond should allow that sector to continue dominating the economy. The high number of prospecting licenses bodes well for additional mineral development. Precious metals should continue to receive continuing attention. Industrial minerals, in particular building and dimension stone, as well as aggregate, should have significant growth owing to planned construction and infrastructure expansion. Labor union membership is expected to continue to increase, and the cost of labor may negatively impact some future mine development plans.

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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 P1.8734=US\$1 for 1990 and P2.0125=US\$1 for 1989.

## OTHER SOURCES OF INFORMATION

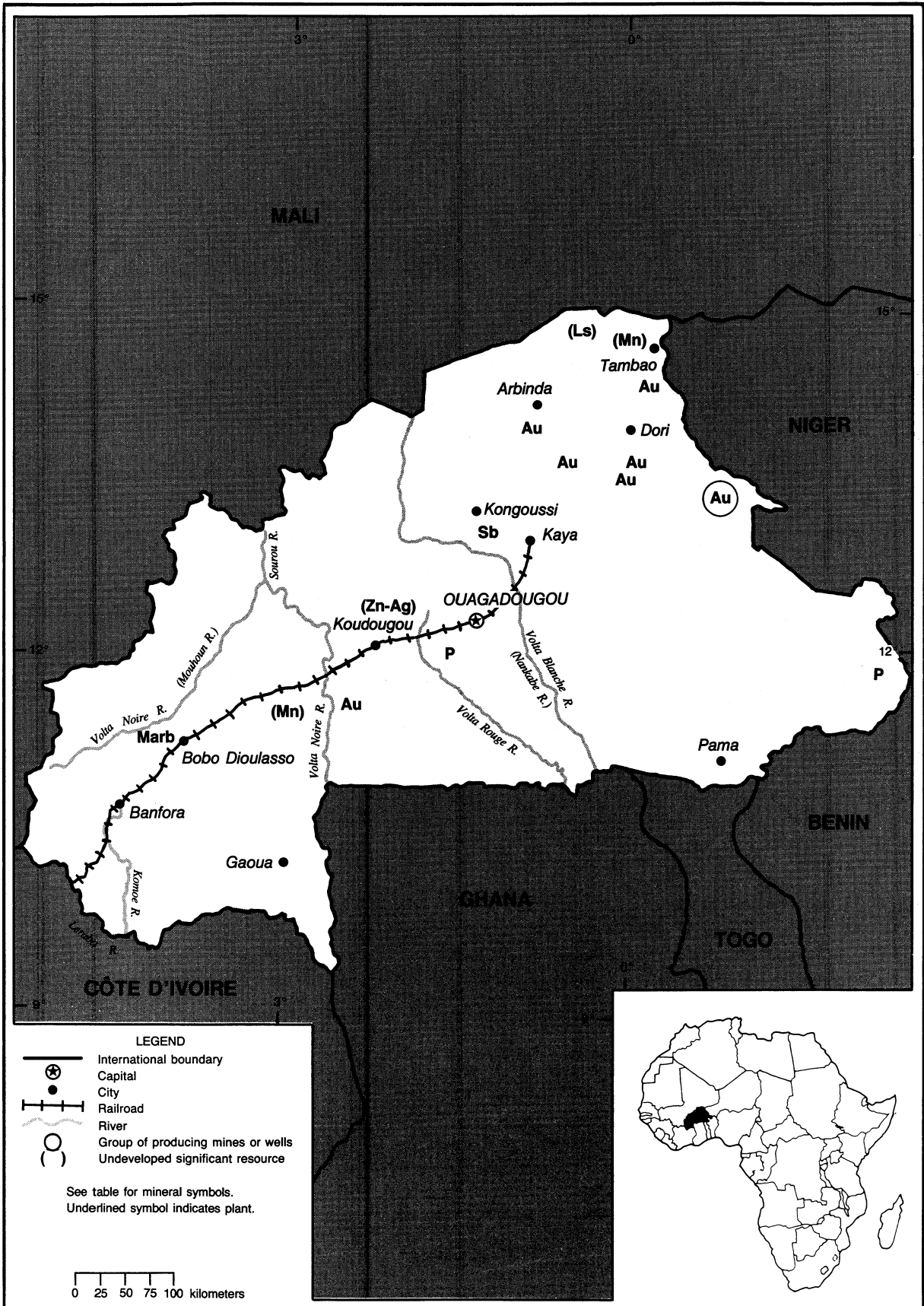
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P.O. Box 0018  
Gaborone, Botswana  
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# BURKINA FASO

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

POPULATION 9.1 million



# THE MINERAL INDUSTRY OF BURKINA FASO

By Hendrik G. van Oss

Official data suggest that mining sector revenues, mostly from gold, were equivalent to about 2% of Burkina Faso's 1990 GDP of about \$1.9 billion.<sup>1</sup> However, most gold production is probably smuggled out of the country. Estimates of this smuggled trade imply that the true mineral component of the GDP was closer to 5%. This further implies that gold was the country's largest export, accounting for about one-third of total exports. Formal gold production is all from the parastatal Poura Mine, southwest of Ouagadougou. Repairs made to the mine in mid-1989 allowed normal output levels during 1990, and production increased 51% to 1,164 kg, accordingly. The Government offered improved prices in 1990 for artisanally mined gold and almost doubled purchases of such to 2,298 kg. Mineral commodity imports in 1990 amounted to an estimated \$100 million, of which about 80% was petroleum products. The bulk of the remaining mineral commodity imports were cement and fertilizers.

Besides gold, the country's most significant mineral resources are the unexploited Perkoa zinc and Tambao manganese deposits. Boliden International Mining of Sweden was undertaking feasibility work on the Perkoa massive sulfide deposit north of Koudougou. Reserves were believed adequate for 10 to 12 years of production, with

TABLE 1  
BURKINA FASO: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>  
(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>                    | 1986   | 1987               | 1988 <sup>3</sup>  | 1989 <sup>3</sup>  | 1990               |
|---|--------|--------------------|--------------------|--------------------|--------------------|
| Gold <sup>e</sup> kilograms               | 1,866  | <sup>3</sup> 7,000 | <sup>3</sup> 9,300 | <sup>3</sup> 7,600 | <sup>3</sup> 7,800 |
| Phosphate rock <sup>e</sup> thousand tons | 3      | 3                  | 3                  | 3                  | 3                  |
| Pumice and related                        |        |                    |                    |                    |                    |
| Volcanic materials <sup>e</sup>           | 10,000 | 10,000             | 10,000             | 10,000             | 10,000             |
| Salt <sup>e</sup>                         | 6,500  | 6,500              | 6,500              | 6,500              | 6,500              |
| Stone: Marble <sup>e</sup> thousand tons  | 100    | 100                | 100                | 100                | 100                |

<sup>e</sup>Estimated. <sup>3</sup>Preliminary.

<sup>1</sup>Includes data available through Dec. 15, 1991.

<sup>2</sup>In addition to the commodities listed, Burkina Faso produced clay, and sand and gravel for local constructional uses. There has been a small, erratic output of antimony from one operation since 1980. Information is inadequate to make reliable estimates of output levels.

<sup>3</sup>Estimate based on reported formal and legal artisanal production, and estimated smuggled artisanal output. Approximately 75% of artisanal production for 1986-89, and 65% for 1990, is believed to be smuggled out of the country. Original data for 1986-89 are for doré or bullion and have been adjusted for this table assuming a gold content of 90%. Data for 1990 were reported as fine gold.

output averaging at least 130,000 mt/a of concentrate grading 55% zinc and 170 g/mt silver. Production is unlikely before 1995, and faced an unresolved problem of ore transport because the nearby Ouagadougou-Abidjan (Côte d'Ivoire) railroad is in poor condition. Development of the Tambao manganese deposit, which has a potential economic resource of about 15 Mmt grading 51% manganese, continued to be hindered by lack of transportation infrastructure. The Government has put aside plans to build a connecting railroad to the deposit.

<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 CFAF272.26=US\$1.00.

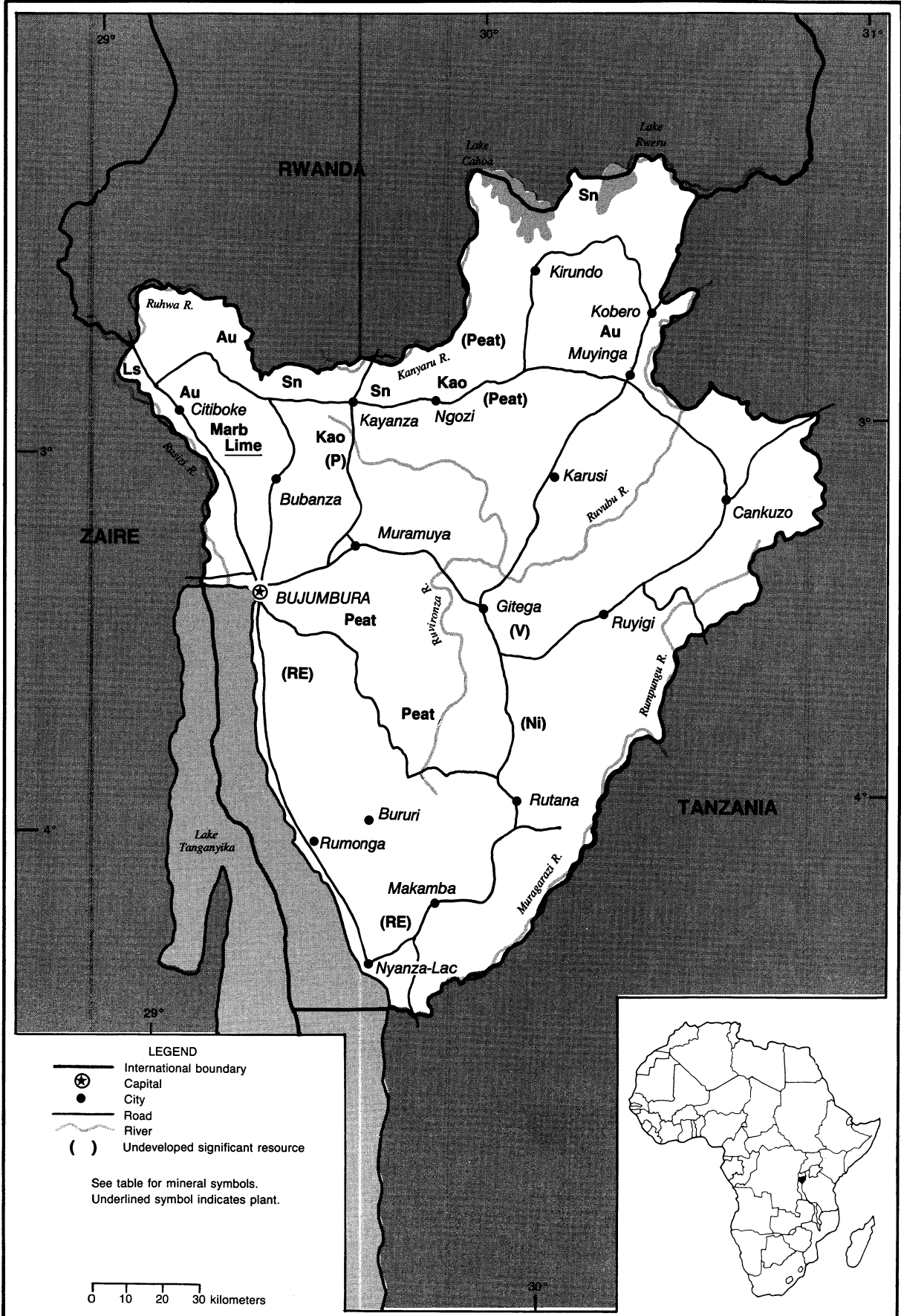
## OTHER SOURCES OF INFORMATION

Bureau des Mines et de la Géologie du  
Burkina (BUMIGEB)  
01 B.P. 601  
Ouagadougou 01  
Burkina Faso

# BURUNDI

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

POPULATION 5.6 million



# THE MINERAL INDUSTRY OF BURUNDI

By Lloyd E. Antonides

Any substantial realization of Burundi's rather significant mineral potential continued to be delayed. Optimism in early 1990 was somewhat dampened toward yearend when the Gulf Crisis resulted in a Middle Eastern investor group suspending further funding of a substantial gold development program. Early in 1991, a replacement for the source of funding was being sought.

Although minerals were of considerable interest in the Maryland-size country for many years, even in the most productive years they contributed less than 1% to the GDP. Mineral production, starting in the 1920's, has included gold, tin, tungsten, rare earths, columbium-tantalum, and peat, as well as various construction materials. During the past 20 years, nickel, vanadium, and phosphate deposits, in many cases with associated precious and other valuable minerals, attracted some attention, as did oil and gas possibilities. However, lack of infrastructure, especially reasonable-cost transportation, was cited as a major obstacle to development. On the other hand, availability of water and hydroelectric power were favorable factors, and the latter had potential for major expansion.

In 1990, GDP was estimated at about \$1.1 billion<sup>1</sup>. Agriculture provided 60% of GDP and 95% of export earnings. It was predominately subsistence farming and, for export, cultivation of primarily coffee and increasingly some tea and cotton. Per capita income was one of the world's lowest. After a jump to 11% in 1989, 1990's regionally low 4% consumer price inflation was a return to its previous downtrend. Trade and Government deficits were persistent although a Structural Adjustment Program started in 1986 with World Bank and International Monetary Fund guidance was showing some promise of improvement. But international agencies generally believed the economy would continue to need an infusion of foreign aid for some time to come, especially to provide for development capital demands.

The dense population continued its high growth rate of about 3%. About 90% of the predominately Christian, French-speaking

people lived on scattered farmsteads. In 1990, major strides were made on a program of national reconciliation since 1988's bloody, violent eruption of centuries old ethnic conflict between the two principal tribes. By early 1991, a more balanced distribution of cabinet ministers appeared to have calmed tensions appreciably. Cabinet changes also included a different post for the former Minister of Energy and Mines and a new appointee as the replacement.

Burundi's Investment Code provided tax and other benefits for domestic and foreign private investors. Additional privileges were available if the venture had priority status as being important to the economic development of the country. This was particularly so for ventures involving import substitution and/or increased exports. The 1976 Mining and Petroleum Code was also designed to be attractive to investors. An Overseas Private Investment Corp. (OPIC) insurance program agreement with the United States was in effect for some time.

During 1990, investment in cement, nickel, phosphate and other mineral projects continued to be promoted by the Ministry of Energy and Mines. It also encouraged and advised small-scale domestic mining activities. A final feasibility study on a phosphate project was commissioned, and a search began for funding a project on nickel.

The Director General of Geology and Mines was expected to attend a forum in

the United States in April 1991 funded by the U.S. Trade and Development Program (TDP). The forum for several Francophone countries was aimed at promoting U.S. trade and investment in mining by acquainting the country representatives with U.S. sources of goods, services, and investment and, conversely, U.S. companies with available markets. The Burundi Government planned a forum on opportunities for investment in mineral ventures in November 1991 in Bujumbura.

Reported mineral production for 1990 showed an appreciable drop in total value compared with that of 1989, mostly owing to decreases in the quantity of gold and in the price of tin.

The mineral export value, principally of gold and tin, mostly to Europe, continued to be small in 1990 compared with the value of mineral imports. Petroleum products, cement, steel, and fertilizer were again the major mineral-related imports.

The Government was a principal participant in most mineral activities for many years. At least one-half dozen donor countries and agencies, especially the UN Development Program, also were involved at various times during the past 20 years. In the past decade, several large international firms investigated some of the nickel, phosphate, and vanadium deposits as well as the oil-gas possibilities, but none took a substantial investment position. Mineral exploitation was limited mostly to efforts of individuals or small groups of artisans,

TABLE 1

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

(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>                   | 1986   | 1987   | 1988   | 1989 <sup>a</sup> | 1990 <sup>a</sup> |
|--|--------|--------|--------|-------------------|-------------------|
| Clays: Kaolin                            | 5,113  | 5,290  | 4,021  | 4,305             | 5,281             |
| Gold kilograms                           | 31     | 26     | 14     | 18                | 9                 |
| Lime                                     | 160    | 137    | 96     | 202               | 188               |
| Peat                                     | 12,455 | 17,000 | 17,589 | 14,200            | 11,984            |
| Tin, mine output (60% SnO <sub>2</sub> ) | —      | 5      | 50     | 106               | <sup>c</sup> 150  |

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

<sup>1</sup>Includes data available through July 1, 1991.

<sup>2</sup>In addition to commodities listed, crushed stone and presumably other crude construction materials (clays, sand and gravel, et al.) are produced, but information is inadequate for making reliable estimates of output levels.



often part-time when not farming, who sold their product to export traders.

The Government was directly involved in peat operations through a National Peat Office (Onatour) reportedly established in the late 1970's.

Amoco Burundi Petroleum Corp., identified as a subsidiary of Amoco International Oil Co., held an oil concession acquired in 1985.

Burundi Mining Corp. (Buminco), formed in March 1989, was owned 25% by the Government and 75% by Mannai Investment Corp. headquartered in Qatar. The initial paid-in share capital was reportedly \$2 million. It initiated gold exploration in the northeast and assisted the Government in other minerals-related activities. Further financing by Mannai was suspended due to the Gulf Crisis, and a search for other partners and/or international lending agency funding was started in early 1991.

Gold lodes in quartzites at a number of sites near Muyinga, 120 km northeast of Burumjura, were evaluated by Buminco since starting work in 1989. The Masaka prospect was found most promising, with several veins and stockworks showing in excavations to 20 m. Drilling was planned for 1991 as well as the purchase of a pilot processing plant. Loss of Middle Eastern financing was expected to disrupt plans while alternative funds were sought.

Alluvial gold deposits in the northwest were studied under a 2-year German aid program that was reported near completion at yearend.

Nickel laterite deposits near Musongati, about 90 km southeast of Bujumbura, were considered sufficiently promising to be the subject of a final feasibility study. Early in 1991, the Burundi Government was actively searching for financing of the estimated \$4.4 million, for 18 to 24 months of investigation. Discussions with several international agencies were expected. The deposits were of considerable interest since discovery under a UN program in the early 1970's. In June 1990, a report concluded that parameters for a \$490 million project producing 30,000 mt/a of nickel were attractive enough to recommend further work. The report prepared by Buminco, with assistance from Lonrho PLC, was based on a review of past work by UN agencies, the U.S.'s Ralph M. Parsons Co. engineers, and others. It also considered the market outlook, planned Government transportation and power projects, and Government laws and policies.

Tin ore, or cassiterite, production by private parties on an artisanal level was reported

in 1990 to have started again in 1987 after a lapse of 8 years. The location was in the north-central area near the border with Rwanda. Concentrates were said to be going to export traders in Bujumbura.

Cement production was the subject of a preliminary feasibility study completed during 1990 by the Austrian agency Austroplan. It concluded a more detailed effort was appropriate. A Chinese agency began a final feasibility study that was to be completed in 1991. But early in 1991, information indicated their interest had waned, and the Burundi Government was negotiating with a German firm to continue.

The Austrian investigation found that calcareous concretions in the Rusizi Valley, 50 to 80 km north of Bujumbura, were suitable for a viable project. The carbonatite underlying the Matongo phosphate deposit in the north-central region was long considered attractive for cementmaking, but the study claimed 50 to 100 m of overburden made it uneconomic for the time. The evaluation settled on a plant at Citiboke near the middle of the deposits. It would produce 60,000 mt/a of clinker, further processing about 40,000 tons into finished cement and selling 20,000 tons locally. Apparently, the latter would be used in an existing cementmaking facility near Bujumbura that was reportedly installed about 1958 and idle since 1962. Burundi imported more than 50,000 mt/a of cement for the past several years, and consumption was projected at more than 70,000 tons by 1995.

Phosphate production from the Matongo apatite-carbonatite deposit, 75 km north of Bujumbura, was the subject of a final feasibility study competitively awarded to London-headquartered Mackay & Schnellmann Ltd. Norsk Hydro was also participating in the study. Foreign exchange costs, budgeted at about \$900,000, were funded by an African Development Bank grant. The market portion of the study was reported nearly completed early in 1991 and to be indicating good economics for a simple operation producing single superphosphate to satisfy regional agricultural demand. The deposit was the subject of a number of investigations since discovery by aerial geophysics during a UN program in 1971. It was on a paved road, convenient to water and electric power.

Peat production capacity was about 30,000 mt/a from mechanized operations using Irish equipment. But the National Peat Office was able to market less than one-half. A Canadian agency was working on a scheme to produce a cleaner burning carbonized product that could increase use in home and industry.

Petroleum exploration by Amoco continued on a limited basis across the border in Zaire but remained suspended in Burundi since 1988. The Rusizi Valley and north end of Lake Tanganyika was the area of interest.

The size of Burundi's known mineral resources was generally considered not of world importance. But if exploitation were shown to be feasible, the mineral resources could give a significant boost to the country's economy.

Transportation within Burundi was totally dependent on an extensive network of roads. However, even some of the main routes were unpaved, and maintenance requirements were increasing throughout the system. For years a steady program of upgrading was aided by many grants and loans from international and donor country agencies. In 1990, the World Bank announced further funding of maintenance and improvement projects, and other foreign aid was expected to continue for some time.

The hydroelectric power distribution system was also to receive similar funding.

If the pace of activity witnessed by the industry in 1990 can be continued or improved, mineral production can be expected to increase. A slight rise could come in the shorter term from smaller simple operations by local businessmen. More sophisticated operations with foreign funding and management will probably be required to achieve significant increases, and such ventures would take a few years to reach production. Lack of trained personnel in the minerals field and the long transportation routes will continue to be a restriction on growth.

<sup>1</sup>Where necessary, values have been converted from Burundi francs (BF) to U.S. dollars at the rate of BF171.26=US\$1 in 1990, BF158.67=US\$1.00 in 1989, and BF140.40=US\$1.00 in 1988.

## OTHER SOURCES OF INFORMATION

### Agencies

Department of Geology and Mines  
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### Publication

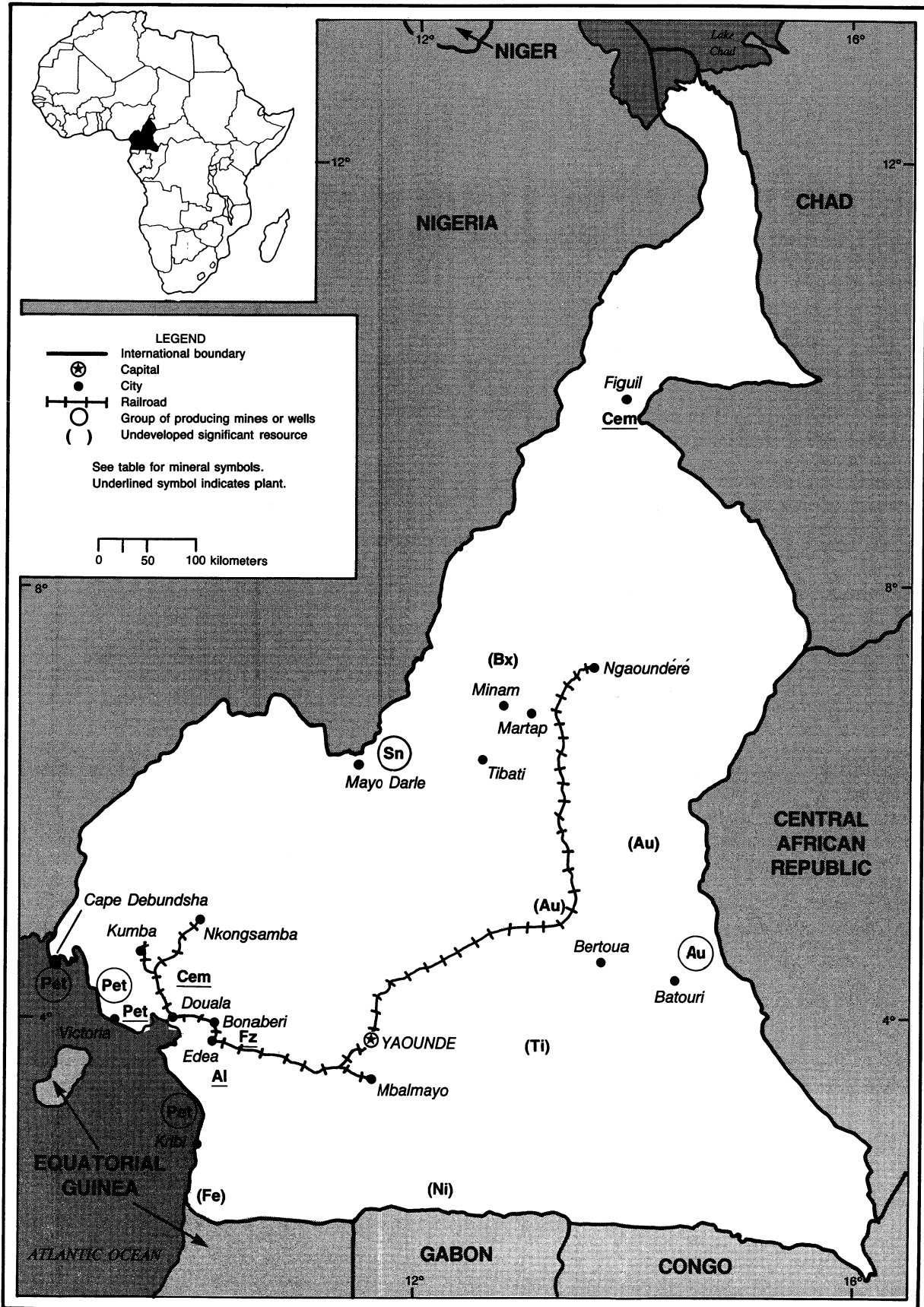
Atlas du Burundi, Universite de Bordeaux, 1979, 96 pp.



# CAMEROON

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

POPULATION 11 million



# THE MINERAL INDUSTRY OF CAMEROON

By Thomas P. Dolley

In 1990, petroleum production remained the leading generator of Government revenue in Cameroon. Additionally, oil remained the chief export commodity of Cameroon. Despite declining production from existing fields, additional revenue from oil in late 1990 aided the Government's balance of payments. This additional revenue was due to Iraq's invasion of Kuwait and the concomitant market increase in oil prices. Cameroon's export revenue in 1990 for petroleum and petroleum products was estimated at \$1.2 billion.<sup>1</sup> However, Cameroon's external debt was predicted to exceed \$6 billion in 1991 or about 50% of the GDP.

## GOVERNMENT POLICIES AND PROGRAMS

The year 1990 was highlighted by changes in the hydrocarbons code. 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.

In May 1990, the decree regulating oil companies was altered by the Government's Ministry of Mines and Energy. The changes in the law were to allow foreign petroleum exploration companies greater operational freedom, thus stimulating increased investment in Cameroon's oil exploration sector. Formerly, the law provided for production-sharing guidelines of 30% of output to the foreign operator and 70% of output to Cameroon's Société Nationale des Hydrocarbures (SNH). Additionally, the Government took 87% of net profits in the form of fees and taxes. However, the new agreements stipulate that reimbursable exploration and production costs rise from 20% to 30%. Guaranteed aftertax mining allowances also rise from 22% to 33%. Crude petroleum reserved for the SNH has also been reduced to 60%.

## PRODUCTION

The primary mineral commodities produced in Cameroon were crude petroleum, aluminum metal, and tin ore and concentrate. All registered production increases with the exception of tin. Cameroon's production of tin is not significant on a global scale. This scenario is due to the world market price for tin being historically low, coupled with a market oversupply.

## TRADE

Cameroon's trading sector has maintained a positive balance in the past several years. However, the nation's balance of payments runs a considerable deficit. Total export revenues for Cameroon in 1990 were estimated at \$2.1 billion; of which petroleum products accounted for 56%.

The United States remained Cameroon's leading trading partner. The leading import commodity for the United States from Cameroon is crude petroleum. There was a marked decline in U.S. imports from Cameroon between 1989 and 1990. The value of U.S. imports declined from approximately \$415 million in 1989 to about \$158 million in 1990. Of this total, the value of crude pe-

troleum imports decreased from \$349 million in 1989 to \$90 million in 1990.

## STRUCTURE OF THE MINERAL INDUSTRY

Although the Government is actively involved in the mining sector, its equity in a mineral project generally does not exceed 33%. Foreign operators in Cameroon's mineral industry are usually involved in joint ventures with the Government. The Government's dominant parastatal in the mineral industry is Société Nationale d'Investissement (SNI).

SNH was the state-owned company involved in hydrocarbon exploitation. Compagnie Camerounaise de l'Aluminium (Alucam) and the Société Nationale Raffinage (Sonara) are the state-owned companies that manage the aluminum smelter and oil refining facilities, respectively.

## COMMODITY REVIEW

### Metals

**Aluminum.**—Exceeding its design production capacity of 85 kmt/a for the past 2

TABLE 1

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

| Commodity <sup>2</sup>                                    |             | 1986                | 1987    | 1988             | 1989 <sup>a</sup>   | 1990 <sup>a</sup>   |
|---|-------------|---------------------|---------|------------------|---------------------|---------------------|
| Aluminum metal, primary                                   | metric tons | 83,810              | 79,008  | 86,513           | 91,716              | <sup>3</sup> 93,284 |
| Cement, hydraulic   | do.         | 783,368             | 718,869 | 584,523          | 580,000             | 580,000             |
| Gold, mine output, Au content                             | kilograms   | 8                   | 8       | 8                | 8                   | 8                   |
| Petroleum, crude <sup>c</sup> —thousand 42-gallon barrels |             | 53,000              | 63,500  | 62,780           | <sup>3</sup> 58,648 | <sup>3</sup> 64,605 |
| Pozzolana   | metric tons | 168,425             | 128,574 | 130,490          | 130,000             | 130,000             |
| Stone:  |             |                     |         |                  |                     |                     |
| Limestone   | do.         | 78,260              | 42,443  | 57,369           | 57,000              | 57,000              |
| Marble  | do.         | 331                 | 209     | <sup>a</sup> 200 | 200                 | 200                 |
| Tin ore and concentrate:                                  |             |                     |         |                  |                     |                     |
| Gross weight  | kilograms   | <sup>a</sup> 13,000 | 7,685   | 4,894            | 4,800               | <sup>3</sup> 4,300  |
| Sn content <sup>c</sup>                                   | do.         | 9,300               | 5,533   | 3,400            | 3,400               | 3,050               |

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

<sup>1</sup>Includes data available through Dec. 1991.

<sup>2</sup>In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (clays, stone, and sand and gravel) 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: EXPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity   | 1989              | Destinations, 1989 |  |
|---|-------------------|--------------------|--|
|   |                   | United States      | Other (principal)  |
| <b>METALS</b>   |                   |                    |  |
| Aluminum: Metal including alloys:                           |                   |                    |  |
| Scrap   | 2,041             | —                  | France 1,814; Ghana 215.   |
| Unwrought   | 67,263            | —                  | France 39,823; Belgium-Luxembourg 27,440.                          |
| Semimanufactures  | 7,239             | 122                | Gabon 2,331; Cote d'Ivoire 1,724; Central African Republic 1,236.  |
| Copper: Metal including alloys:                             |                   |                    |  |
| Scrap   | 328               | —                  | Belgium-Luxembourg 209; Netherlands 99.                            |
| Unwrought   | 13                | —                  | Netherlands 9; Belgium-Luxembourg 4.                               |
| Semimanufactures  | value, thousands  | \$4                | France \$3; Equatorial Guinea \$1.                                 |
| Iron and steel: Metal:                                      |                   |                    |  |
| Scrap   | 10,278            | —                  | West Germany 8,202; France 2,036.                                  |
| Semimanufactures:   |                   |                    |  |
| Bars, rods, angles, shapes, sections                        | value, thousands  | \$254              | Central African Republic \$161; Equatorial Guinea \$42; Chad \$26. |
| Universals, plates, sheets                                  | do.               | \$6                | Chad \$4; Equatorial Guinea \$2.                                   |
| Rails and accessories                                       |                   | 72                 | Senegal 66; Chad 3.  |
| Wire  |                   | 1                  | Mainly to Equatorial Guinea.                                       |
| Tubes, pipes, fittings                                      | value, thousands  | \$641              | Congo \$237; Equatorial Guinea \$152; Gabon \$104.                 |
| Lead: Metal including alloys, unwrought                     |                   | 80                 | All to Greece.   |
| Molybdenum: Ore and concentrate                             |                   | 10                 | All to France.   |
| Nickel: Matte and speiss                                    | value, thousands  | \$1                | All to Zaire.  |
| Zinc: Metal including alloys:                               |                   |                    |  |
| Unwrought   |                   | 50                 | Nigeria 30; Belgium-Luxembourg 20.                                 |
| Semimanufactures  | value, thousands  | \$1                | All to Equatorial Guinea.  |
| <b>INDUSTRIAL MINERALS</b>                                  |                   |                    |  |
| Abrasives, n.e.s.: Grinding and polishing wheels and stones |                   |                    |  |
|   |                   | 7                  | Netherlands 5; France 2.   |
| Barite and witherite  |                   | 3                  | All to Benin.  |
| Cement  |                   | 335,838            | Equatorial Guinea 284,905; Central African Republic 49,030.        |
| Clays, crude  |                   | 183                | Nigeria 90; Chad 54; Gabon 38.                                     |
| Fertilizer materials: Manufactured, nitrogenous             |                   | 3                  | All to Equatorial Guinea.  |
| Gypsum and plaster  |                   | 2                  | Do.  |
| Lime  |                   | 16                 | Nigeria 12; Chad 4.  |
| Salt and brine  |                   | 591                | Chad 299; Equatorial Guinea 236; Nigeria 56.                       |
| Stone, sand and gravel: Gravel and crushed rock             |                   | 19                 | NA West Germany 3; unspecified 16.                                 |
| <b>MINERAL FUELS AND RELATED MATERIALS</b>                  |                   |                    |  |
| Petroleum refinery products:                                |                   |                    |  |
| Liquefied petroleum gas                                     | 42-gallon barrels | 116                | All to Nigeria.  |
| Gasoline  | do.               | 1,853              | Chad 1,743; Central African Republic 110.                          |
| Mineral jelly and wax                                       | do.               | 441                | Nigeria 386; Chad 55.  |
| Kerosene and jet fuel                                       | do.               | 202                | Nigeria 155; Chad 47.  |
| Lubricants  | do.               | 6,244              | Central African Republic 4,165; Gabon 987.                         |
| Bituminous mixtures   | do.               | 91                 | All to Chad.   |

NA Not available.

<sup>1</sup>Comparable data are not available for 1988. Table prepared by Virginia A. Woodson.

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

(Metric tons unless otherwise specified)

| Commodity  | 1989             | Sources, 1989 |   |
|--|------------------|---------------|---|
|  |                  | United States | Other (principal)                               |
| <b>METALS</b>  |                  |               |   |
| <b>Aluminum:</b>   |                  |               |   |
| Ore and concentrate  | 164,675          | —             | Guinea 164,669.                                 |
| Oxides and hydroxides  | 195              | —             | All from France.                                |
| <b>Metal including alloys:</b>   |                  |               |   |
| Scrap  | 29               | —             | Central African Republic 15; Gabon 9; Congo 5.  |
| Unwrought  | 19               | —             | All from Belgium-Luxembourg.                    |
| Semimanufactures   | 731              | (?)           | France 393; Netherlands 144; West Germany 70.   |
| Chromium: Oxides and hydroxides  | 5                | —             | Netherlands 3; France 2.                        |
| Cobalt: Oxides and hydroxides  | value, thousands | \$4           | —   |
|  |                  |               | France \$2; West Germany \$2.                   |
| <b>Copper:</b>   |                  |               |   |
| Matte and speiss including cement copper                                     | do.              | \$3           | —   |
|  |                  |               | All from France.                                |
| <b>Metal including alloys:</b>   |                  |               |   |
| Unwrought  | 1                | —             | Mainly from West Germany.                       |
| Semimanufactures   | 266              | (?)           | France 158; West Germany 55; Italy 20.          |
| <b>Iron and steel: Metal:</b>  |                  |               |   |
| Scrap  | value, thousands | \$2           | NA  |
|  |                  |               | NA.   |
| Pig iron, cast iron, related materials                                       | 544              | —             | France 533.                                     |
| Ferrous alloys: Unspecified  | 86               | —             | France 85.                                      |
| Steel, primary forms   | value, thousands | \$9,514       | —   |
|  |                  |               | Brazil \$5,161; Zimbabwe \$2,831; France \$559. |
| <b>Semimanufactures:</b>   |                  |               |   |
| Bars, rods, angles, shapes, sections   | 16,700           | —             | France 8,684; West Germany 2,634; Spain 1,399.  |
| Universals, plates, sheets   | 12,010           | —             | France 5,067; Japan 1,738; Netherlands 1,628.   |
| Hoop and strip   | 1,477            | —             | Netherlands 620; France 208; West Germany 192.  |
| Rails and accessories  | 84               | —             | Netherlands 47; France 37.                      |
| Wire   | 3,582            | 5             | Zimbabwe 1,606; France 835; Poland 340.         |
| Tubes, pipes, fittings   | 5,174            | 24            | France 2,360; Brazil 914; Spain 786.            |
| <b>Lead:</b>   |                  |               |   |
| Ore and concentrate  | 24               | —             | Mainly from Belgium-Luxembourg.                 |
| Oxides   | 231              | —             | France 115; Netherlands 56; Angola 15.          |
| <b>Metal including alloys:</b>   |                  |               |   |
| Unwrought  | 9                | 9             |   |
| Semimanufactures   | 45               | —             | Netherlands 40; France 5.                       |
| Magnesium: Metal including alloys, unwrought                                 | 184              | 83            | France 61; Norway 41.                           |
| <b>Manganese:</b>  |                  |               |   |
| Ore and concentrate, metallurgical-grade                                     | 2,360            | —             | All from Gabon.                                 |
| Oxides   | value, thousands | \$2           | NA  |
|  |                  |               | NA.   |
| Nickel: Metal including alloys, semimanufactures                             | do.              | \$74          | \$34  |
|  |                  |               | France \$31.                                    |
| Platinum-group metals: Metals including alloys, unwrought and partly wrought | do.              | \$3           | —   |
|  |                  |               | All from Netherlands.                           |
| Silver: Metal including alloys, unwrought and partly wrought                 | do.              | \$17          | —   |
|  |                  |               | France \$12; Canada \$5.                        |
| Tin: Metal including alloys, semimanufactures                                | do.              | \$40          | \$1   |
|  |                  |               | France \$35; Netherlands \$2.                   |
| Titanium: Oxides   | 55               | —             | France 45; Czechoslovakia 4.                    |
| <b>Tungsten: Metal including alloys, unwrought</b>                           |                  |               |   |
|  | value, thousands | \$1           | —   |
|  |                  |               | All from France.                                |
| <b>Zinc:</b>   |                  |               |   |
| Oxides   | 22               | —             | France 19; Netherlands 3.                       |

See footnotes at end of table.

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

(Metric tons unless otherwise specified)

| Commodity  | 1989             | Sources, 1989    |   |
|--|------------------|------------------|---|
|  |                  | United States    | Other (principal)                                   |
| <b>METALS—Continued</b>                                  |                  |                  |   |
| Zinc:—Continued  |                  |                  |   |
| Metal including alloys:                                  |                  |                  |   |
| Unwrought  | 50               | —                | Mainly from France.                                 |
| Semimanufactures   | 52               | —                | France 33; West Germany 10.                         |
| Other: Oxides and hydroxides                             | 1                | —                | Mainly from Norway.                                 |
| <b>INDUSTRIAL MINERALS</b>                               |                  |                  |   |
| Abrasives, n.e.s.:                                       |                  |                  |   |
| Natural: Corundum, emery, pumice, etc.                   | 13               | —                | All from Greece.                                    |
| Artificial: Corundum                                     | 3                | —                | All from Italy.                                     |
| Grinding and polishing wheels and stones                 | 67               | ( <sup>2</sup> ) | France 47; Netherlands 9.                           |
| Barite and witherite                                     | 100              | —                | All from France.                                    |
| Boron materials: Oxides and acids                        | 1                | —                | Do.   |
| Bromine <sup>3</sup>                                     | 1                | —                | Mainly from Canada.                                 |
| Cement   | 467,348          | —                | Cyprus 244,552; Tunisia 161,837; Greece 34,811.     |
| Chalk  | 2,175            | —                | France 1,849; Nigeria 324.                          |
| Diatomite and other infusorial earth                     | 1,788            | 218              | France 1,508; Netherlands 43.                       |
| Fertilizer materials: Manufactured:                      |                  |                  |   |
| Ammonia  | 182              | —                | Belgium-Luxembourg 86; France 81; Netherlands 16.   |
| Nitrogenous  | 41,662           | —                | France 23,074; Norway 6,730; Nigeria 6,500.         |
| Phosphatic   | 1,151            | 180              | Belgium-Luxembourg 400; France 238.                 |
| Potassic   | 32,702           | 1,000            | France 17,354; Norway 5,000; Spain 5,000.           |
| Graphite, natural  | 1                | —                | All from Austria.                                   |
| Gypsum and plaster                                       | 33,170           | —                | Morocco 20,020; Cyprus 12,012.                      |
| Lime   | 1,967            | —                | France 1,229; Belgium-Luxembourg 545.               |
| Magnesium compounds: Magnesite, crude                    | 14               | —                | All from Belgium-Luxembourg.                        |
| Mica:  |                  |                  |   |
| Crude including splittings and waste                     | 18               | —                | Mainly from France.                                 |
| Worked including agglomerated splittings                 | value, thousands | \$4              | \$3 India \$1.                                      |
| Phosphates, crude  | 175              | —                | Morocco 100; Belgium-Luxembourg 60; France 15.      |
| Pigments, mineral: Iron oxides and hydroxides, processed | 45               | —                | Netherlands 30; West Germany 6; Italy 5.            |
| Potassium salts, crude                                   | 824              | —                | East Germany 524; France 300.                       |
| Salt and brine   | 38,833           | —                | Tunisia 26,000; Egypt 12,793.                       |
| Stone, sand and gravel:                                  |                  |                  |   |
| Dimension stone: Worked                                  | value, thousands | \$2,914          | West Germany \$2,435; France \$234.                 |
| Dolomite, chiefly refractory-grade                       | 3,774            | —                | France 3,405; Belgium-Luxembourg 369.               |
| Gravel and crushed rock                                  | 213              | —                | France 108; West Germany 79; Togo 23.               |
| Quartz and quartzite                                     | 10               | —                | All from France.                                    |
| Sand other than metal-bearing                            | 156              | 18               | France 131.   |
| Sulfur:  |                  |                  |   |
| Elemental:   |                  |                  |   |
| Crude including native and byproduct                     | value, thousands | \$1              | All from Canada.                                    |
| Colloidal, precipitated, sublimed                        | 8                | —                | Netherlands 5; France 3.                            |
| Sulfuric acid  | 358              | —                | France 166; Belgium-Luxembourg 124; Netherlands 46. |
| Other: Crude   | 4                | —                | Mainly from France.                                 |

See footnotes at end of table.

TABLE 3—Continued

CAMEROON: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity                                  | 1989 | Sources, 1989 |                                    |
|--|------|---------------|------------------------------------|
|  |      | United States | Other (principal)                  |
| <b>MINERAL FUELS AND RELATED MATERIALS</b> |      |               |                                    |
| Asphalt and bitumen, natural               | 27   | —             | France 24; Belgium-Luxembourg 2.   |
| Carbon black                               | 360  | —             | France 269; Portugal 70; China 10. |
| Coal: Anthracite                           | 17   | —             | Spain 9; France 8.                 |
| Coke and semicoke                          | 42   | —             | All from Netherlands.              |
| Peat including briquets and litter         | 4    | —             | All from France.                   |

NA Not available.

<sup>1</sup>Comparable data are not available for 1988. Table prepared by Virginia A. Woodson.<sup>2</sup>Less than 1/2 unit.<sup>3</sup>May include fluorine and iodine.

TABLE 4

## CAMEROON: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

(Thousand metric tons unless otherwise specified)

| Commodity                          | Major operating companies                     | Location of main facilities                            | Annual capacity                                  |
|------------------------------------|---|--|--|
| Aluminum                           | Société Camerounaise de de l'Aluminium        | Edea, south of Douala                                  | 85.  |
| Cement                             | Société des Cimenteries du Cameroun           | Bonaberi and Figuil                                    | 900.<br>100.                                     |
| Fertilizer                         | Société Camerounaise des Engrais              | Bonaberi   | 58 ammonium,<br>36 sulfate,<br>66 sulfuric acid. |
| Gold                               | Artisanal workings                            | Batouri  | NA.  |
| Petroleum, crude million barrels   | Société Nationale de Hydrocarbures            | Rio Del Rey Oilfields (offshore and North of Victoria) | 63.  |
| Petroleum, refined million barrels | Société Nationale Raffinage and Hydrocarbures | Limbe  | 15.  |
| Tin                                | Artisanal workings                            | Mayo Darle   | NA.  |

NA Not available.

years, the aluminum smelter at Edea benefited from increased world demand. Managed by Alucam, the smelter's capacity is expected to double in the mid-1990's. Alucam's equity ownership is by Pechiney of France (58%) and the Government (42%).

Feedstock for the smelter is alumina supplied from Guinea. The operation utilizes hydroelectric power of 263-MW capacity generated from the Sanaga River. The Fongo-Bongo bauxite deposits in north-western Cameroon had attracted interest during the year from Société des Bauxites du Cameroun (Sebacam). Sebacam hoped to commence mining the bauxite in the mid-1990's at a rate of 1 to 2 Mmt/a.

**Titanium.**—The parastatal Société d'Etudes de Rutile d'Akonolinga (Serak) was

created by the Government in 1988. Serak's mission was to determine the feasibility of mining rutile in the Akonolinga region 140 km east of Yaounde. The study determined a resource potential of 300 kmt of rutile in the region. The Government was hoping to attract foreign mining investment in the exploitation of this deposit. The current dirt road from Yaounde to Akonolinga is to be improved by the funding of \$80 million by the EC. For the past 40 years the mining of rutile in the area has been artisanal. No production data have been available.

#### Mineral Fuels

As a result of the revision of the hydrocarbons code, France's Société Nationale Elf Aquitaine (Elf) and Pecten International

signed oil and gas exploration agreements on May 23, 1990. Pecten is a subsidiary of Shell Petroleum of the United States and is Cameroon's largest oil producer. Additionally, Pecten currently operates the offshore Mokoko-Abana Oilfield and is a shareholder in Elf's offshore oilfield production. The agreements cover a wide offshore area from the maritime border with Equatorial Guinea to the mainland near Cape Debundsha.

By yearend 1990, two French natural gas firms were awarded exploration and feasibility contracts with the Government. Sofregaz, a subsidiary of Gaz de France, and Beicip of the French Petrol Institute will study Cameroon's gas reserves over an 18-month period. The study will be entirely financed by grants.



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## RESERVES

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Bauxite reserves at Minim-Martap had been estimated at 1 billion tons by France's Bureau de Recherches Géologiques et Minières (BRGM) and Sebacam. Gold-bearing pyrite deposits exist in the Mborguene area of eastern Cameroon. Minerals endemic to Cameroon include diamond, iron ore, lead, lignite, manganese, sapphire, uranium, and zinc. Although a variety of minerals occurs in Cameroon, with the exception of tin and limestone, few have been commercially exploited. Incomplete exploration and a lack of infrastructure development continue to hinder mineral development in Cameroon.

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## INFRASTRUCTURE

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Total installed electrical generation capacity is approximately 801 MW. The

electrical distribution network is 6,491 km. Railroads total 1,003 km of track, 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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Government authorities conceded that without additional commercial hydrocarbon discoveries, Cameroon's petroleum reserves could be exhausted by the end of the century. With the recent code revision and incentives offered by the Government, oil exploration has returned to Cameroon. However, poor infrastructure and marginal ore grades may continue to hamper development of known mineral deposits.

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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 CFAF272.26=US\$1.00.

## OTHER SOURCES OF INFORMATION

### Agencies

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

### Publication

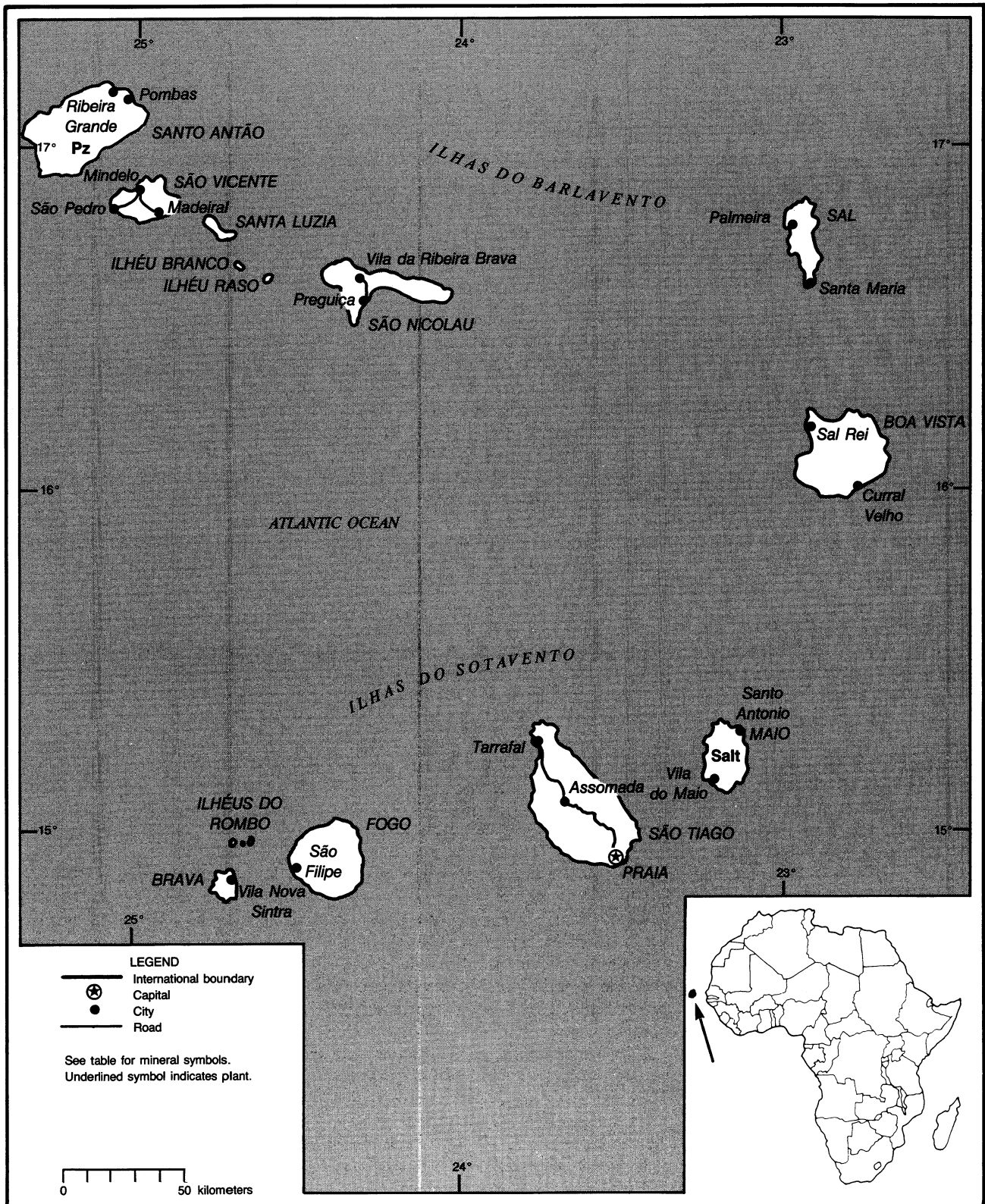
Ministry De L'Economie Et Du Plan,  
Yaounde:  
Bulletin Mensuel De Statistique.



# CAPE VERDE

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

POPULATION 375,000



# THE MINERAL INDUSTRY OF CAPE VERDE

By Audie L. King

**M**ining continued to be a very small contributor to the Cape Verdean economy, which was concentrated in the services and the agricultural sectors. Cape Verde produced minor quantities of salt and pozzolana, but the total value was less than 0.2% of the GNP. Gypsum, kaolin, limestone, ornamental building stone, and pumice had been either mined or identified as possible resources. A plan initiated in 1984 to produce 64,000 tons per year of cement on Maio Island was suspended by the Government in 1988 when it was decided that domestic demands could be met more cheaply through imports.

The economy expanded by an estimated 3.2% during 1988, the latest year available, continuing an impressive growth trend that continued throughout the 1980's. Real GDP had increased at an average rate of 6% per year between 1980 and 1987. This strong economic performance is partially due to the Government's conservative economic policies. Nevertheless, the country remains strongly dependent on foreign aid and emigrant remittances.

The African Party for Independence of Cape Verde (PAICV), in power since independence from Portugal in 1975, lost its position during multiparty elections in February 1991. It was still unsure if the new democratically elected Government would continue to pursue the conservative economic practices that marked the previous administration's policies. Cape Verde's Second National Development Plan (1986-90) remained in force throughout the year. Its primary goals were to improve the country's balance of trade. In 1988, the latest year for which such data were available, Cape Verde had a trade deficit of \$74.7 million (\$77.9 million in imports and \$3.2 million in exports). The Government began to realign the economy to deal with the country's high levels of unemployment and its shortage of natural resources. New economic policies emphasized labor-intensive activities in the manufacturing sector, such as the transformation of imported raw materials, and the service sector, such as tourism.

The Third Party Congress, held in November 1988, approved a number of policies

focusing on ways to utilize Cape Verde's strategic geographical position to promote exports and economic growth. The development of the country's tourist, fishing, and offshore banking concerns were dealt with specifically.

In December 1988, the Cape Verdean constitution was amended to provide for private banking and insurance companies.

In 1989, a duty-free warehousing system was established under which most goods could be stored for up to 4 years without the payment of duties. These new warehousing laws would facilitate the importation of raw, semifinished, or finished materials that would be used in Cape Verde's export industries.

A new investment code that favors foreign investment did not stipulate minimum

local ownership for joint venturers. The investment code also provided for the repatriation of profits in foreign currency provided that a portion of profits are reinvested.

Small quantities of salt and pozzolana were mined for domestic consumption. Salt production had decreased markedly since 1985 owing apparently to technical problems. During the same period of time, high demand from the construction industry caused pozzolana production to more than double.

Cape Verde's main export items, bananas, tuna, lobster, leather products, and textiles, were shipped primarily to Algeria and Portugal. Net salt and pozzolana exports stopped in the early 1980's as domestic demand for construction materials out-

TABLE 1

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

| Commodity <sup>2</sup> | 1986   | 1987   | 1988   | 1989 <sup>p</sup> | 1990 <sup>e</sup> |
|------------------------|--------|--------|--------|-------------------|-------------------|
| Salt metric tons       | 4,855  | *5,000 | *3,000 | 3,000             | 3,500             |
| Pozzolana do.          | 33,000 | 43,000 | 53,000 | 53,000            | 53,000            |

<sup>e</sup>Estimated. <sup>p</sup>Preliminary.

<sup>1</sup>Includes data available through Oct. 4, 1991.

<sup>2</sup>In addition to commodities listed, small quantities of limestone, clay, 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.

stripped production capacity and salt output fell below domestic needs. The total value of Cape Verdean exports, however, was less than 4% of the values of its imports. Portugal, Japan, and the Netherlands continued to supply Cape Verde with most of the necessities of life, including at least 50% of its food supply.

Cape Verde's four pozzolana mines and two salt producers were all privately owned. The mining industry employed an estimated 170 people in 1990, of which 50 worked in the salt industry and 120 in the extraction of naturally occurring building materials.

The Government was studying the feasibility of building a 90,000 mt/a marine salt production facility on Maio Island. Two marine salt plants were reportedly in operation on Maio Island. The operating 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 was also produced on Sal and Boa Vista Islands. Several price increases and a slight increase in production allowed SCV to increase its profits to about \$78,000 in 1990 from \$31,000 in 1989. Even though it accounted for less than 0.03% of Cape Verde's GNP, the salt industry along with other marine industries such as shipping and fishing, was singled out for future development in Cape Verde's most recent National Development Plan. Salt was considered important because one of its main uses was to conserve Cape Verde's fish harvest. The fishing industry employed more than 6,000 persons and accounted for about 60% of the nation's exports in recent years. Salt consumption is expected to grow hand in hand with fishing, whose growth potential was considered high due to reports

that it harvested only an estimated 25% of its renewable limit. Despite continued domestic demand, salt production fell sharply during the past few years, from a peak of 31,000 tons in 1977 to only 3,000 tons in 1988. The main reasons for the decline were technical problems. During the same time period, Cape Verde stopped exporting and became a net importer of salt.

Together with its value added products, pozzolana accounted for about 90% of the value of all minerals produced for construction purposes. The industrial minerals industry had quadrupled from 1980 to 1985 and has since been growing at 10% per year. Pozzolana was mined from four mines on Santo Antão Island.

Foreign trade is served through the ports of Porto Grande, at Mindelo on São Vicente Island, and Praia on São Tiago Island. Goods arriving at these two ports were distributed to the other islands, making adequate ports on all the islands essential. The ports collectively handled 394,000 tons of freight in 1986, the latest year for which such statistics were available.

The International Bank for Reconstruction and Development announced in November 1990 that the Praia Port Project, which began in 1983 when it received a \$7.2 million credit, was completed on schedule. The funding was a joint effort by the Governments of Portugal, Cape Verde, and Norway and by the IDA, Arab Bank for Economic Development in Africa, and the Empresa Nacional de Administração dos Portos. The project reconstructed two rapidly deteriorating deepwater berths and provided them with necessary support facilities. It increased the efficiency of port

operations at Praia and Porto Grande by providing modern cargo handling and workshop equipment. It also provided technical assistance and training in the maritime sector by establishing a training center at Mindelo.

The Amilcar Cabral international airport on Sal Island, which had a capacity of 1 million passengers per year, was being enlarged in 1988, even though air traffic had decreased in recent years. Because of its strategic location, the airport was used for refueling airliners from Angola, Guinea Bissau, Cuba, Portugal, the Republic of South Africa, and the U.S.S.R.. Smaller airports were on most other islands.

There were 2,250 kilometers of roads in 1981, the last year that such data were available, of which 660 kilometers was paved.

Electricity came from several public enterprises. In 1982, three municipal utilities on Praia, Mindelo, and Sal merged to form the parastatal Electra, which then was in charge of all major generating facilities. It operated a 2.8-MW plant in Praia, a 6.5-MW plant in Mindelo, and a 1-MW plant in Sal. There were also 12 smaller rural powerplants operated by local councils, which totaled a little more than 2-MW. All the plants were diesel. There were plans for combined wind-diesel plants for the future. Electra foresaw an interconnected system of combined plants and isolated facilities. Two 55-kW wind generators were in operation at Praia to study the feasibility of such a system.

The availability of water was the major concern in a country that had suffered devastating droughts and famines every 20 to 30 years throughout its history. The most recent

drought started in 1968 and lasted 10 years.

Only international aid and the importation of nearly all of the islands' food requirements have averted disaster. Past droughts have wiped out 15% to 40% of the population. Rainfall finally broke the latest drought in 1978, but has been erratic during most of the 1980's. In 1984, heavy rainfall caused catastrophic floods. Recent programs included reforestation, the building of rainwater dikes, water well drilling, and irrigation to reduce some of Cape Verde's weather-related problems.

If recently formulated Government policies designed to attract investment in labor-intensive industries that add value to imported materials are successful, the country's reliance on foreign aid may decrease. For the foreseeable future, however, Cape Verde will remain highly dependent on foreign donors and remittances from its citizens living abroad. The mineral industry will continue to be of minor importance to the overall economy. The extraction of building materials will likely increase as growth in the construction sector continues. Much of the building material, such as cement, will probably still be imported because Cape Verde's small market would not allow local manufacturing companies to compete with larger foreign manufacturers. The salt industry, which has been producing far below capacity, should be capable of expanding production to meet rising domestic demand as the population grows and the fishing industry expands.

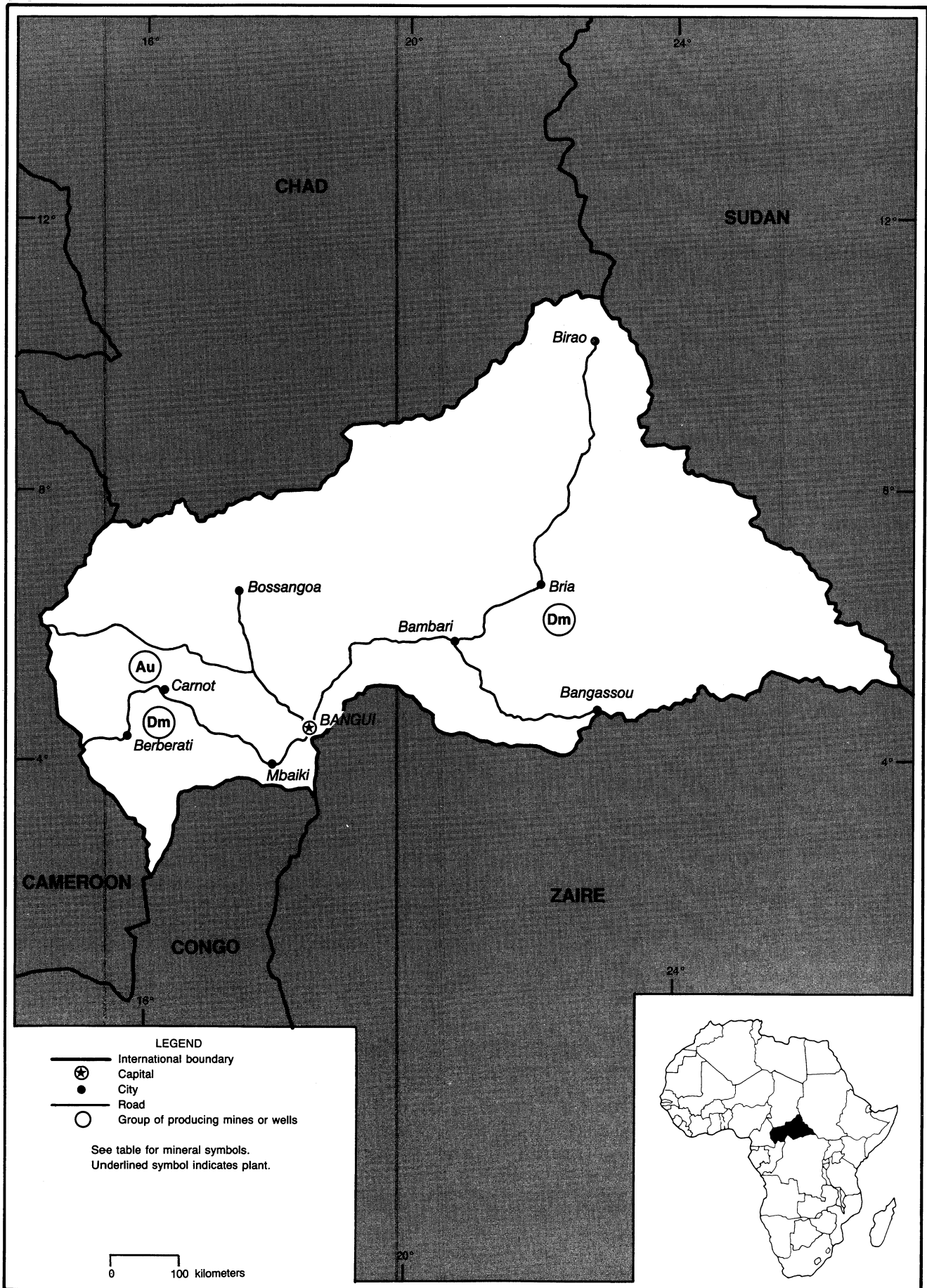
<sup>1</sup>Where necessary, values have been converted from Cape Verdean escudos (CVEsc) to U.S. dollars at the rate of 64CVEsc=US\$1.00.



# CENTRAL AFRICAN REPUBLIC

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

POPULATION 2.9 million



# THE MINERAL INDUSTRY OF CENTRAL AFRICAN REPUBLIC

By Thomas P. Dolley

The Central African Republic's mining sector remained undercapitalized in 1990. The mining industry continued to be based on the production and export of diamonds. Alluvial diamonds of gem quality along with some gold were the primary minerals exploited. The estimated GDP for the Central African Republic in 1990 was \$1.3 billion,<sup>1</sup> and per capita income was \$440. Agriculture is the dominant industry, accounting for 40% of the GDP. Revenues from mining, manufacturing, and construction were equivalent to about 15% of the GDP.<sup>2</sup>

The primary diamond mining areas in the Central African Republic are at Carnot and Berberati. Diamond production supports an artisanal labor force of approximately 40,000 miners. Production of diamonds and gold declined in 1990. However, production figures do not take into account clandestine mining activities. Clandestine production of these mineral commodities could represent more than one-half of total production.

The Government reported that gem-quality diamond production generated approximately \$46.7 million in 1990. Receipts for industrial-grade diamonds were valued at slightly more than \$3 million. The primary destination for the Central African Republic's gem-quality diamonds was Belgium. Diamond exports to the United States were slightly more than \$1 million in 1990.

Mining legislation was based on the

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

| Commodity <sup>2</sup> | 1986    | 1987    | 1988    | 1989    | 1990 <sup>P</sup> |
|------------------------|---------|---------|---------|---------|-------------------|
| <b>Diamond:</b>        |         |         |         |         |                   |
| Gem carats             | 258,701 | 303,769 | 284,130 | 334,396 | 302,530           |
| Industrial do.         | 98,677  | 108,455 | 59,278  | 80,806  | 78,496            |
| Total do.              | 357,378 | 412,224 | 343,408 | 415,202 | 381,026           |
| Gold kilograms         | 219     | 223     | 381     | 328     | 241               |

<sup>P</sup>Preliminary.

<sup>1</sup>Includes data available through Jan. 30, 1992.

<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.

Mining Code, law No. 61/208 of April 11, 1961. This law was subsequently modified, beginning in 1979. In all, 12 additional annexes have been made to the law, the latest in 1984. These annexes provide guidelines for the ownership, exploitation, possession, and marketing of gold and raw diamonds. Permission of the Ministry of Mines is required before mining or purchasing precious stones or minerals. Hydrocarbon legislation was based on the Petroleum Code, Ordinance No. 73/016, of February 10, 1973.

Electricity is generated and distributed by Energie Electrique Centrafricaine (EEC). Total installed capacity was 35 MW. Of electricity produced, 60% was from hydroelectric plants and 40% was from diesel plants. EEC has extensive rehabili-

tation plans along with the extension of existing electrical supply facilities in Bangui.

Government data on mineral reserves were unavailable. However, the degree of artisanal diamond mining suggests that considerable resources exist. The lack of adequate transportation and industrial infrastructure continue to hinder the development of a viable mineral industry in the Central African Republic. There were no major plans by the Government to restructure the mining sector.

<sup>1</sup>Where necessary, values have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF272.26=US\$1.00.

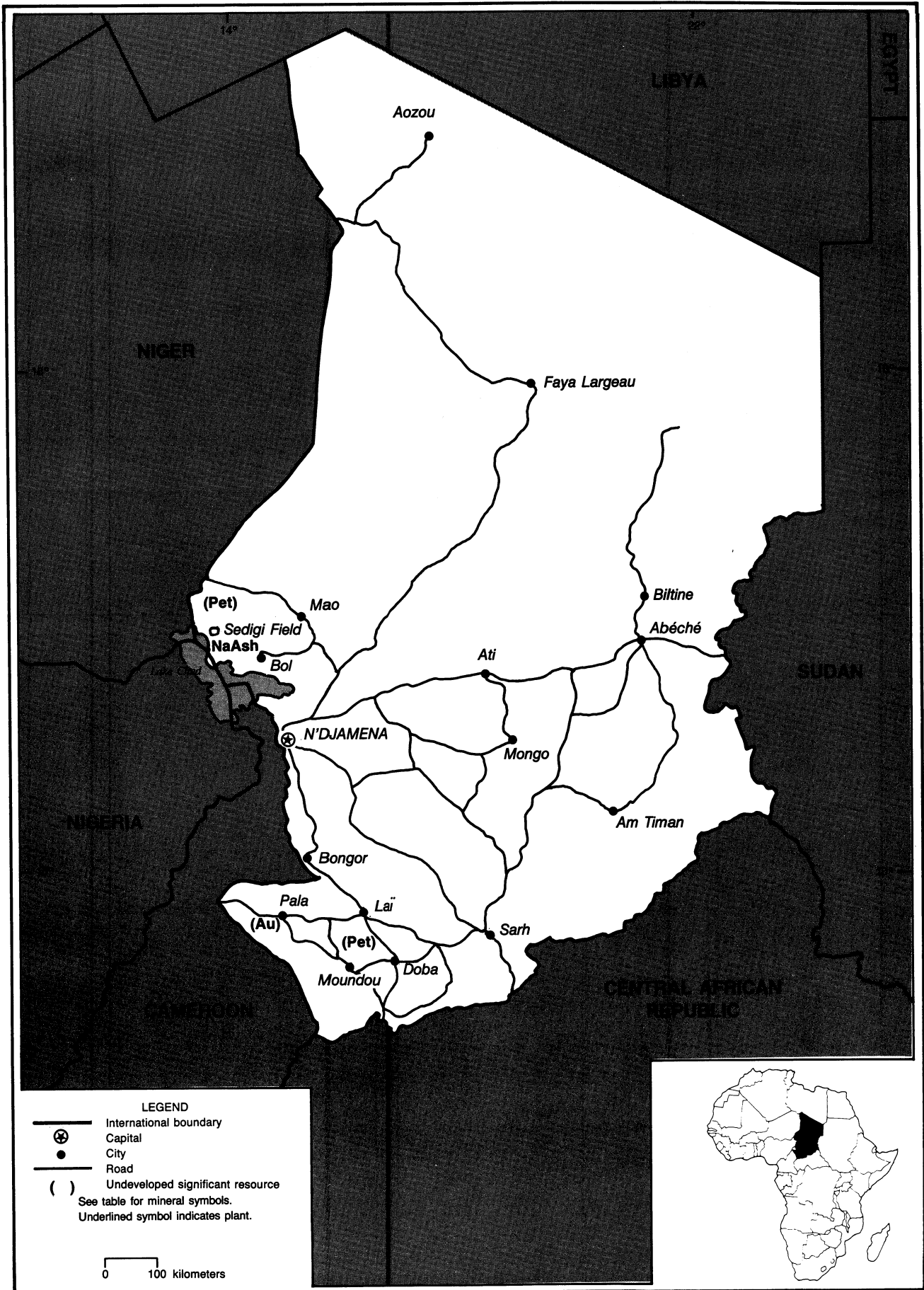
<sup>2</sup>U.S. Department of Commerce, International Trade Administration: Foreign Economic Trends and Their Implications for the United States. Central African Republic, annual.



# CHAD

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

POPULATION 5 million



# THE MINERAL INDUSTRY OF CHAD

By Thomas P. Dolley

One of the most undeveloped countries in the world, Chad possessed virtually no mineral industry. Underdevelopment characterized Chad's mining sector since independence in 1960. An unsettled political situation, compounded by drought and landlocked geography, continued to inhibit Chad's development in 1990.

Chad remained heavily dependent on international donors, and 70% of public funds are financed externally. France remained the leading donor nation for Chad. The signing of a peace treaty between Chad and neighboring Libya in mid-1989 led to Libya's relinquishing claims on the mineral-bearing Aouzou strip in northern Chad.

Chad's industrial base continued to be supported through the production of cotton. The estimated GDP for 1990 was \$1.1 billion.<sup>1</sup> Per capita income in Chad for 1990 was \$205.

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 continues to support a mineral policy centered on the exploration and development of domestic hydrocarbons.

Significant mineral production did not exist in Chad. This situation has been exacerbated over the past several years by war, poor infrastructure, drought, and famine. Natron is extracted north of the Lake Chad region by the local population using rudimentary methods at a rate of 10 kmt/a. Salt is extracted from the salt lakes in northern Chad. Construction materials in the form of aggregates are extracted from a quarry located south of Lake Chad along with clay, limestone, and sand. Historically, artisanal exploitation of alluvial gold had been reported near Pala in southern Chad. Additionally, small-scale exploitation of tungsten in the Tibesti mountain region has been reported.

Major export destinations for Chadian products were France, Nigeria and Cameroon. In 1990, Chadian exports had an estimated value of \$174 million. Cotton

accounted for approximately 50% of this value. Total U.S. imports from Chad in 1990 amounted to \$2.1 million. This latter value did not represent any mineral commodities. The major import trading partners for Chad remained Cameroon, France, Nigeria, and the United States. Valued at \$264 million, Chadian imports consisted mainly of machinery and transportation equipment.

Petroleum products consumed in Chad are exclusively imported from Nigeria and Cameroon. Owing to the fact that there are no railway or pipeline facilities, importation of petroleum is by trucks, which are privately owned and operated. Entry of these trucks into Chad is uncontrolled, and substantial but unspecified quantities of fuel and petroleum products are transported. Substantial smuggling of fuel and petroleum products occurs. Distribution of the majority of petroleum products is through Shell Oil Corp. and Mobil Oil Corp. of the United States and Total of France, respectively. Various imported petroleum products are composed of jet fuel, gasoline, distillate fuel oil, kerosene, lubricants, and natural asphalt.

Following a coup in late 1990, the new Government expressed its desire for foreign oil exploration companies to remain in Chad. The Government's principal mineral agency was the Ministry of Mines, Petroleum and Energy in N'Djamena. Petroleum exploration was initiated in 1970 by a consortium of oil companies headed by the Continental Oil Co. (CONOCO) of the United States and augmented by Exxon Corp., Chevron U.S.A. Inc., and Shell Oil Co. of the United States. CONOCO later transferred its holdings to Esso Chad, a consortium of Shell, Chevron, and Exxon of the United States. The Société d'Etude et d'Exploitation de la Raffinerie du Tchad (SEERAT) is a Chadian parastatal, which is owned 51% by the Government, with the remaining 49% of the shares owned by Shell, Esso, and Chevron. Future petroleum refining development in Chad will be SEERAT's prime responsibility.

Commercial hydrocarbon production does not exist in Chad. However, crude oil

was discovered in Chad in 1974 at Sedigi, north of Lake Chad, approximately 300 km from N'Djamena. The World Bank indicated that drilling in 1989 by Esso Chad confirmed the presence of oil with reserves of 10.5 Mbbl. World Bank funding for an oil pipeline from the Sedigi Oilfields to a micro refinery in N'Djamena is still pending. Oil exploration, curtailed by the coup, was expected to resume.

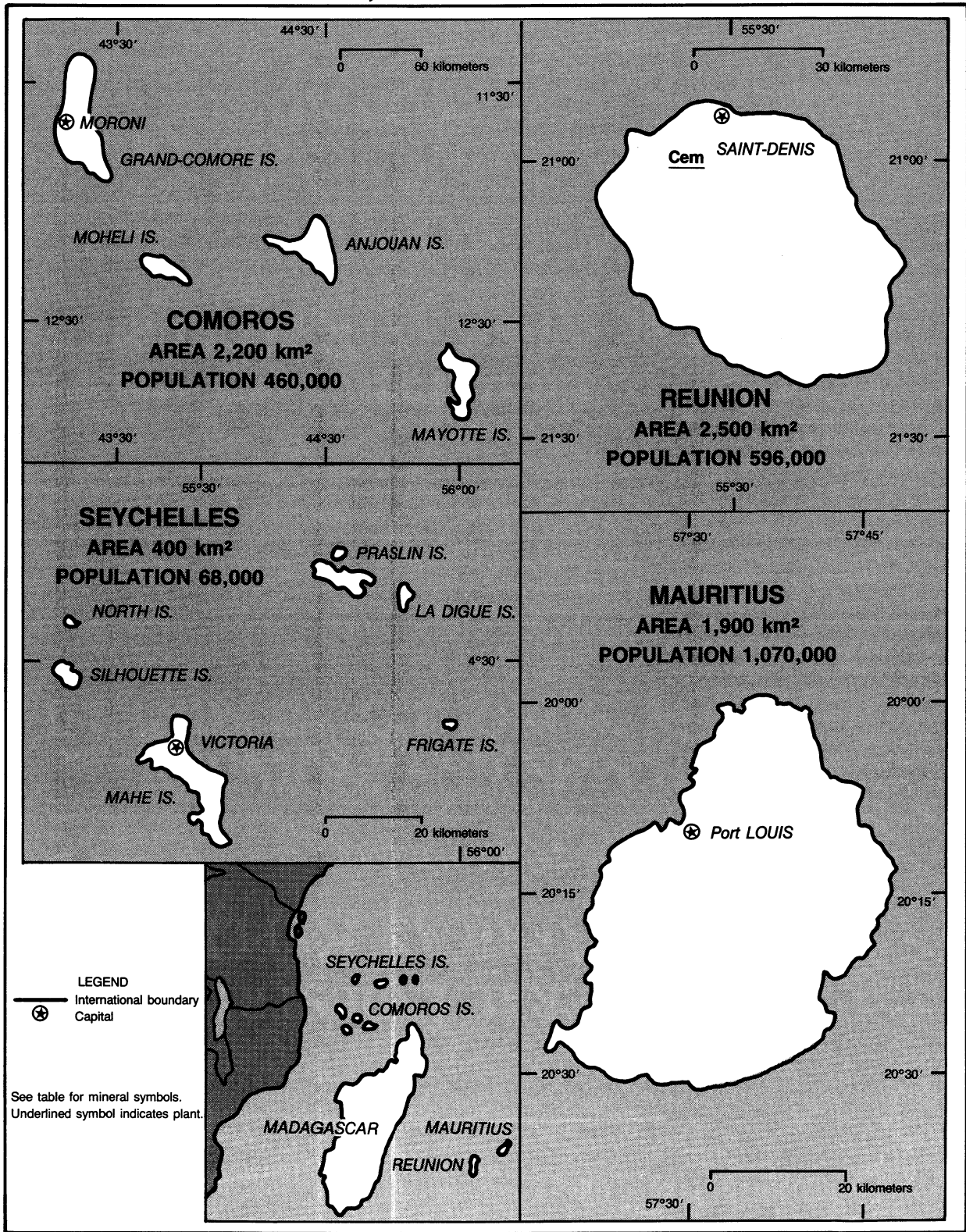
Since independence no thorough geological survey has been conducted in Chad. A variety of minerals have been reported to occur in Chad; however, official Government reserve figures have not been reported. Columbium-tantalum, tin, tungsten, and uranium are associated with granites and pegmatites of the Aouzou region and Tibesti mountain region of northern Chad. Indications of bauxite, chrome, copper, iron, lead, nickel, titanium, and zinc have been reported. Trona resources constitute a significant mineral commodity obtained from Lake Chad for some export and domestic use.

Diesel generators produce all electrical power utilized in Chad using imported diesel fuel. Total installed generating capacity amounted to 38 MW managed by Société Tchadienne d'Énergie Electrique. Only the major cities of N'Djamena, Moundou, and Abeche possess electric power and are not interconnected. Communications network infrastructure is not sufficient. Chad possessed no railroad or river port facilities. Roadways totaled 31,322 km, with 200 km of roadway being paved with asphalt.

The new Government's policy on mineral industry development remained largely undefined by yearend 1990. The decimation of forest and woodfuel resources for energy use by 99% of Chadian households is expected to continue. Compounding these problems with frequent droughts and delayed development of domestic hydrocarbon potential could create a serious energy imbalance in Chad.

<sup>1</sup>Where necessary, values have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF272.26=US\$1.00.

# ISLANDS OF COMOROS, MAURITIUS, REUNION, AND SEYCHELLES



# THE MINERAL INDUSTRIES OF COMOROS, MAURITIUS, REUNION, AND SEYCHELLES

By Audie King and Lloyd E. Antonides

## COMOROS

Comoros depended mostly on subsistence agriculture, fishing, and forestry. Its mineral industry was very limited, producing only common building materials, such as sand, gravel, and crushed stone. Production of these common building materials had slowed since the late seventies and early eighties with the completion of major public works projects.

A new home construction technology, based on research conducted by the Council for Scientific and Industrial Research (CSIR) of the Republic of South Africa, was being adopted in an effort to stimulate the ailing construction sector. The new method, which would be undertaken by unskilled labor, utilizes abundant local sources of lava and volcanic ash both for structural support and for plastering. It may eliminate the need for the island to engage in environmentally undesirable coral mining and may limit costly cement imports.

The GDP was estimated at \$245 million<sup>1</sup> in 1990. The United States took 53% of Comoros' exports, including cloves, perfume essences, and copra. Comoros was the world's major source for essence of ylang-ylang, which is used in perfumes, and the second largest producer of vanilla. Imports were mostly rice and other food stuffs and petroleum products.

Electricité et Eaux des Comoros had responsibility for both power generation and delivery. In 1989, the latest year that data were available, total generating capacity was 16 MW, all based on diesel fuel, except for 1 MW from hydroelectric power. The country's chief future concern is preservation of its relatively fragile environment, as it copes with population growth while minimizing erosion from deforestation and other industrial activities.

## MAURITIUS

Mauritius produced salt, lime, sand, and rock for use in its construction sector and in

other industries. In 1990, 2,000 tons of coral was extracted for uses such as pigments for paint and about 300,000 tons of coral sand was produced, of which about 80% was used in the construction trade and about 20% in other industries. Sugar production continued to be important, although it no longer dominated the island's economy. Since the early 1980's, Mauritius' economy had become increasingly diversified owing to the success of its Export Processing Zone (EPZ). The EPZ expanded by an average 30% per year from 1984 through 1987, but its growth rate has since slowed to about 4% per year. Export-oriented textile businesses still accounted for more than one-half of the EPZ's output, but recent efforts to broaden the nation's scope of manufactured products had seen the formation of firms specializing in plastics, electronics, and engineering. Successful agricultural and industrial sectors, coupled with tourism, had resulted in nearly full employment for the country's work force.

Exports were \$1.04 billion, and imports were \$1.3 billion in 1988, the latest date that these data were available. Exports of textiles and clothing were \$454 million, and exports of sugar were \$334 million. Mineral exports were diamond, \$22 million; fertilizers, 8,811 tons; and iron and steel scrap, 4,845 tons. The major portion of the country's exports were to France, the United Kingdom, and the United States. France,

the Republic of South Africa, and the United States were major sources of imports. Total U.S. exports to Mauritius were \$136 million, and total U.S. imports from Mauritius were \$151 million.

The principal mineral commodities imported by Mauritius as sea cargo in 1988 were cement, 346,948 tons; coal, 34,009 tons; fertilizers, 42,342 tons; liquefied petroleum gas, 161,600 bbl; and other petroleum products, 3 Mbbbl. Other general imports were clays, 5,541 tons; iron and steel ingots, 25,403 tons; and iron and steel semimanufactures, 67,484 tons.

Electric power generating capacity, which is under the control of the Central Electricity Board, was 233 MW in 1989, the latest year these data were available. Projects underway for increasing such capacity included the Bocage-Guibes dam and hydroelectric project, costing \$35 million, and expansion of existing thermal generating capacity, costing \$24 million. During crop season, the sugar industry supplied much of its own electrical power through the consumption of bagasse. Lonrho, a United Kingdom-based multinational, was investing in new facilities that would allow it to feed bagasse generated energy into the national grid throughout the year.

The Government looked forward to a \$121 million development plan for 1990-93, \$60 million of which was to be donated by foreign governments primarily for

TABLE 1

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

(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>               | 1986       | 1987       | 1988       | 1989 <sup>P</sup> | 1990 <sup>E</sup> |
|--------------------------------------|------------|------------|------------|-------------------|-------------------|
| Lime                                 | 7,000      | 7,000      | 7,000      | 7,000             | 7,000             |
| Salt                                 | 6,000      | 6,000      | 6,000      | 6,000             | 6,000             |
| Sand                                 | 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>E</sup>Estimated. <sup>P</sup>Preliminary. <sup>R</sup>Revised.

<sup>1</sup>Includes data available through Feb. 7, 1992.

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

training workers. It was recommended that, for environmental reasons, mining of coral sand and coral be terminated to prevent damage to the nation's lagoons. The mining and crushing of local basalt was proposed as an alternative to coral.

It was reported that International Finance Corp. (IFC), a World Bank affiliate, was considering purchasing about \$200 million equity in Consolidated Steel Ltd. (CSL). The IFC would also loan CSL about \$500 million for the construction of a steel mill. Under the proposed scheme, CSL would operate a steel rolling mill to produce rebar from imported standard billets. Funding for the steel mill's construction had previously been discussed with Iraqi and Kuwaiti sources.

The Government's plans to jointly build an oil refinery with the Government of

Kuwait, announced in November 1989, were presumably put on hold owing to Iraq's invasion of Kuwait in August.

## REUNION

The mineral industry of Reunion produced rock and coral for domestic consumption. A clinker grinding plant with 200,000-mt/a capacity, supplied from imported materials, was near Saint Denis. The economy was agriculture based, with tourism increasing in importance. The principal export products were sugar and spices; imports were mainly manufactured goods, food, equipment, and petroleum products. Total electric generating capacity was 245 MW.

## SEYCHELLES

Seychelles' only mineral production of significance was guano for use as phosphate fertilizer, of which annual output was estimated at about 4,500 tons for 1986-90. Tourism employed about 30% of the population and was the island's main source of foreign exchange earnings. The Government had been promoting farming and fishing to reduce the nation's chronic trade deficit and lessen its dependence on tourism. The latest trade data available showed that, in 1989, Seychelles exported \$31 million worth of fish, copra, and cinnamon bark; and reexported petroleum products; and imported \$131 million in manufactured goods, food, and petroleum products.

TABLE 2

### SEYCHELLES: EXPORTS AND REXPORTS OF MINERAL COMMODITIES<sup>1</sup>

| Commodity   | 1989    | Destinations   |
|---|---------|--|
| Aluminum: Metal including alloys:                                 |         |  |
| Scrap metric tons   | 24      | Netherlands 16; United Kingdom 8.                      |
| Semimanufactures do.  | 2       | Mainly to United Kingdom.                              |
| Copper: Metal including alloys, scrap do.                         | 12      | All to United Kingdom.                                 |
| Petroleum refinery products:                                      |         |  |
| Gasoline, motor 42-gallon barrels                                 | 3       | All to Kuwait.   |
| Kerosene and jet fuel do.   | 1       | All to bunkers.  |
| Distillate fuel oil do.   | 562,976 | Kuwait 230,130; Yemen (Sanaa) 55,050; bunkers 277,795. |
| Lubricants do.  | 248     | Kuwait 189; bunkers 58.                                |
| Stone, sand and gravel: Sand other than metal-bearing metric tons | 26      | All to Republic of South Africa.                       |

<sup>1</sup>Comparable data are not available for 1988. No mineral commodities were reported as being exported to the United States in 1989.

Table prepared by Virginia A. Woodson.

TABLE 3

### SEYCHELLES: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity  | 1989 | Sources, 1989 |   |
|--|------|---------------|---|
|  |      | United States | Other (principal)                                 |
| <b>METALS</b>                                    |      |               |   |
| Aluminum: Metal including alloys:                |      |               |   |
| Unwrought kilograms                              | 816  | 673           | Republic of South Africa 143.                     |
| Semimanufactures                                 | 156  | 1             | Netherlands 47; United Kingdom 44; Singapore 23.  |
| Chromium: Oxides and hydroxides kilograms        | 18   | 18            |   |
| Cobalt: Oxides and hydroxides do.                | 786  | —             | United Kingdom 468; Republic of South Africa 318. |
| Copper: Metal including alloys, semimanufactures | 30   | 7             | United Kingdom 9; Singapore 6.                    |
| Iron and steel: Metal:                           |      |               |   |
| Scrap kilograms                                  | 77   | —             | All from Republic of South Africa.                |
| Steel, primary forms do.                         | 203  | —             | All from France.                                  |

See footnotes at end of table.

TABLE 3—Continued

SEYCHELLES: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity  | 1989   | Sources, 1989 |   |
|--|--------|---------------|---|
|  |        | United States | Other (principal)   |
| <b>METALS—Continued</b>  |        |               |   |
| Iron and steel:—Continued  |        |               |   |
| Semimanufactures:  |        |               |   |
| Bars, rods, angles, shapes, sections                                   | 1,839  | 1             | Republic of South Africa 1,365; France 122; Singapore 99.       |
| Universals, plates, sheets   | 1,356  | (?)           | Japan 427; Republic of South Africa 238; France 145.            |
| Hoop and strip kilograms   | 98     | —             | All from Singapore.   |
| Wire   | 40     | —             | Republic of South Africa 38; United Kingdom 2.                  |
| Tubes, pipes, fittings   | 461    | (?)           | United Kingdom 124; Republic of South Africa 110; Singapore 89. |
| Castings and forgings, rough   | 5      | —             | Mainly from United Kingdom.                                     |
| Lead: Metal including alloys, semimanufactures                         | 14     | (?)           | France 9; Zimbabwe 4.   |
| Nickel: Metal including alloys:  |        |               |   |
| Unwrought kilograms  | 2      | —             | All from United Kingdom.  |
| Semimanufactures   | 1      | —             | All from Australia.   |
| Silver: Metal including alloys, unwrought and partly wrought kilograms | 4      | —             | Singapore 2; United Kingdom 2.                                  |
| Tin: Metal including alloys:   |        |               |   |
| Unwrought  | 1      | —             | All from Mauritius.   |
| Semimanufactures   | 308    | —             | Mainly from France.   |
| Tungsten: Metal including alloys, unwrought <sup>3</sup> kilograms     | 19     | —             | All from United Kingdom.  |
| Zinc: Metal including alloys, semimanufactures                         | 20     | —             | Republic of South Africa 15; Hong Kong 3.                       |
| <b>INDUSTRIAL MINERALS</b>   |        |               |   |
| Abrasives, n.e.s.: Grinding and polishing wheels and stones            |        |               |   |
|  | 5      | —             | United Kingdom 3; Republic of South Africa 1.                   |
| Boron materials: Oxides and acids kilograms                            | 70     | —             | All from Japan.   |
| Cement   | 20,871 | —             | Kenya 10,700; Indonesia 6,947; United Arab Emirates 3,200.      |
| Clays, crude   | 1      | —             | All from United Kingdom.  |
| Fertilizer materials:  |        |               |   |
| Crude, n.e.s.  | 1      | —             | Mainly from Republic of South Africa.                           |
| Manufactured:  |        |               |   |
| Ammonia kilograms  | 153    | —             | United Kingdom 138; Singapore 9.                                |
| Nitrogenous  | 100    | —             | Mainly from Belgium-Luxembourg.                                 |
| Unspecified and mixed  | 7      | (?)           | Netherlands 5; Singapore 1.                                     |
| Gypsum and plaster   | 10     | —             | Singapore 7; Republic of South Africa 3.                        |
| Mica:  |        |               |   |
| Crude including splittings and waste kilograms                         | 80     | —             | All from Republic of South Africa.                              |
| Worked including agglomerated splittings do.                           | 4      | —             | All from Singapore.   |
| Pigments, mineral: Iron oxides and hydroxides, processed do.           | 190    | —             | Do.   |
| Salt and brine   | 462    | 1             | Republic of South Africa 424; Pakistan 32.                      |
| Sodium compounds, n.e.s.:  |        |               |   |
| Soda ash, manufactured kilograms                                       | 340    | 45            | Republic of South Africa 295.                                   |
| Sulfate, manufactured do.  | 204    | —             | All from West Germany.  |
| Stone, sand and gravel:  |        |               |   |
| Dimension stone:   |        |               |   |
| Crude and partly worked  | 9      | —             | West Germany 3; Republic of South Africa 3; Singapore 2.        |
| Worked   | 107    | —             | United Kingdom 50; Republic of South Africa 29; Thailand 11.    |

See footnotes at end of table.

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

(Metric tons unless otherwise specified)

| Commodity                                    | 1989             | Sources, 1989    |   |
|--|------------------|------------------|---|
|  |                  | United States    | Other (principal)                                     |
| <b>INDUSTRIAL MINERALS—Continued</b>         |                  |                  |   |
| Stone, sand and gravel:—Continued            |                  |                  |   |
| Dimension stone:—Continued                   |                  |                  |   |
| Gravel and crushed rock kilograms            | 919              | —                | Singapore 812; United Kingdom 50; West Germany 33.    |
| Limestone other than dimension               | 72               | —                | Republic of South Africa 62; Belgium-Luxembourg 10.   |
| Sand other than metal-bearing                | 9                | 7                | Republic of South Africa 1.                           |
| Sulfur:                                      |                  |                  |   |
| Elemental: Colloidal, precipitated, sublimed | 1                | ( <sup>2</sup> ) | Mainly from Republic of South Africa.                 |
| Sulfuric acid                                | 18               | —                | United Kingdom 12; Japan 3.                           |
| Other: Crude kilograms                       | 6                | —                | All from United Kingdom.                              |
| <b>MINERAL FUELS AND RELATED MATERIALS</b>   |                  |                  |   |
| Asphalt and bitumen, natural do.             | 18               | —                | Do.   |
| Coal: Anthracite                             | 2                | —                | Mainly from West Germany.                             |
| Petroleum:                                   |                  |                  |   |
| Crude 42-gallon barrels                      | ( <sup>2</sup> ) | ( <sup>2</sup> ) |   |
| Refinery products:                           |                  |                  |   |
| Liquefied petroleum gas do.                  | 2,993            | ( <sup>2</sup> ) | United Kingdom 1,926; Republic of South Africa 1,056. |
| Gasoline do.                                 | 51,546           | ( <sup>2</sup> ) | Kuwait 51,536.  |
| Mineral jelly and wax do.                    | 496              | ( <sup>2</sup> ) | West Germany 448; Republic of South Africa 39.        |
| Kerosene and jet fuel do.                    | 179,091          | ( <sup>2</sup> ) | Mainly from Kuwait.                                   |
| Distillate fuel oil do.                      | 930,198          | —                | All from Kuwait.                                      |
| Lubricants do.                               | 9,601            | 7                | United Kingdom 4,885; Singapore 3,077; Italy 1,571.   |
| Residual fuel oil do.                        | 68,007           | —                | All from Kuwait.                                      |
| Bitumen and other residues do.               | 5,921            | —                | Singapore 5,908.                                      |

<sup>1</sup>Comparable data for 1988 are not available. Table prepared by Virginia A. Woodson.

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

<sup>3</sup>May include scrap.

The Electricity Division of the Public Utilities Corp. had an electric generating capacity of 24 MW from three diesel powerplants, two on Mahe Island and one on Praslin Island. An undersea cable extending 10 km from Praslin Island supplied electricity to La Digue Island. Limited land area, increasing population, and dependency upon tourism raised concerns regarding concurrent environmental degradation.

The first Indian Ocean area regional seminar on petroleum exploration was held in Victoria, Seychelles, on December 10-15, 1990. One hundred delegates from 27 countries attended the proceedings, representing 10 international organizations and 27 oil companies, including 7 from the United States.

In January 1990, Mobil officials, accompanied by representatives from Seychelles National Oil Co. (SNOC), visited Coetivy Island, about 330 km south-southeast of Victoria. Tar balls from underground seeps were known to occur on the island's beaches for many years. The officials evaluated the feasibility of participating in drilling some

exploration wells in the area, within Seychelles' exclusive economic zone. Mobil, as well as Texaco, and two French Companies, Elf and Total, had been invited to participate in the exploration by Enterprise Oil Ltd. (EOL), a British firm. EOL signed an exploration agreement covering the area in 1987 and did preliminary seismic work. It hoped to start at least one test well by yearend 1990.

Oil exploration began in Seychelles in 1969 and continued throughout the 1970's as Texaco, Burmah Oil Co. and several other licensees performed seismic surveys. Texaco drilled the first two exploratory wells in 1970. Following Independence in 1976, the Oil Productions Act went into effect. Amoco was active during the early 1980's and drilled three dry holes off Silhouette Island, about 30 km northwest of Victoria. Under the Ministry of National Development, a petroleum office was set up in 1981. In 1984, SNOC was formed as a parastatal company, and a small technical staff was established. The Government adopted a new petroleum law in 1986 and began actively promoting oil exploration.

<sup>1</sup>Where necessary, values have been converted from Comoran francs (CF) to U.S. dollars at the rate of CF272.26=US\$1.00, Mauritian rupees (MauRs) at MauRs14.84=US\$1.00, French francs (F) at F5.45=US\$1.00, and from Seychelles rupees (SR) at SR5.34=US\$1.00.

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Service Géologique, Ocean Indian  
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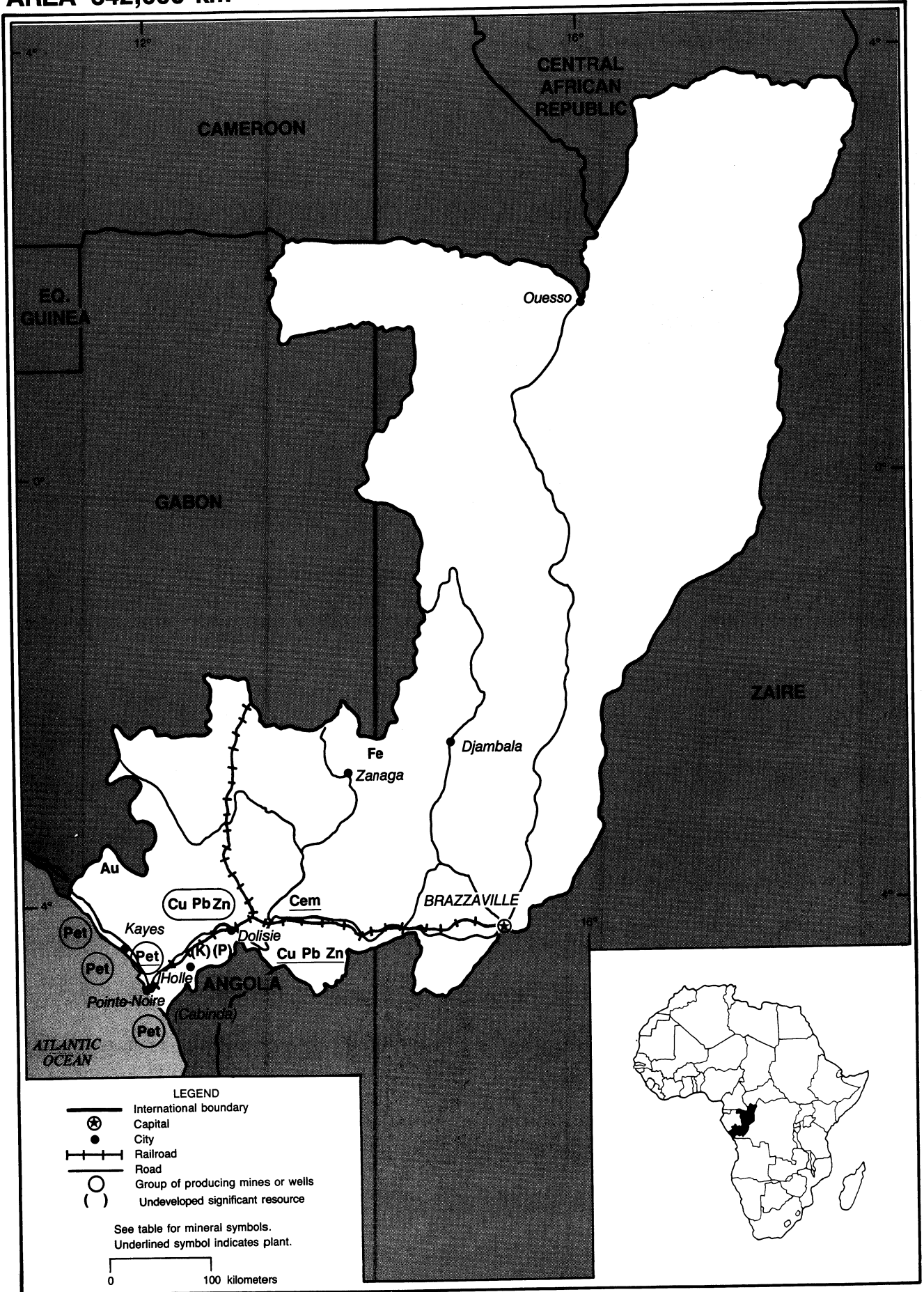




# CONGO

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

POPULATION 2.2 million



# THE MINERAL INDUSTRY OF CONGO

By Thomas P. Dolley

The Republic of the Congo remained a major crude petroleum producer in sub-Saharan Africa in 1990. After 5 years of steadily increasing output, crude petroleum production achieved a record-high level in the Congo for 1990. Petroleum is the mainstay of the Congolese economy and provides at least 50% of the Government's revenue and 90% of export earnings. However, in recent years, the global decline in oil prices caused plummeting revenue and increased debt liabilities for the Government. Consequently, the GDP soared to about \$5 billion<sup>1</sup> in 1990 before a Paris Club debt rescheduling took place in September 1990. Subsequently, the estimated GDP for yearend 1990 was \$2.2 billion. The nonfuel minerals sector in the Congo remained virtually unexploited.

Mining legislation in the 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. Hydro-Congo is the state-owned petroleum company.

Congolese crude oil exports reached approximately 52 Mbbl in 1990. Congo's producing oilfields are all offshore. Of the total crude oil production in the Congo, at least 70% is exported to the United States. The United States imported approximately \$360 million worth of Congolese crude oil in 1990. Additionally, Gabonese manganese ore and concentrate transshipments are exported through the Congo. The United States imported about \$1.7 million worth of manganese exported through the Congo in 1990.

The petroleum industry in the Congo was beset by strikes and labor unrest in late 1990. Though short lived, the strikes were in response to the planned restructuring of Hydro-Congo and the concomitant employee layoffs. Some loss of revenue was incurred due to the strikes being coincident with the world oil price surge caused by Iraq's invasion of Kuwait. Despite these problems, the Congo experienced record production levels and revenues, with the trend expected to continue into 1991.

Société Nationale Elf Aquitaine (Elf) of France, operating through its subsidiary Elf-Congo, was the primary petroleum producer and accounted for 80% of total production within the Congo. Production of crude oil from the Congo represented 19% of Elf's global production. The other major producer in the Congo, accounting for about 20% of total crude oil output, was Italy's Azienda Generali Italiana Petroli S.p.A. (Agip). Elf-Congo and Agip together produce virtually all of the Congo's crude petroleum.

In early 1990, U.S. companies were making a new presence in petroleum exploration and development in the Congo. On February 1, 1990, Atlantic Richfield Co. (Arco), Apache Oil, and Citizens Energy Corp. of the United States signed an oil exploration agreement with Hydro-Congo. The signing followed more than 1 year of negotiations and covered exploration and production rights on the Marine 8 Field offshore of Pointe-Noire. The tract was reported to cover 980 km<sup>2</sup>. Arco was designated as the operator of the field. Equity partnerships in the permit were 50% Hydro-

Congo; 26.79% Arco; 21.21% Apache Oil; and 3% Citizens Energy Corp. The American companies will pay exploration and startup costs.

Following a 5-year hiatus, the state-owned Société Congolaise de Recherche et d'Exploitation Minières (Socorem) had hoped to resume mining operations during 1990 at two base metal deposits in the M'Fouati region, 290 km southwest of Brazzaville. The two deposits, Djenguile and Yanga-Koubenza, were to produce copper, lead, and zinc. However, mining had not re-commenced by yearend 1990. A beneficiation plant for the mines, built by the U.S.S.R. with a capacity of 6 kmt/a of lead, already existed in the region. Prior to the closure of this plant, lead and zinc were mined and exported to the U.S.S.R. Some small base metal mining still persists. Additionally, Socorem reported that negotiations were proceeding with unnamed U.S. companies to study possible exploitation of diamonds and gold in the Congo. Congo exported more than \$7 million worth of gem-quality and industrial-grade diamonds

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

| Commodity <sup>2</sup>                                    | 1986   | 1987   | 1988   | 1989 <sup>p</sup> | 1990 <sup>e</sup> |
|---|--------|--------|--------|-------------------|-------------------|
| Cement, hydraulic <sup>3</sup> metric tons                | 58,000 | 76,000 | 77,000 | 77,000            | 77,000            |
| Copper, mine output,<br>Cu content do.                    | 250    | 726    | 726    | 1,000             | 1,000             |
| Gas, natural: <sup>e</sup>                                |        |        |        |                   |                   |
| Gross million cubic meters                                | 368    | 368    | 368    | 368               | 368               |
| Marketed do.  | 350    | 350    | 350    | 350               | 350               |
| Gold, mine output,<br>Au content <sup>e</sup> kilograms   | 5      | 4      | 4      | 4                 | 4                 |
| Lead, mine output,<br>Pb content <sup>e</sup> metric tons | 1,400  | 1,400  | 1,750  | 1,000             | 1,000             |
| Lime <sup>e</sup> do.                                     | 7,000  | 7,000  | 7,000  | 7,000             | 7,000             |
| Petroleum, crude<br>thousand 42-gallon barrels            | 43,435 | 44,895 | 49,275 | 55,000            | 458,765           |
| Zinc, mine output,<br>Zn content <sup>e</sup> metric tons | 2,300  | 2,300  | 1,750  | 1,000             | 1,000             |

<sup>e</sup>Estimated. <sup>p</sup>Preliminary.

<sup>1</sup>Includes data available through Jan. 31, 1992.

<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>Includes imported clinker.

<sup>4</sup>Reported figure.

to the United States in 1990. This represented an increase over previous Congolese diamond exports to the United States for 1989, which were more than \$3.5 million. The vast majority of diamonds exported from the Congo originate in Zaire. Historically, diamond production in the Congo has been insignificant.

Société Nationale d'Énergie is the Government's electrical utility in Congo. Total installed electrical capacity is 133 MW.

Most of this capacity is hydroelectric, with diesel generators operating in isolated areas. Railroads within Congo total 797 km. Highways total 12,000 km, of which 560 km has a bituminous surface.

Congo's nonfuel mineral resource potential has yet to be exploited. Copper, lead, and zinc mineralization exist in the Congo along with occurrences of iron ore. Industrial mineral resource potential includes potash and phosphate in southeastern

Congo and bentonite, granite, gypsum, kaolin, marble, and talc elsewhere. Successful nonfuel mineral resource development in the Congo is dependent on the development of an adequate transportation infrastructure.

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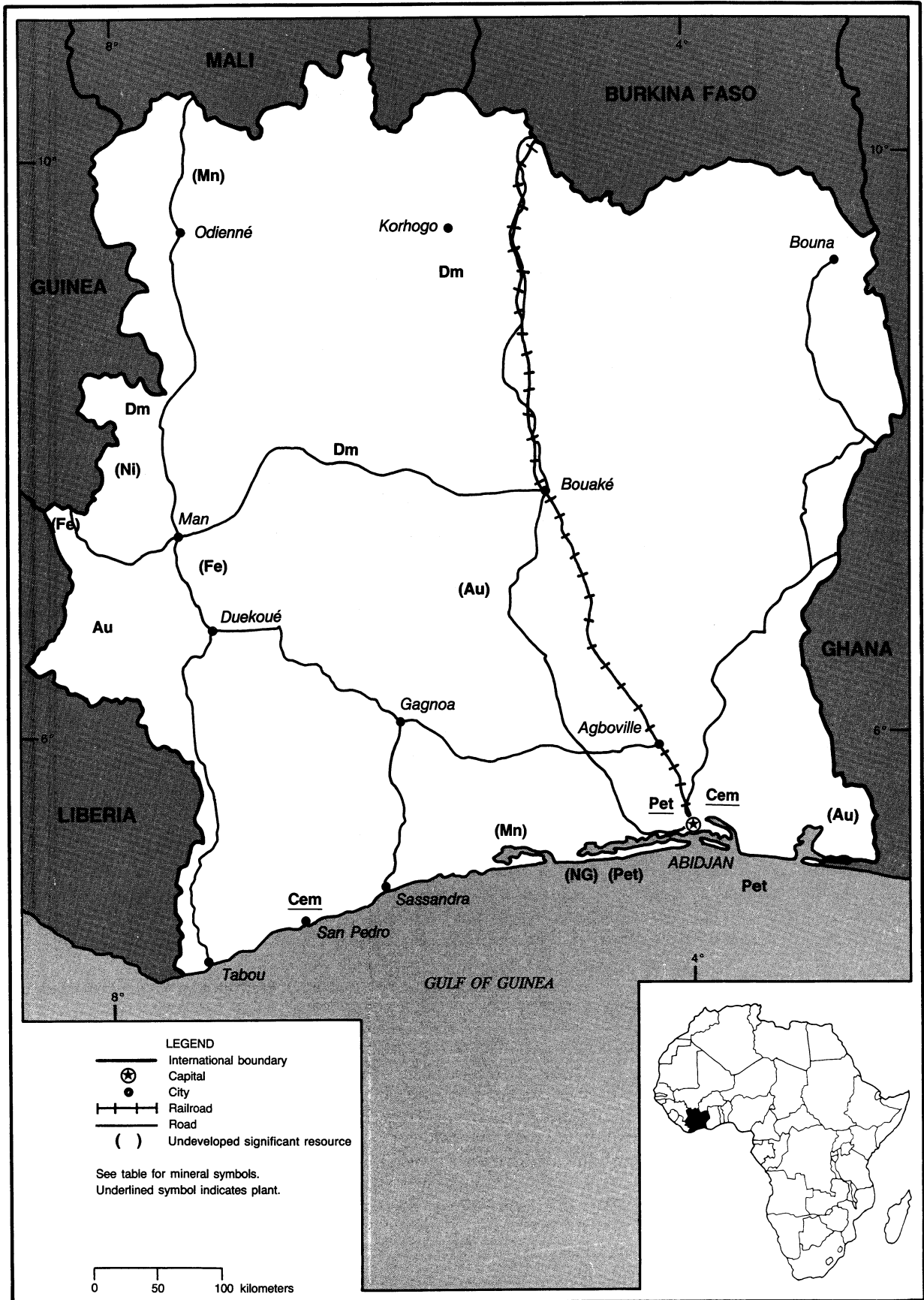
<sup>1</sup>Where necessary, values have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF272.26=US\$1.00.



# COTE D'IVOIRE

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

POPULATION 12.5 million



# THE MINERAL INDUSTRY OF CÔTE D'IVOIRE

By Hendrik G. van Oss

**T**he production of mineral commodities played a relatively minor role in the economy of Côte d'Ivoire in 1990. Mining revenues were equivalent to an estimated 5% to 6% of the country's GDP of about \$9.8 billion;<sup>1</sup> however, minerals accounted for about 13% of the value of the country's total exports. The Ivoirian economy remained dominated by the production of agricultural products, notably cocoa, coffee, and timber. As in 1989, low world prices for cocoa and coffee severely hurt the country's export revenues and its economy in general. Noting the significant revival in the past few years of the mining industries in some other West African countries such as Ghana and Mali, the Government has begun to reassess past policies favoring the non-mining sectors.

The Ivoirian mineral economy in 1990 remained dominated by the production of petroleum, albeit at the modest level resulting from the late 1988 closure of one of the country's two oilfields. Two oil refineries operated during the year, largely on imported input, but their output was inadequate to meet demand. In the past, Côte d'Ivoire has had a modest production of gold, diamonds, and manganese ore, as well as construction materials. However, manganese has not been produced since 1970, and gold and diamonds have in recent years only been produced by artisanal methods, in small quantities. The country's cement production in 1990 was well below capacity and was entirely dependent on imported clinker.

Employment in the minerals industry is relatively insignificant, numbering about 1,500 in the petroleum production and refining companies and perhaps 1,000 others in the cement and construction materials sector. Estimates of the number of artisanal gold and diamond miners are not available, but the number in 1990 probably did not exceed 1,000 persons.

Following the lead of other countries in the region, the Government began drafting a new mining code in 1990; however, the basic mining law of Côte d'Ivoire during

the year remained the Mining Code (law No. 64-249) of July 3, 1964. In a similar vein, a new contractual framework for oil and gas exploration was drafted during 1989 and was released in June 1990 as part of a new exploration promotion program. This supplemented the Petroleum Code (law No. 70-849) of August 3, 1970, as modified in 1975, 1982, and 1983. The Government has traditionally taken an equity interest in mineral exploitation, either through the Société Nationale d'Opérations Pétrolières de la Côte d'Ivoire (PETROCI), or through the Société d'Etat pour le Développement Minier de la Côte d'Ivoire (SODEMI), for fuel and nonfuel minerals, respectively. These parastatals are also involved in mineral exploration, commonly in cooperation with foreign entities. The degree of state equity participation in new ventures has decreased in recent years; however, foreign investors are still encouraged to take Ivoirian partners.

The Government's new attitude to mining, and the geologic similarity of the country to its mineral-rich neighbors, have encouraged both the reevaluation of certain known deposits in Côte d'Ivoire and the startup of a number of new grassroots mineral exploration programs. These efforts have begun to pay off, and mineral production is expected to play a larger role in the Ivoirian economy in the near future. The country's first new gold mine in many decades commenced operations late in 1990, and another gold property is expected to be in production by about 1993. Other gold exploration efforts are underway. A feasibility study on a large nickel laterite deposit was completed during the year, and financing is being sought to bring the property into production. Oil exploration was ongoing during the year, and efforts were being made to develop a known natural gas field. A number of offshore petroleum exploration blocks were opened to bidding at midyear.

Virtually all of Côte d'Ivoire is made up of Precambrian rocks, including a number of northeast-trending belts containing

volcanosedimentary rocks of the Birimian series. This terrane hosts lode gold and other deposits, such as iron, manganese and nickel. Some gold deposits are in extensions of greenstone belts that have been the source of significant gold production in Ghana and Mali. Placer gold occurrences, most derived from Birimian lode occurrences, are widespread. Diamond-bearing kimberlites have been found in north-central Côte d'Ivoire; some of these have been mined, as have several placer deposits derived from these kimberlites and from sources outside the country.

Tertiary clastic sedimentary rocks exist along and offshore part of the country's Atlantic coast, and form a sedimentary basin that hosts Côte d'Ivoire's modest known oil and natural gas reserves and holds promise of additional discoveries.

With the closure of the Espoir offshore oilfield toward yearend 1988, brought on by severely declining reserves, the country's oil production fell almost 85% to only about 2,000 bbl/d in 1989, with about the same production in 1990.

Côte d'Ivoire's trade is dominated by the export of agricultural products, the import of petroleum products, and the transshipment of goods for some of the country's landlocked neighbors. Total exports increased slightly in 1989 to about \$2.7 billion and are estimated to have been about \$3 billion in 1990. In 1989, the latest year for which complete data were available, sales of cocoa, coffee, and timber amounted to about \$1.3 billion.

Total mineral commodity exports in 1990, including trans-shipments, are estimated to have amounted to about \$390 million, of which petroleum product exports contributed an estimated \$325 to \$340 million. By comparison, petroleum product exports in 1989 amounted to about \$265 million. Although much of the petroleum product exports represent refinery output based on imported crude petroleum, the increase in export value in 1990 appears to be at least in part due to petroleum price increases associated with instability in the

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

| Commodity <sup>2</sup>                   | 1986               | 1987               | 1988   | 1989 <sup>p</sup>   | 1990 <sup>e</sup> |
|--|--------------------|--------------------|--------|---------------------|-------------------|
| Cement <sup>3</sup> thousand metric tons | 776                | 653                | 700    | 500                 | 500               |
| Diamond <sup>4</sup> carats              | 13,600             | 21,000             | 11,157 | <sup>5</sup> 11,689 | 12,000            |
| Gold <sup>4</sup> kilograms              | 5                  | 7                  | 6      | 13                  | 20                |
| Petroleum:                               |                    |                    |        |                     |                   |
| Crude thousand 42-gallon barrels         | <sup>6</sup> 6,600 | <sup>6</sup> 6,200 | 4,721  | <sup>7</sup> 771    | <sup>7</sup> 770  |
| Refinery products: <sup>c</sup>          |                    |                    |        |                     |                   |
| Motor gasoline do.                       | 2,190              | 2,555              | 2,562  | 2,562               | 2,562             |
| Kerosene and jet fuel do.                | 3,285              | 3,285              | 3,294  | 3,294               | 3,294             |
| Distillate fuel oil do.                  | 3,650              | 3,650              | 3,660  | 3,660               | 3,660             |
| Residual fuel oil do.                    | 3,650              | 3,650              | 3,660  | 3,660               | 3,660             |
| Liquefied petroleum gas do.              | 350                | 350                | 350    | 350                 | 350               |
| Other do.                                | 365                | 365                | 366    | 366                 | 366               |
| Total do.                                | 13,490             | 13,855             | 13,892 | 13,892              | 13,892            |

<sup>e</sup>Estimated. <sup>p</sup>Preliminary.

<sup>1</sup>Includes data available through May 31, 1991.

<sup>2</sup>In addition to the commodities listed, Côte d'Ivoire produces clay, stone, and sand and gravel 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>Data are for fiscal year ending July 30.

<sup>7</sup>Production from the Bélier Field only. Espoir Field shut down Oct. 26, 1988.

TABLE 2  
COTE D'IVOIRE: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

| Major commodity                     | Major operating companies                  | Location of main facilities                               | Annual capacity                     |
|-------------------------------------|--|---|-------------------------------------|
| Cement thousand metric tons         | Société des Ciments d'Abidjan              | Clinker-grinding plant at Abidjan                         | <sup>e</sup> 600.                   |
| Do.                                 | Société Ivoirienne de Ciments et Matériaux | do.   | <sup>e</sup> 750.                   |
| Do.                                 | Société des Ciments du Sud Ouest           | Clinker-grinding plant at San Pedro                       | <sup>e</sup> 300.                   |
| Gold kilograms                      | Société des Mines d'Ity <sup>1</sup>       | Open pit mine, 90 kilometers southwest of Man             | 650.                                |
| Petroleum, crude thousand barrels   | Esso consortium                            | Bélier offshore field, 32 kilometers southeast of Abidjan | 730.                                |
| Petroleum, refined thousand barrels | Société Ivoirienne de Raffinage (SIR)      | Petroleum refinery in Abidjan                             | Crude input: 21,500.                |
| Do.                                 | Société Multinationale de Bitumes          | Petroleum refinery in Abidjan                             | Crude input: 10, asphalt output: 5. |

<sup>e</sup>Estimated.

<sup>1</sup>Mining commenced in 1990. First gold pour was in Jan. 1991. Reported grade is 7 grams per ton.

Persian Gulf region. Exports of non-metallic minerals amounted to an estimated \$30 to \$35 million in 1990, of which cement exports accounted for about 90%. Fertilizer exports are estimated to have amounted to almost \$10 million. Exports of metallic minerals are estimated to have been worth less than \$1 million. About 85% of Côte d'Ivoire's total mineral commodity exports

were to neighboring West African countries. Mineral commodity exports to Europe and to the United States accounted for about 10% and 5% of the total, respectively; most of these exports were of refined petroleum products.

Total imports in 1990 are estimated to have amounted to about \$1.95 billion, an apparent 30% increase from those of 1989. Petroleum and petroleum product imports

accounted for about 25% of the increase--largely as a result of higher oil prices induced by the conflict in the Persian Gulf. Petroleum and petroleum product imports amounted to an estimated 21% of total imports and about 85% of mineral commodity imports. Crude petroleum imports alone accounted for an estimated 75% of total mineral imports. About one-third of the

petroleum and petroleum product imports were destined for reexport, either as transhipped petroleum products, or after refining in Côte d'Ivoire. The country's imports of non-metallic minerals amounted to an estimated \$39 million, of which about 75% was accounted for by clinker and gypsum imports for the cement industry. Salt imports amounted to an estimated \$5 million, and fertilizer imports were an estimated \$20 million. Imports of metallic minerals were minor, amounting to about \$2 million.

France was the source of about one-third of Côte d'Ivoire's total imports, but only about 4% of the country's imports of mineral commodities. Imports of mineral commodities were from a wide range of countries, especially in Africa. Mineral commodity imports from African countries totaled an estimated \$390. Most of the country's crude petroleum imports were from Nigeria. The non-petroleum mineral component of imports from African countries amounted to an estimated \$18 million, including salt, \$5 million, and clinker, \$8 million. Metallic mineral imports were only a minor component of these imports; the most significant imports of this type were of manganese ore from Gabon, worth an estimated \$700,000. Fertilizer imports (including manufactured) from African countries amounted to an estimated \$8 million. Imports of mineral commodities from the United States were estimated to have been worth about \$11 million, about 50% of which was of partially refined petroleum products, and about 45% was of fertilizers.

Société des Mines d'Ity, a joint venture between SODEMI, 60%; and COFRAMINES of France, 40%, commenced site preparation early in 1990 on the Ity gold deposit southwest of Man. A cyanide plant adequate for the planned 700-mt/d heap-leach operation was constructed for the mine by Kappes, Cassidy and Associates of the United States and was shipped to Côte d'Ivoire at the end of September 1990. Gold production had been anticipated by yearend, but minor startup problems delayed the first gold pour until the end of January 1991. The open pit mine's reserves are in gold-bearing laterite and were reported by the SODEMI to be 715,000 tons grading 7 g/mt of gold. In addition, there is a resource of almost 1.5 Mmt grading 9 g/mt of gold within a columnar clay zone beneath the laterite. However, metallurgical problems with this clay material have, to date, prevented it from being added to the reserves. The existing mining operation is restricted to the laterite

and envisions a 7-year mine life, with an average annual gold output of 650 kg.

Marshall Minerals Corp. of Canada continued both exploration and reserve-delineation drilling in its Afema shear zone gold concession in the southeastern corner of the country. The Afema shear zone is an extension of the gold-rich Bibiani belt in Ghana. Exploration by Marshall to date has only covered part of the company's 7.5-km by 27-km concession and a few of the known deposits; most of the reserves so far delineated are in the Asupiri and Aniuri deposits. The former appears to have the largest reserves and the best grades, but is an underground mining proposition. A prefeasibility study, completed in November, concluded that open pit mining of the oxide ore in the Aniuri and some smaller satellite deposits was economic using heap-leach extraction of the gold. Gold resources have also been identified in sulfide ore underlying the oxide ore at several of the deposits; however, this material, which also contains active carbon, requires preoxidation and is thus not amenable to heap leaching.

Reserves presented in the prefeasibility study were almost immediately superseded by the results of a continuing drilling program. The adjusted surface reserves at yearend for Aniuri were given by Marshall as about 640,000 tons, grading 4.31 g/mt of gold. This included about 140,000 tons of mixed sulfide-oxide ore in the lowest pit bench; leaching of this material will have a gold recovery of only about 50% to 60%, compared with 85% to 90% in the overlying pure oxide ore. The adjusted underground reserves for Aniuri were 456,000 tons (all classes) at an average gold grade of 4.6 g/mt. For Asupiri, the underground reserves (all classes) were about 463,000 tons at an average gold grade of 7.4 g/mt. Total surface reserves for the Afema concession, including several satellite deposits, were listed as 1.6 Mmt (all classes) at 3.5 g/mt of gold. The total underground reserves were given as about 920,000 tons grading about 6 g/mt of gold.

Financing for the mine was being negotiated at yearend, and it was anticipated that site preparation would commence in early 1991. Kappes Cassidy was to construct the cyanide plant for the heap-leach operation, which was to mine 150,000 tons in the first year and 180,000 mt/a thereafter. The first gold pour was anticipated by early 1992. The operating company is Société Minière d'Afema, a joint venture of Eden Roc Mineral Corp. of Canada, 90%, and SODEMI,

10%. Marshall purchased Eden Roc's share of the property in early 1989, but the latter's name has been retained.

A number of companies are known to be exploring for gold in Côte d'Ivoire, although few results have been announced. In their 1989 annual report, France's Bureau de Recherches Géologiques et Minières announced that drilling on the Angovia gold deposit southwest of Bouaké had indicated a resource of 2.8 Mmt grading 5 g/mt of gold.

Côte d'Ivoire has significant nickel and cobalt resources in laterites overlying ultramafic rocks near Sipilou, northwest of Man. Discovered in the early 1970's by SODEMI, the nickel deposits were drilled by Falconbridge Ltd. of Canada from 1979 to 1982. At Sipilou, a resource in excess of 50 Mmt, grading 1.9% Ni, was outlined. At yearend 1989, Trillion Resources of Canada signed a joint venture with SODEMI to further evaluate the deposit. A feasibility study, which reevaluated the SODEMI and Falconbridge drilling, recalculated the reserves, and did some additional metallurgical work, was completed in September 1990. According to Trillion, the study concluded that the Sipilou deposit has minable reserves of 81 Mmt grading 1.65% Ni-equivalent (defined as equal parts Ni and Co), at a 1.4% Ni-equivalent cutoff. Because the stripping ratios are high, the company was seeking a partner to exploit the deposit, and in the interim, was hoping to do exploration work on some smaller, higher grade deposits in the area that could be more cheaply mined. The best of these, to date, is the Moyango deposit, with apparent reserves of 20 Mmt grading 2.5% Ni-equivalent.

<sup>1</sup>Where necessary, values have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate CFAF272.26=US\$1.00.

## OTHER SOURCES OF INFORMATION

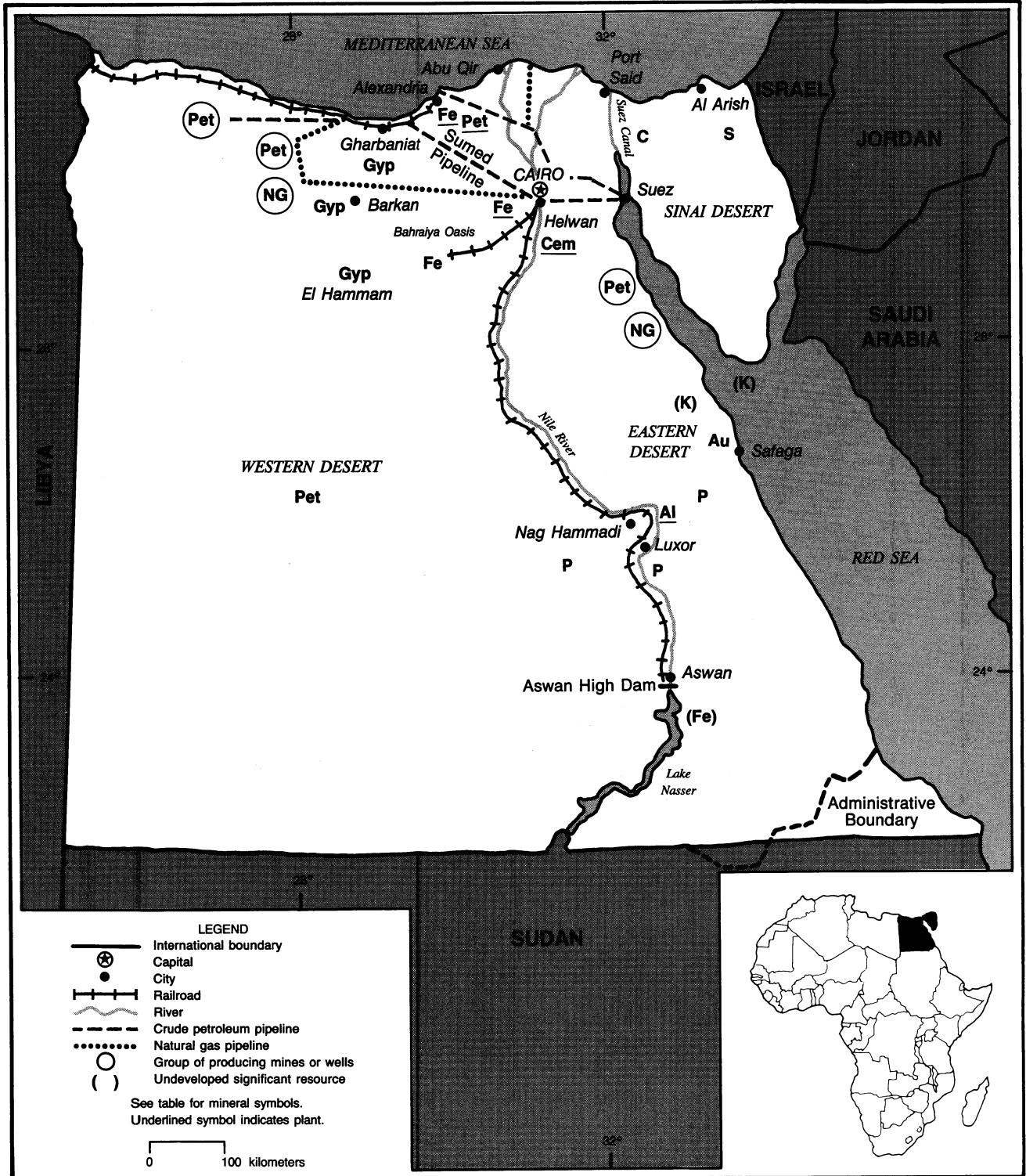
Direction de la Géologie  
Ministère des Mines  
B.P. V28  
Abidjan, Côte d'Ivoire  
Société Nationale d'Opérations Pétrolières  
de la Côte d'Ivoire (PETROCI)  
B.P. V194  
Abidjan, Côte d'Ivoire  
Société pour le Développement Minier  
de la Côte d'Ivoire (SODEMI)  
01 B.P. 2816  
Abidjan 01, Côte d'Ivoire



# EGYPT

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

POPULATION 54.7 million



# THE MINERAL INDUSTRY OF EGYPT

By Thomas P. Dolley

**T**he mineral industry remained a minor contributor to the Egyptian economy in 1990. The mineral fuels sector was the exception by virtue of its petroleum production and export revenues. Foreign petroleum exploration operators in Egypt were encouraging the Government to allow greater flexibility concerning cost recovery and profit sharing, and longer periods of exploration and evaluation time. The operators acknowledged that greater flexibility would allow for more intense exploration at the Western Desert frontier with Libya, and the Red Sea along with the Sinai peninsula.

Remittances of Egyptian workers in the gulf states remained the largest foreign exchange earner in Egypt in 1990. However, the Egyptian economy suffered in 1990 from inflation, foreign exchange shortages, arrears in debt service, and increasing unemployment and underemployment. These economic trends continued unabated into early 1991 and were exacerbated by the Persian Gulf Crisis and War commencing in August 1990. The estimated gross domestic product for the year ending June 30, 1990, was \$34 billion.<sup>1</sup>

The developments in Iraq and Kuwait precipitated an exodus of expatriated Egyptian workers back to Egypt. The results of this were increased unemployment, which was estimated at 22%. This condition was exacerbated by the loss of an estimated \$5 billion in hard currency from displaced gulf workers' salaries and sagging tourism, the second leading foreign exchange earner in Egypt.

The burgeoning Egyptian debt service was partially relieved by the United States and the Gulf states through the forgiveness of \$15 billion of debt. The trade deficit for 1990 was approximately \$7.4 billion.

## GOVERNMENT POLICIES AND PROGRAMS

Mining legislation dated back to the Mining and Petroleum Code, Law No. 66 of 1953, and Mining Code Law No. 86 of 1956. 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. Additionally, a new natural gas clause should allow foreign concessionaires to share directly in the profits from gas production and provide exploration incentives where they previously did not exist.

Egypt was not a member of the Organization of Petroleum Exporting Countries. Thus, a Government commission sets the price per barrel of crude oil exports on the 1st and 15th of each month. The price set usually paralleled the world petroleum price. Because of the high-sulfur content of Egyptian crudes, the price tended to be somewhat lower than the comparable world petroleum price.

## PRODUCTION

Total crude petroleum production averaged 875,000 bbl/d in 1990, representing an estimated 3% increase over the previous year. Natural gas production along with foreign interest and activities in hydrocarbon exploration also increased.

Dominant nonfuel mineral production and concomitant downstream products in 1990 were phosphates, kaolin, gypsum, sand for glass, handmade porcelain, and finished glass products.

## TRADE

With the exception of petroleum, phosphates and salt remained the primary mineral exports of Egypt. The United States was Egypt's leading trading partner in 1990, followed by Italy, Romania, and Israel. The U.S. exports to Egypt in 1990 were an estimated \$2.3 billion, down from the \$2.6 billion in exports of 1989.

Hydrocarbon exports account for approximately 43% of total exports. These hydrocarbon exports represent an estimated 47% of total Egyptian crude oil production. Petroleum exports continued to be an important source of foreign exchange for the Egyptian

economy, amounting to \$1.3 billion in fiscal year 1989-1990. Total exports of Egyptian products amounted to approximately \$4.3 billion, an increase of almost \$1 billion over the 1989 figure. However, total import trade amounted to an estimated \$11.7 billion in 1990.

## 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 the Egyptian Geological Survey and Mining Authority (EGSMA), which is subordinate to the Ministry of Petroleum and Mineral Wealth. In the event that the foreign mining investor enters the production stage of development, a joint venture company is formed with EGSMA.

Maric controls five major parastatals which dominate the Egyptian mining industry. These companies are the El Nasr Phosphate Company, Red Sea Phosphate Company, Misr Phosphate Company, the Sinai Manganese Company, and the El Nasr Saline Company.

Iron and steel production, along with oil production and refining, was based on production-sharing agreements when involved with foreign oil companies. The Government generally held a 50% equity ownership in these production-sharing agreements.

## COMMODITY REVIEW

### Metals

**Iron and Steel.**—By yearend 1990, the Government anticipated German loans to increase railway and landing facilities for the iron ore mine at the Bahariya Oasis in the Western Desert. The refurbishment is expected to increase domestic iron ore

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

(Metric tons unless otherwise specified)

| Commodity                                  | 1986                       | 1987                 | 1988                  | 1989 <sup>p</sup>      | 1990 <sup>e</sup>    |                      |
|--|----------------------------|----------------------|-----------------------|------------------------|----------------------|----------------------|
| <b>METALS</b>                              |                            |                      |                       |                        |                      |                      |
| Aluminum metal                             | 175,000                    | 178,850              | 173,460               | <sup>2</sup> 179,500   | <sup>2</sup> 179,167 |                      |
| Copper, refined, secondary <sup>c</sup>    | 2,500                      | 2,500                | <sup>2</sup> 4,000    | <sup>2</sup> 3,600     | 3,600                |                      |
| Iron and steel:                            |                            |                      |                       |                        |                      |                      |
| Iron ore and concentrate                   | thousand tons              | 2,135                | 1,700                 | 2,000                  | <sup>2</sup> 2,562   | <sup>2</sup> 2,405   |
| Pig iron                                   | do                         | 121                  | 46                    | 132                    | 132                  | <sup>2</sup> 108     |
| Crude steel                                | do                         | 281                  | 347                   | 347                    | <sup>2</sup> 1,400   | <sup>2</sup> 2,100   |
| Semimanufactures                           | do                         | NA                   | NA                    | NA                     | NA                   | NA                   |
| Ferroalloys: Ferrosilicon                  | 7,221                      | 7,702                | 7,806                 | 7,800                  | <sup>2</sup> 7,922   |                      |
| <b>INDUSTRIAL MINERALS</b>                 |                            |                      |                       |                        |                      |                      |
| Asbestos                                   | 476                        | 209                  | 166                   | <sup>2</sup> 312       | <sup>2</sup> 369     |                      |
| Barite                                     | 3,385                      | 4,116                | 5,651                 | <sup>2</sup> 7,295     | <sup>2</sup> 66,197  |                      |
| Cement: Hydraulic                          | thousand tons              | 7,612                | 8,746                 | 9,787                  | <sup>2</sup> 9,507   | <sup>2</sup> 15,299  |
| Clays:                                     |                            |                      |                       |                        |                      |                      |
| Bentonite                                  | 5,126                      | 3,827                | 3,166                 | <sup>2</sup> 3,512     | <sup>2</sup> 4,904   |                      |
| Fire clay                                  | 364,300                    | 148,727              | 150,000               | <sup>2</sup> 250,000   | <sup>2</sup> 128,130 |                      |
| Kaolin                                     | 127,784                    | 125,256              | <sup>1e</sup> 124,000 | <sup>2</sup> 121,515   | <sup>2</sup> 49,032  |                      |
| Feldspar, crude                            | 19,287                     | 15,963               | 6,131                 | <sup>2</sup> 27,731    | <sup>2</sup> 9,894   |                      |
| Fluorspar                                  | 80                         | 776                  | 1,849                 | <sup>2</sup> 1,721     | <sup>2</sup> 1,249   |                      |
| Gypsum and anhydrite, crude                | 905,688                    | 1,088,472            | 1,100,000             | <sup>2</sup> 1,309,426 | <sup>2</sup> 482,310 |                      |
| Lime <sup>c</sup>                          | 95,000                     | 95,000               | 95,000                | 95,000                 | <sup>2</sup> 67,650  |                      |
| Nitrogen: Ammonia, N content               | thousand tons              | <sup>2</sup> 679     | <sup>2</sup> 789      | <sup>2</sup> 788       | <sup>2</sup> 728     | 735                  |
| Phosphate: Phosphate rock                  | do                         | 1,271                | 1,167                 | 1,146                  | <sup>2</sup> 1,347   | <sup>2</sup> 1,143   |
| Salt, arine                                | do                         | 976                  | 1,012                 | 922                    | <sup>2</sup> 1,162   | <sup>2</sup> 989     |
| Sodium compounds:                          |                            |                      |                       |                        |                      |                      |
| Soda ash                                   | <sup>e</sup> 50,000        | <sup>e</sup> 45,000  | 47,711                | 47,000                 | <sup>2</sup> 52,180  |                      |
| Sodium sulfate                             | 18,940                     | 42,484               | <sup>e</sup> 42,000   | <sup>2</sup> 45,677    | <sup>2</sup> 41,418  |                      |
| Stone, sand and gravel:                    |                            |                      |                       |                        |                      |                      |
| Basalt                                     | thousand cubic meters      | 899                  | 1,044                 | 1,050                  | <sup>2</sup> 873     | 870                  |
| Dolomite <sup>c</sup>                      | thousand tons              | 500                  | 500                   | 500                    | 500                  | 500                  |
| Granite, dimension                         | cubic meters               | 2,938                | 2,000                 | <sup>1e</sup> 12,000   | <sup>2</sup> 21,487  | 21,000               |
| Gravel                                     | thousand cubic meters      | 11,214               | 11,200                | <sup>e</sup> 11,000    | <sup>2</sup> 11,527  | 11,000               |
| Limestone and other calcareous n.e.s.      | do                         | 13,476               | 14,785                | <sup>e</sup> 15,000    | <sup>2</sup> 16,347  | <sup>2</sup> 286     |
| Marble blocks (including alabaster)        | cubic meters               | 40,000               | 27,814                | 13,000                 | <sup>2</sup> 27,857  | <sup>2</sup> 743     |
| Quartz                                     | NA                         | NA                   | NA                    | NA                     | NA                   | NA                   |
| Sand including glass sand                  | thousand cubic meters      | 13,122               | 246                   | 55                     | <sup>2</sup> 11,645  | <sup>2</sup> 23,315  |
| Sandstone                                  | do                         | 475                  | 417                   | <sup>e</sup> 400       | <sup>2</sup> 316     | 300                  |
| Sulfur:                                    |                            |                      |                       |                        |                      |                      |
| Elemental, byproduct <sup>c</sup>          | 7,300                      | 7,600                | 7,600                 | 7,600                  | 7,600                |                      |
| Sulfuric acid                              | 55,000                     | <sup>1e</sup> 57,000 | 31,274                | 31,000                 | <sup>2</sup> 65,268  |                      |
| Talc, steatite, soapstone, pyrophyllite    | 8,800                      | <sup>e</sup> 7,500   | 7,268                 | <sup>2</sup> 7,146     | <sup>2</sup> 6,340   |                      |
| Vermiculite                                | 495                        | <sup>e</sup> 500     | 236                   | <sup>2</sup> 272       | <sup>2</sup> 28      |                      |
| <b>MINERAL FUELS AND RELATED MATERIALS</b> |                            |                      |                       |                        |                      |                      |
| Coke: Oven and beehive                     | thousand tons              | 908                  | <sup>e</sup> 900      | 936                    | 930                  | <sup>2</sup> 1,077   |
| Gas, natural:                              |                            |                      |                       |                        |                      |                      |
| Gross production                           | million cubic feet         | 180,000              | 195,200               | 195,000                | <sup>2</sup> 226,000 | <sup>2</sup> 240,000 |
| Marketed                                   | do                         | 155,000              | 155,000               | 155,000                | 155,000              | 155,000              |
| Petroleum and refinery products:           |                            |                      |                       |                        |                      |                      |
| Crude                                      | thousand 42-gallon barrels | 296,745              | 327,040               | 309,520                | <sup>2</sup> 310,980 | <sup>2</sup> 319,375 |

See footnotes at end of table.

TABLE 1—Continued

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

(Metric tons unless otherwise specified)

| Commodity  | 1986    | 1987     | 1988     | 1989 <sup>2</sup> | 1990 <sup>2</sup> |
|--|---------|----------|----------|-------------------|-------------------|
| <b>MINERAL FUELS AND RELATED MATERIALS—Continued</b> |         |          |          |                   |                   |
| <b>Petroleum and refinery products:—Continued</b>    |         |          |          |                   |                   |
| Refinery products:                                   |         |          |          |                   |                   |
| Gasoline and naphtha do                              | 27,000  | *27,000  | *27,000  | 27,000            | 27,000            |
| Kerosene and jet fuel do                             | 20,000  | *20,000  | *20,000  | 20,000            | 20,000            |
| Distillate fuel oil do                               | 30,000  | *30,000  | *30,000  | 30,000            | 30,000            |
| Residual fuel oil do                                 | 60,000  | *60,000  | *60,000  | 60,000            | 60,000            |
| Lubricants do  | 1,000   | *1,000   | *1,000   | 1,000             | 1,000             |
| Liquefied petroleum gas do                           | 5,000   | *5,000   | *5,000   | 5,000             | 5,000             |
| Asphalt do   | 2,000   | *2,000   | *2,000   | 2,000             | 2,000             |
| Unspecified do                                       | 4,500   | *4,500   | *4,500   | 4,500             | 4,500             |
| Refinery fuel and losses do                          | 6,500   | *6,500   | *6,500   | 6,500             | 6,500             |
| Total do   | 156,000 | *156,000 | *156,000 | 156,000           | 156,000           |

<sup>\*</sup>Estimated. <sup>2</sup>Preliminary. <sup>1</sup>Revised. NA Not available.<sup>1</sup>Table includes data available through March 25, 1991.<sup>2</sup>Reported figure.

TABLE 5

EGYPT: EXPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity                                | 1988    | 1989    | Destinations, 1989 |   |
|--|---------|---------|--------------------|---|
|  |         |         | United States      | Other (principal)                                     |
| <b>METALS</b>                            |         |         |                    |   |
| Alkali and alkaline-earth metals         | 20      | —       |                    |   |
| Aluminum: Metal including alloys:        |         |         |                    |   |
| Scrap                                    | 300     | 366     | —                  | Lebanon 365.  |
| Unwrought                                | 1       | 1,375   | —                  | Jordan 642; Japan 402; Switzerland 100.               |
| Semimanufactures                         | 121,513 | 115,883 | 20                 | Netherlands 55,461; Italy 34,763; Saudi Arabia 5,326. |
| Copper:                                  |         |         |                    |   |
| Matte and speiss including cement copper | —       | 51      | —                  | West Germany 41; Greece 10.                           |
| Metal including alloys:                  |         |         |                    |   |
| Scrap                                    | 857     | 38      | —                  | Netherlands 22; Belgium-Luxembourg 16.                |
| Unwrought                                | —       | 3,181   | —                  | Italy 1,289; Netherlands 779; West Germany 560.       |
| Semimanufactures                         | 302     | 1,272   | ( <sup>2</sup> )   | Netherlands 463; Iraq 300; Austria 255.               |
| Iron and steel: Metal:                   |         |         |                    |   |
| Scrap                                    | 1,392   | 2,292   | —                  | Netherlands 1,412; United Kingdom 355; Japan 268.     |
| Pig iron, cast iron, related materials   | 3       | 120     | —                  | Saudi Arabia 90; Sudan 30.                            |
| Ferroalloys:                             |         |         |                    |   |
| Ferromanganese                           | 10      | —       |                    |   |
| Ferrosilicon                             | 15,170  | 14,815  | —                  | Japan 5,419; West Germany 4,387; Italy 1,068.         |
| Steel, primary forms                     | 43,101  | 14,270  | —                  | West Germany 5,000; Austria 2,997; Albania 2,623.     |

See footnotes at end of table.

TABLE 2—Continued

EGYPT: EXPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity  | 1988    | 1989    | Destinations, 1989 |   |
|--|---------|---------|--------------------|---|
|  |         |         | United States      | Other (principal)   |
| <b>METALS—Continued</b>                                      |         |         |                    |   |
| <b>Iron and steel:—Continued</b>                             |         |         |                    |   |
| <b>Semimanufactures:</b>                                     |         |         |                    |   |
| Bars, rods, angles, shapes, sections                         | 17,632  | 29,971  | —                  | West Germany 12,307; Belgium-Luxembourg 9,433; Spain 3,522.   |
| Universals, plates, sheets                                   | 32,648  | 28,166  | —                  | Spain 6,343; Turkey 4,779; West Germany 4,117.                |
| Hoop and strip   | 523     | 2,588   | —                  | Iraq 2,100; Turkey 470.                                       |
| Wire   | 23,914  | 62,412  | 2,844              | West Germany 24,186; Spain 14,818; Belgium-Luxembourg 14,306. |
| Tubes, pipes, fittings                                       | 4,348   | 3,731   | 3,092              | Sudan 401; Jordan 199.  |
| Castings and forgings, rough                                 | 390     | 916     | —                  | Iraq 464; Oman 111; Libya 93.                                 |
| <b>Lead:</b>   |         |         |                    |   |
| Oxides   | 49      | —       | —                  |   |
| Metal including alloys: Semimanufactures                     | 34      | —       | —                  |   |
| Magnesium: Metal including alloys, scrap                     | —       | 30      | —                  | All to Netherlands.   |
| Manganese: Ore and concentrate, metallurgical-grade          | 1       | —       | —                  |   |
| Nickel: Metal including alloys, semimanufactures             | —       | 3       | —                  | All to Ethiopia.  |
| <b>Zinc:</b>   |         |         |                    |   |
| Oxides   | —       | 60      | —                  | All to India.   |
| <b>Metal including alloys:</b>                               |         |         |                    |   |
| Scrap  | —       | 580     | —                  | India 320; Republic of Korea 260.                             |
| Unwrought  | 6       | 135     | —                  | India 86; Japan 20; Greece 10.                                |
| Semimanufactures   | 350     | 268     | —                  | All to India.   |
| <b>INDUSTRIAL MINERALS</b>                                   |         |         |                    |   |
| Abrasives, n.e.s.: Grinding and polishing wheels and stones  | 18      | 22      | —                  | All to Cyprus.  |
| Cement   | 9,986   | 1,400   | —                  | All to Sudan.   |
| Clays, crude   | 5,785   | 386     | —                  | United Kingdom 152; undetermined 218.                         |
| Feldspar, fluorspar, related materials                       | —       | 21      | —                  | Italy 20.   |
| <b>Fertilizer materials: Manufactured:</b>                   |         |         |                    |   |
| Ammonia  | —       | 1,804   | —                  | Jordan 1,503; Greece 300.                                     |
| Nitrogenous  | 13,757  | 38,824  | —                  | France 17,161; Belgium-Luxembourg 8,998; Jordan 5,262.        |
| Phosphatic   | 4,000   | —       | —                  |   |
| Potassic   | —       | 45      | —                  | All to Italy.   |
| Unspecified and mixed  | 3,711   | 60      | —                  | All to U.S.S.R.   |
| Lime   | 80      | 80      | —                  | All to Kuwait.  |
| Mica: Worked including agglomerated splittings               | —       | 1       | —                  | All to U.S.S.R.   |
| Phosphates, crude  | 122,254 | 291     | —                  | Sudan 150; Oman 100; Saudi Arabia 41.                         |
| Pigments, mineral: Iron oxides and hydroxides, processed     | 51      | 12      | —                  | All to Jordan.  |
| Salt and brine   | 122,017 | 131,775 | —                  | Italy 104,852; Lebanon 16,308; Nigeria 10,000.                |
| Sodium compounds, n.e.s.: Soda ash, natural and manufactured | —       | 5       | —                  | All to West Germany.  |
| <b>Stone, sand and gravel:</b>                               |         |         |                    |   |
| <b>Dimension stone:</b>                                      |         |         |                    |   |
| Crude and partly worked                                      | 2,945   | 2,854   | —                  | West Germany 2,164; Italy 458.                                |

See footnotes at end of table.

TABLE 2—Continued

EGYPT: EXPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity  | 1988                       | 1989             | Destinations, 1989 |   |  |
|--|----------------------------|------------------|--------------------|---|--|
|  |                            |                  | United States      | Other (principal)                             |  |
| <b>INDUSTRIAL MINERALS—Continued</b>                 |                            |                  |                    |   |  |
| Stone, sand and gravel:—Continued                    |                            |                  |                    |   |  |
| Dimension stone:—Continued                           |                            |                  |                    |   |  |
| Worked   | 372                        | 14               | —                  | Saudi Arabia 8; Austria 4.                    |  |
| Gravel and crushed rock                              | 2,011                      | —                |                    |   |  |
| Sand other than metal-bearing                        | 24,284                     | 16,646           | 200                | Oman 16,310.                                  |  |
| Sulfur: Elemental: Colloidal, precipitated, sublimed |                            |                  |                    |   |  |
|  | —                          | 40               | —                  | All to Sudan.                                 |  |
| Sulfuric acid  | —                          | 230              | —                  | Qatar 200; Libya 30.                          |  |
| Talc, steatite, soapstone, pyrophyllite              | 528                        | 285              | —                  | East Germany 185; Poland 100.                 |  |
| Other: Crude   | —                          | 25               | —                  | All to Saudi Arabia.                          |  |
| <b>MINERAL FUELS AND RELATED MATERIALS</b>           |                            |                  |                    |   |  |
| Asphalt and bitumen, natural                         | 60                         | —                |                    |   |  |
| Carbon black   | 1                          | —                |                    |   |  |
| Coal: Anthracite and bituminous                      | —                          | 233              | —                  | Saudi Arabia 120; West Germany 113.           |  |
| Coke and semicoke                                    | 72,544                     | 167,748          | 18,428             | Tunisia 68,345; Brazil 33,000; France 28,921. |  |
| Petroleum:   |                            |                  |                    |   |  |
| Crude  | thousand 42-gallon barrels | 51,022           | 42,909             | 1,922   | Israel 11,745; Italy 10,367; Singapore 4,826.    |
| Refinery products:                                   |                            |                  |                    |   |  |
| Liquefied petroleum gas                              | do.                        | 49               | 936                | —   | Yemen (Sanaa) 572; Lebanon 117; India 62.        |
| Gasoline   | do.                        | 200              | 13                 | —   | All to France.                                   |
| Mineral jelly and wax                                | do.                        | 342              | 162                | 34  | West Germany 122.                                |
| Kerosene and jet fuel                                | do.                        | 10,706           | ( <sup>2</sup> )   | —   | All to Austria.                                  |
| Distillate fuel oil                                  | do.                        | 1,077            | 19,730             | 101   | France 6,018; Italy 4,936; bunkers 6,013.        |
| Lubricants   | do.                        | 12               | 3                  | —   | Jordan 2; Kuwait 1.                              |
| Residual fuel oil                                    | do.                        | 13,377           | 358                | 29  | West Germany 116; France 110; United Kingdom 68. |
| Bitumen and other residues                           | do.                        | 215              | —                  |   |  |
| Bituminous mixtures                                  | do.                        | ( <sup>2</sup> ) | —                  |   |  |
| Petroleum coke                                       | do.                        | ( <sup>2</sup> ) | 168                | —   | France 91; United Kingdom 55.                    |

<sup>1</sup>Revised.<sup>1</sup>Table prepared by Virginia A. Woodson.<sup>2</sup>Less than 1/2 unit.<sup>3</sup>Unreported quantity valued at \$17,354,000.

TABLE 3

EGYPT: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity                        | 1988             | 1989  | Sources, 1989 |                   |   |
|----------------------------------|------------------|-------|---------------|-------------------|---|
|                                  |                  |       | United States | Other (principal) |   |
| <b>METALS</b>                    |                  |       |               |                   |   |
| Alkali and alkaline-earth metals | value, thousands | —     | \$26          | \$1               | West Germany \$24.                        |
| Aluminum:                        |                  |       |               |                   |   |
| Ore and concentrate              |                  | 2     | 784           | 14                | West Germany 299; Brazil 178; Ireland 92. |
| Oxides and hydroxides            |                  | 554   | 1,216         | 35                | India 1,023; West Germany 59.             |
| Metal including alloys:          |                  |       |               |                   |   |
| Unwrought                        |                  | 1     | —             |                   |   |
| Semimanufactures                 |                  | 2,089 | 2,657         | 11                | Italy 809; West Germany 761; France 265.  |

See footnotes at end of table.

TABLE 3—Continued

EGYPT: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity                                 | 1988    | 1989    | Sources, 1989 |  |
|---|---------|---------|---------------|--|
|   |         |         | United States | Other (principal)  |
| <b>METALS—Continued</b>                   |         |         |               |  |
| Chromium: Oxides and hydroxides           | 111     | 116     | —             | Poland 55; China 54.                                     |
| Cobalt: Oxides and hydroxides             | —       | 15      | —             | China 6; United Kingdom 2; undetermined 6.               |
| <b>Copper:</b>                            |         |         |               |  |
| Matte and speiss including cement copper  | 998     | 17      | —             | All from Italy.  |
| <b>Metal including alloys:</b>            |         |         |               |  |
| Scrap                                     | 11      | 4       | —             | All for ship's stores.                                   |
| Unwrought                                 | 5       | —       | —             |  |
| Semimanufactures                          | 14,853  | 12,870  | 972           | West Germany 4,221; Turkey 3,689; Greece 1,085.          |
| <b>Iron and steel:</b>                    |         |         |               |  |
| <b>Iron ore and concentrate:</b>          |         |         |               |  |
| Excluding roasted pyrite                  | 826,602 | 545,673 | —             | Brazil 422,534; Sweden 123,098.                          |
| Pyrite, roasted                           | 4       | 21      | NA            | NA.  |
| <b>Metal:</b>                             |         |         |               |  |
| Scrap                                     | 11,772  | 34,029  | 26,567        | NA.  |
| Pig iron, cast iron, related materials    | 61,818  | 18,323  | 5             | Canada 9,787; Poland 5,501.                              |
| <b>Ferrous alloys:</b>                    |         |         |               |  |
| Ferromanganese                            | 11,770  | 7,962   | —             | Switzerland 3,150; France 3,001; West Germany 940.       |
| Ferrosilicon                              | 162     | 3,149   | —             | Switzerland 3,075.                                       |
| Unspecified                               | 333     | 307     | —             | West Germany 215; Italy 85.                              |
| Steel, primary forms                      | 66,394  | 86,791  | 14,819        | Bulgaria 14,514; West Germany 13,544; Hungary 13,388.    |
| <b>Semimanufactures:</b>                  |         |         |               |  |
| Bars, rods, angles, shapes, sections      | 752,613 | 635,673 | 1             | Romania 333,156; Czechoslovakia 78,653; Turkey 62,252.   |
| Universals, plates, sheets                | 256,437 | 142,964 | 6,406         | West Germany 19,552; France 14,979; Bulgaria 11,104.     |
| Hoop and strip                            | 1,717   | 2,457   | 200           | Turkey 935; West Germany 838; France 271.                |
| Rails and accessories                     | 5,815   | 14,880  | —             | Netherlands 3,038; Switzerland 2,358; Italy 1,964.       |
| Wire                                      | 22,319  | 11,162  | 1             | Turkey 2,663; Poland 2,265; China 1,608.                 |
| Tubes, pipes, fittings                    | 96,260  | 63,418  | 10,625        | Japan 7,514; Albania 5,099; West Germany 4,371.          |
| Castings and forgings, rough              | 35,720  | 14,874  | 1,911         | Romania 2,326; France 2,116; U.S.S.R. 1,486.             |
| <b>Lead:</b>                              |         |         |               |  |
| Oxides                                    | 1,564   | 1,047   | —             | Bulgaria 812; France 189.                                |
| <b>Metal including alloys:</b>            |         |         |               |  |
| Scrap                                     | 3,013   | 518     | —             | Tunisia 150; United Kingdom 133; Belgium Luxembourg 131. |
| Unwrought                                 | 16,058  | 7,888   | —             | United Kingdom 4,026; Italy 1,792; East Germany 987.     |
| Semimanufactures                          | 69      | 44      | —             | Netherlands 23; Hungary 20.                              |
| <b>Magnesium: Metal including alloys:</b> |         |         |               |  |
| Scrap                                     | —       | 20      | —             | All from Netherlands.                                    |
| Unwrought                                 | 42      | 50      | —             | All from Yugoslavia.                                     |
| <b>Manganese:</b>                         |         |         |               |  |
| Ore and concentrate, metallurgical-grade  | 408     | 539     | —             | West Germany 428; Singapore 101.                         |

See footnotes at end of table.

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

(Metric tons unless otherwise specified)

| Commodity  | 1988          | 1989    | Sources, 1989    |   |  |
|--|---------------|---------|------------------|---|--|
|  |               |         | United States    | Other (principal)   |  |
| <b>METALS—Continued</b>  |               |         |                  |   |  |
| <b>Manganese:—Continued</b>  |               |         |                  |   |  |
| Oxides   | 24            | 541     | —                | Belgium-Luxembourg 326; Ireland 148.                        |  |
| Mercury  | 16            | 69      | —                | Hungary 20; Netherlands 20; United Kingdom 16.              |  |
| Molybdenum: Metal including alloys, unwrought <sup>2</sup>                   | 13            | 5       | —                | Mainly from United Kingdom.                                 |  |
| <b>Nickel:</b>   |               |         |                  |   |  |
| Matte and speiss   | 19            | 40      | —                | Canada 13; United Kingdom 16.                               |  |
| <b>Metal including alloys:</b>   |               |         |                  |   |  |
| Unwrought  | 6             | 42      | —                | Netherlands 25; France 6; Zimbabwe 5.                       |  |
| Semimanufactures   | 64            | 56      | —                | Belgium-Luxembourg 25; West Germany 22.                     |  |
| Platinum-group metals: Metals including alloys, unwrought and partly wrought |               |         |                  |   |  |
| value, thousands   | \$17          | —       |                  |   |  |
| Silver: Metal including alloys, unwrought and partly wrought                 | do.           | \$2,627 | \$1,877          | —   | Switzerland \$989; West Germany \$322; France \$249. |
| <b>Tin: Metal including alloys:</b>  |               |         |                  |   |  |
| Scrap  | —             | 1       | —                | All from United Kingdom.                                    |  |
| Unwrought  | 297           | 312     | —                | Malaysia 100; West Germany 88; Belgium-Luxembourg 60.       |  |
| Semimanufactures   | 46            | 20      | ( <sup>3</sup> ) | Republic of Korea 12; United Kingdom 3.                     |  |
| Titanium: Oxides   | 2,296         | 2,148   | 59               | West Germany 934; France 436; Belgium-Luxembourg 159.       |  |
| Tungsten: Metal including alloys, unwrought                                  | —             | 2       | —                | France 1; Hungary 1.  |  |
| <b>Zinc:</b>   |               |         |                  |   |  |
| Oxides   | 998           | 499     | —                | France 186; China 143; Spain 51.                            |  |
| <b>Metal including alloys:</b>   |               |         |                  |   |  |
| Scrap  | 209           | 560     | 19               | Switzerland 450; Netherlands 71.                            |  |
| Unwrought  | 10,432        | 9,341   | 20               | Zaire 7,107; Switzerland 1,000; France 750.                 |  |
| Semimanufactures   | 12            | 23      | 1                | Norway 19; China 1.   |  |
| <b>Other:</b>  |               |         |                  |   |  |
| Ore and concentrate  | 1,100         | 5,314   | 289              | China 4,000; West Germany 482.                              |  |
| Oxides and hydroxides  | 125           | 187     | —                | West Germany 155; Italy 6.                                  |  |
| Base metals including alloys, all forms                                      | 142           | 241     | —                | Netherlands 102; China 70; Switzerland 61.                  |  |
| <b>INDUSTRIAL MINERALS</b>   |               |         |                  |   |  |
| <b>Abrasives, n.e.s.:</b>  |               |         |                  |   |  |
| Natural: Corundum, emery, pumice, etc.                                       | 184           | 832     | ( <sup>3</sup> ) | Greece 542; Japan 187.                                      |  |
| Artificial: Corundum   | 62            | 155     | 73               | West Germany 72.  |  |
| Grinding and polishing wheels and stones                                     | 2,376         | 1,951   | ( <sup>3</sup> ) | Italy 1,051; Yugoslavia 520; Czechoslovakia 213.            |  |
| Asbestos, crude  | 12,230        | 17,033  | —                | Greece 9,685; Canada 2,610; Republic of South Africa 1,635. |  |
| Boron materials: Oxides and acids  | 297           | 326     | ( <sup>3</sup> ) | Turkey 220; Italy 100.                                      |  |
| Bromine <sup>4</sup>   | —             | 9       | —                | All from United Kingdom.                                    |  |
| Cement   | thousand tons | 2,373   | 404              | —   | Romania 155; Jordan 63; U.S.S.R. 34.                 |
| Chalk  | 48            | 15      | 3                | West Germany 12.  |  |
| Clays, crude   | 34,353        | 41,948  | 18               | United Kingdom 25,777; Cyprus 4,113; West Germany 3,205.    |  |

See footnotes at end of table.



TABLE 3—Continued

EGYPT: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity  | 1988             | 1989             | Sources, 1989    |   |  |
|--|------------------|------------------|------------------|---|--|
|  |                  |                  | United States    | Other (principal)                                     |  |
| <b>INDUSTRIAL MINERALS—Continued</b>                     |                  |                  |                  |   |  |
| Cryolite and chiolite                                    | 72               | —                |                  |   |  |
| Diamond, natural: Industrial stones value, thousands     | \$107            | —                |                  |   |  |
| Feldspar, fluorspar, related materials                   | 15,345           | 11,379           | —                | Turkey 11,135.  |  |
| Fertilizer materials:                                    |                  |                  |                  |   |  |
| Crude, n.e.s.  | 1                | 9,200            | —                | All from Switzerland.                                 |  |
| Manufactured:  |                  |                  |                  |   |  |
| Ammonia  | 111              | ( <sup>3</sup> ) | —                | All to West Germany.                                  |  |
| Nitrogenous  | 438,261          | 521,466          | —                | U.S.S.R. 259,296; Romania 85,138; Bulgaria 67,582.    |  |
| Phosphatic   | 9,428            | 1,022            | —                | Iraq 500; Jordan 500.                                 |  |
| Potassic   | 14,977           | 25,606           | 15               | Switzerland 13,675; Italy 8,420.                      |  |
| Unspecified and mixed                                    | 651              | 1,481            | 115              | Netherlands 930; Switzerland 117.                     |  |
| Graphite, natural  | 859              | 1,036            | —                | China 758; West Germany 136.                          |  |
| Magnesium compounds, unspecified                         | 34,312           | 21,386           | ( <sup>3</sup> ) | Greece 11,247; Austria 4,736; West Germany 2,631.     |  |
| Mica:  |                  |                  |                  |   |  |
| Crude including splittings and waste                     | 95               | 22               | —                | India 21.   |  |
| Worked including agglomerated splittings                 | 12               | 25               | ( <sup>3</sup> ) | Japan 14; India 8.                                    |  |
| Pigments, mineral: Iron oxides and hydroxides, processed | 3,771            | 4,534            | 1                | China 3,454; East Germany 360.                        |  |
| Precious and semiprecious stones other than diamond:     |                  |                  |                  |   |  |
| Natural  | value, thousands | \$43             | \$51             | —   | Hong Kong \$24; West Germany \$11; United Kingdom \$9. |
| Synthetic  | do.              | \$883            | \$29             | —   | Hong Kong \$16; West Germany \$8.                      |
| Salt and brine   | 137              | 485              | —                | Netherlands 463; France 19.                           |  |
| Stone, sand and gravel:                                  |                  |                  |                  |   |  |
| Dimension stone:   |                  |                  |                  |   |  |
| Crude and partly worked                                  | 707              | 336              | —                | All from Italy.                                       |  |
| Worked   | 1,542            | 620              | ( <sup>3</sup> ) | Italy 569; France 23.                                 |  |
| Dolomite, chiefly refractory-grade                       | 39               | 343              | —                | Hungary 299; Austria 21; Norway 20.                   |  |
| Gravel and crushed rock                                  | 518              | 1,200            | ( <sup>3</sup> ) | Italy 508; France 458.                                |  |
| Quartz and quartzite                                     | 174              | 11,614           | —                | Turkey 11,135.  |  |
| Sand other than metal-bearing                            | 562              | 1,137            | 6                | Belgium-Luxembourg 827; West Germany 176.             |  |
| Sulfur:  |                  |                  |                  |   |  |
| Elemental:   |                  |                  |                  |   |  |
| Crude including native and byproduct                     | 164,873          | 136,878          | —                | Iraq 136,780.   |  |
| Colloidal, precipitated, sublimed                        | 481              | 14,421           | —                | Iraq 14,280.  |  |
| Sulfuric acid  | 219              | 34               | —                | United Kingdom 16; France 14.                         |  |
| Talc, steatite, soapstone, pyrophyllite                  | 1,617            | 4,511            | 3                | Finland 2,526; Norway 1,449.                          |  |
| Other: Crude   | 1,451            | 1,131            | 18               | India 474; Cyprus 394; Italy 119.                     |  |
| <b>MINERAL FUELS AND RELATED MATERIALS</b>               |                  |                  |                  |   |  |
| Carbon black   | 6,652            | 6,441            | 651              | France 1,526; West Germany 1,024; United Kingdom 995. |  |
| Coal:  |                  |                  |                  |   |  |
| Anthracite and bituminous                                | thousand tons    | 1,142            | 1,291            | 439   | U.S.S.R. 491; Australia 361.                           |
| Lignite including briquets                               | —                | 2                | —                | —   | All from Jordan.                                       |
| Unspecified  | 10               | —                | —                | —   |  |

See footnotes at end of table.

TABLE 3—Continued

EGYPT: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity   | 1988 | 1989                | Sources, 1989    |   |
|---|------|---------------------|------------------|---|
|   |      |                     | United States    | Other (principal)                         |
| <b>MINERAL FUELS AND RELATED MATERIALS:—Continued</b> |      |                     |                  |   |
| Coke and semicoke                                     | —    | 6,000               | —                | All from Italy.                           |
| Peat including briquets and litter                    | 700  | 6,844               | —                | Ireland 6,058; West Germany 478.          |
| Petroleum, refinery products:                         |      |                     |                  |   |
| Liquefied petroleum gas                               |      |                     |                  |   |
| thousand 42-gallon barrels                            | 348  | 893                 | —                | Greece 345; Saudi Arabia 276; Italy 200.  |
| Gasoline  | do.  | ( <sup>3</sup> ) 60 | —                | Mainly from Kuwait.                       |
| Mineral jelly and wax                                 | do.  | 14                  | —                | France 2; West Germany 1.                 |
| Kerosene and jet fuel                                 | do.  | 765                 | ( <sup>3</sup> ) | Syria 105; Italy 76; Greece 75.           |
| Distillate fuel oil                                   | do.  | 4,449               | ( <sup>3</sup> ) | Israel 1,141; U.S.S.R. 391; Bulgaria 230. |
| Lubricants  | do.  | 241                 | 35               | Greece 178; United Kingdom 23.            |
| Bituminous mixtures                                   | do.  | 1                   | ( <sup>3</sup> ) | Mainly from the Netherlands.              |

NA Not available.

<sup>1</sup>Table prepared by Virginia A. Woodson.<sup>2</sup>May include scrap.<sup>3</sup>Less than 1/2 unit.<sup>4</sup>May include iodine and fluorine.

TABLE 4

## EGYPT: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

(Thousand metric tons unless otherwise specified)

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

production from an average of 2 Mmt/a to 4 Mmt/a. Modernization work commenced in 1989 on the railway which links Bahraiya to the integrated steelworks at Helwan, with 100 km of the 250-km total completed.

Egypt remained committed in 1990 to self-sufficiency in steel production through plans for expansion of production capacity to reduce rebar and scrap steel imports. Satisfying increasing domestic demand, the 900 kmt/a direct reduction steel plant at Alexandria commenced production in 1986. However, future loans for steel industry expansion have been delayed in part by the

devaluation of the Egyptian pound against the U.S. dollar.

At yearend 1990, International Steel Rolling Mills (ISRM) announced the \$6 million purchase of a 700 kmt/a rebar mill from the United States' Bethlehem Steel Corp. ISRM, a private sector Egyptian firm, was having the rebar mill dismantled at Steelton in the State of Pennsylvania for refurbishment and transport to Egypt. Rebar production is expected to commence in 1992 after a new reheating furnace is installed. ISRM expected to fill Egypt's current rebar production deficit of 400 kmt/a.

**Titanium.**—During the year, EGSMa attempted to generate foreign interest in the development of black sand beach placers along the Mediterranean coast stretching from Abu Qir Bay to Al Arish Bay. As yet undeveloped, drilling conducted by EGSMa indicated that the heavy minerals ilmenite, hematite, magnetite, zircon, garnet, and monazite are contained in Quaternary sediments comprising beach sand, sand dunes, sheets, and sabkha. Within this context a coastal sabkha is a geomorphological feature that is flooded occasionally and is produced by offshore deposition and

sediment accumulation from the landward side. The Geologic Survey of Egypt determined that proven ore reserves of these heavy minerals was approximately 175 Mmt over the entire area. Provenance of the deposits was indicated to be further up the Nile River before the construction of the Aswan High Dam.

### Industrial Minerals

**Cement.**—The country's goal of 20 Mmt/a production of cement in 1990 fell short, but was greatly improved when compared to the previous year. Current self-sufficiency in cement production along with environmental concerns have caused international lenders to shelve financing for further development.

The Government accepts production from public sector cement companies and vends the cement primarily to public sector construction companies. Ambiguously, the only private sector cement company, Suez Cement, has majority ownership by the Government. The international financial community has recommended Government divestiture of Suez Cement and privatization of the public sector cement companies. These conditions, along with air pollution in suburban Cairo caused by particulate emissions of cement fines may preclude further cement industry development in the near future.

**Potash.**—The revenue sharing contract signed in 1989 between the U.S. subsidiary of Australia's Broken Hill Pty. Ltd. Co. (BHP Utah Minerals International) and EGSMa was ratified by the Government on April 9, 1991. The agreement concerned exploration and development of potash resources along the western coast of the Gulf of Suez and the Red Sea. Exploration and development is to commence in late 1991.

**Phosphate Rock.**—Phosphate rock continued to be the major non-fuel mineral product of Egypt, although production had fluctuated since the mid-1980's. The fluctuation was due in part to changing markets and prices, along with export difficulties due to regional military conflict. Attempts to refurbish and improve phosphate industry infrastructure have been curtailed until recently due to Egypt's debt burden.

Production of phosphate rock came principally from the East and West Sebaiya Mines on the Nile River, south of Luxor. Additional production came from mining activity adjacent to the Red Sea port of

Safaga. Egypt's only phosphoric acid plant was located at Abu Zaabal, north of Cairo.

The Government signed an agreement in 1990 with the Soviet Union to provide mining equipment for a phosphate mining project at Abu Tartur. The project was expected to lead to the production of an estimated 2.2 Mmt/a of 31%  $P_2O_5$  phosphate for local consumption and export. However, the project has been in the development stage for years.

Details of the agreement indicated that the Soviet Union would provide \$18.5 million aimed at supplying and installing mining equipment. Construction of a 580 km railway link between Abu Tartur and the port of Safaga on the Red Sea is a primary goal. Approximately 200 km of the railway have been completed from the Nile River to Safaga.

**Sulfur.**—Freeport Egyptian Sulfur Co., a wholly owned subsidiary of Freeport-McMoRan Inc. of the United States, continued sulfur exploration operations at its North Sinai concession in 1990. The concession area covers 1,200 km<sup>2</sup>, both onshore and offshore, near Al Arish. Differing from typical hydrocarbon joint ventures, the concession agreement was unique in Egypt in that it was based on revenue sharing and included a royalty payment. Additionally, both parties will be responsible for their share of the eventual product with Freeport Egyptian Sulfur Co. managing the product marketing side of the venture. As of mid-1990, 58 exploratory wells have been drilled on the concession. Under the terms of the 7-year agreement, the first exploratory phase of the project will terminate in mid-1991. Upon actual development, the sulfur will be mined utilizing the Frasch process.

Freeport's other sulfur concession agreement, covering 14,000 km<sup>2</sup> of onshore and offshore property in the Eastern Desert along the Gulf of Suez, lapsed in early 1991. Unfavorable preliminary data indicated that this concession was uneconomic when compared to the North Sinai discovery.

### Mineral Fuels

Production oilwells in the Gulf of Suez account for 90% of Egyptian petroleum production. The Gulf of Suez Petroleum Company (GUPCO) is a joint-venture company owned by Amoco Egypt Oil Company of the United States and EGPC. GUPCO's daily production of 430,000 barrels accounts for almost 50% of daily

Egyptian production. GUPCO maintains 90 offshore platforms in the Gulf of Suez and by yearend 1990 had drilled approximately 800 wells on both onshore and offshore tracts. Of the total wells drilled, 304 remain producers.

The United Kingdom's British Gas, in consortium with Yukong of South Korea and the United States' Union Pacific Petroleum Suez, announced a major petroleum discovery at yearend 1990. Once thought to be a poor hydrocarbon prospect and located in the geologically complex northern Gulf of Suez, the 241,000 acre north Zafarana concession appraisal well exhibited a flow rate of 7,500 barrels a day. Additional well data was also positive and further evaluation and drilling will continue in 1991.

Shell Egypt, a subsidiary of the Netherlands Royal Dutch Shell, announced a major crude oil discovery at its Badreddin concession in the Western Desert. Company officials stated that the discovery was made in a 15-m thick section of the Abu Rawash structure. Further evaluation was needed to determine the total hydrocarbon reserve. Additionally, Shell Egypt has been a major player in natural gas development in the Western Desert, and yearend 1990 and early 1991 witnessed a continuation of this development. Company officials also announced another natural gas discovery in the area at their Bed 18 well. Official reserve estimates of contained natural gas are about 100 billion feet<sup>3</sup> with production development continuing. Badreddin Petroleum Company (Bapetco), a joint venture between Shell Egypt and EGPC, will process the natural gas through its existing facilities. Bapetco's nearby Bed 3 gasfield came on-stream in September 1990 and is currently pumping approximately 100 to 150 million feet<sup>3</sup> of natural gas per day to its Alexandria processing facilities. Furthermore, Bapetco is developing the Bed 2 gasfield to commence production in 1992.

Egypt possessed eight operating refineries with a total throughput capacity of 523,153 bbl/d.

### Reserves

The Government estimates reserves of crude petroleum at approximately 4.3 billion barrels and natural gas reserves at 325 billion m<sup>3</sup>.

Gold and copper mineralization exist in Egypt, but are not of sufficient grade to be economically viable. However, much of Egypt remained geologically unexplored in detail.

For 1990, Egypt's Suez Canal Authority commissioned an 18-month, \$2 million feasibility study into deepening and widening the Suez Canal. The action was taken in anticipation of a more vigorous petroleum market for the 1990's. If the dredging and widening were to take place, the canal would accommodate fully laden supertankers with a deadweight tonnage of up to 270 kmt with the deepening of the draught to approximately 20 m. Currently, the canal can handle vessels up to 150,000 dwt. At present, dredging activities should increase the canal's accommodation to 180,000 dwt. The study was contracted to the Dutch Nedeco consortium and funded by the Kuwaiti-based Arab Fund for Economic and Social Development.

Rehabilitation plans were announced in May 1990 for the Aswan No. 1 hydroelectric powerplant, which has had a 30-year operational life. The \$117 million scheme was being appraised by the Federal Republic of Germany's Kreditanstalt fuer Wiederaufbau (KfW). The plan called for replacement of generators and turbines. Current output at the plant was 240 MW, with output ranging in the past from 100 MW to 350 MW.

Construction of new electrical generation capacity received additional stimulus during the year. Egypt's diminished hydroelectrical capacity became a concern in 1987-88 because of lowered riverflow in the Nile. A heavy Nile flood in 1989 eased concerns, but construction still continues for 3,100 MW of additional electrical generation capacity to be fueled by natural gas and petroleum. Completion was slated for 1994 and should increase installed capacity by 33%.

In early 1990, the Egyptian Atomic Energy Authority, in cooperation with the International Atomic Energy Agency in Vienna, completed renovations on the Inshas nuclear reactor, which had been inoperative for 10 years. Primarily for research, the reactor will serve industrial needs, such as the production of iodine-131 for medical purposes. Renovations at the reactor included control, measuring and alarm systems, and radioactive monitoring. Control and safety systems made by the U.S.S.R. were replaced by Western equipment. The Government reported that another reactor was under construction and that the Inshas nuclear reactor should serve in the interim.

## OUTLOOK

Future mineral industry development within Egypt would probably be directed toward domestic utilization as opposed to exporting mineral commodities because of the growing population and industrial demands being placed on the nation.

New hydrocarbon discoveries have not kept pace with declining reserves. Increasing the domestic price for crude oil along with greater utilization of natural gas for energy needs within Egypt could reduce domestic oil consumption and make more crude oil available for export.

Despite greater public awareness of the problems of pollution, the Government agency responsible for such activities, the Egyptian Environmental Affairs Agency, lacked the funds, technical staff, and organizational structure to enforce existing

environmental legislation. The Nile River accepts an estimated 66 million cubic meters of industrial effluent every year including land runoff of Government-subsidized fertilizers and pesticides.

<sup>1</sup>Where necessary, values have been converted from Egyptian pounds (£E) to U.S. dollars at a rate of £E1.55=US\$1.00.

## OTHER SOURCES OF INFORMATION

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

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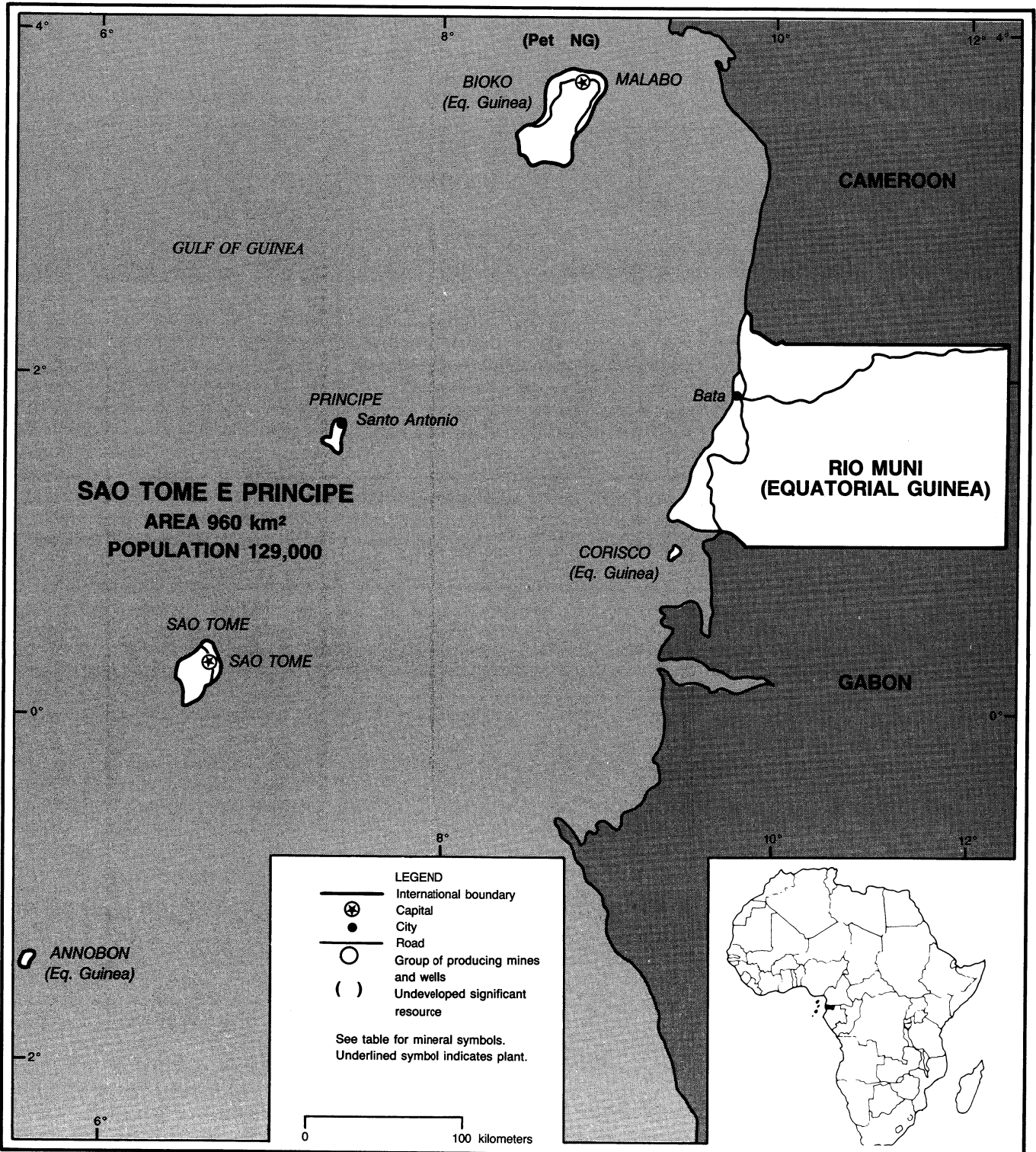
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# EQUATORIAL GUINEA

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

POPULATION 379,000



# THE MINERAL INDUSTRY OF EQUATORIAL GUINEA AND SAO TOME E PRINCIPE

By Thomas P. Dolley

## EQUATORIAL GUINEA

The Republic of Equatorial Guinea had no significant mineral industry activity in 1990. Additionally, exploration of potential offshore oil reserves had been delayed due to the Government's long dispute concerning sovereignty of territorial waters with neighboring Gabon. Volcanic islands and mainland territory comprise the west-central African nation of Equatorial Guinea. With a 2.6% population growth rate, the total population at yearend 1990 was estimated at 379,000 people. Agriculture, forestry, and fishing account for approximately 60% of the GNP and practically all exports.<sup>1</sup>

Petroleum exploitation 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 period of time. The Spanish/Equatorial Guinea Oil Co. (GEPESA) lost its exclusive agreement with the Government, along with sole exploration rights on March 15, 1990, owing to the failure to commence hydrocarbon production on the offshore Alba Field within the specified time of the contract.

Production of crude oil did not exist in Equatorial Guinea as of yearend 1990. Activity was underway in 1990 by Walter International of the United States to exploit the petroleum and natural gas potential of the Alba Field. The Alba Field was first discovered by Repsol of Spain in 1984. The field is 36 kilometers offshore, north of the island of Bioko, and had a lateral extent of 60 kilometers in water 70 meters deep. The current exploration project was capitalized at approximately \$30 million. Walter International planned to drill two wells at the Alba Field, construct a pipeline to shore, and begin constructing a processing plant for recovery of liquids with full production to commence by mid-1991. Approximately \$1 million had been invested in the project by early 1991.

## SAO TOME E PRINCIPE

Sao Tomè e Príncipe is a dual island nation south of Nigeria and west of Gabon on the Equator in the North Atlantic Ocean with a population of approximately 129,000 people. Sao Tomè e Príncipe had no significant mineral industry, with the exception of some small clay and stone open pit operations that are utilized for local construction needs. Sporadic interest has been generated concerning possible offshore hydrocarbon-

bearing strata. The legal system of Sao Tomè 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 for foreign investment.

The major sector of the economy, accounting for approximately 90%, centered on the production and export of the cash crop, cocoa. The nation has been unable to ameliorate its external debt over the past several years. External debt accounted for approximately 80% of export earnings.<sup>2</sup>

<sup>1</sup>Where necessary, values have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF363.29=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 STD122.48=US\$1.00.

## OTHER SOURCES OF INFORMATION

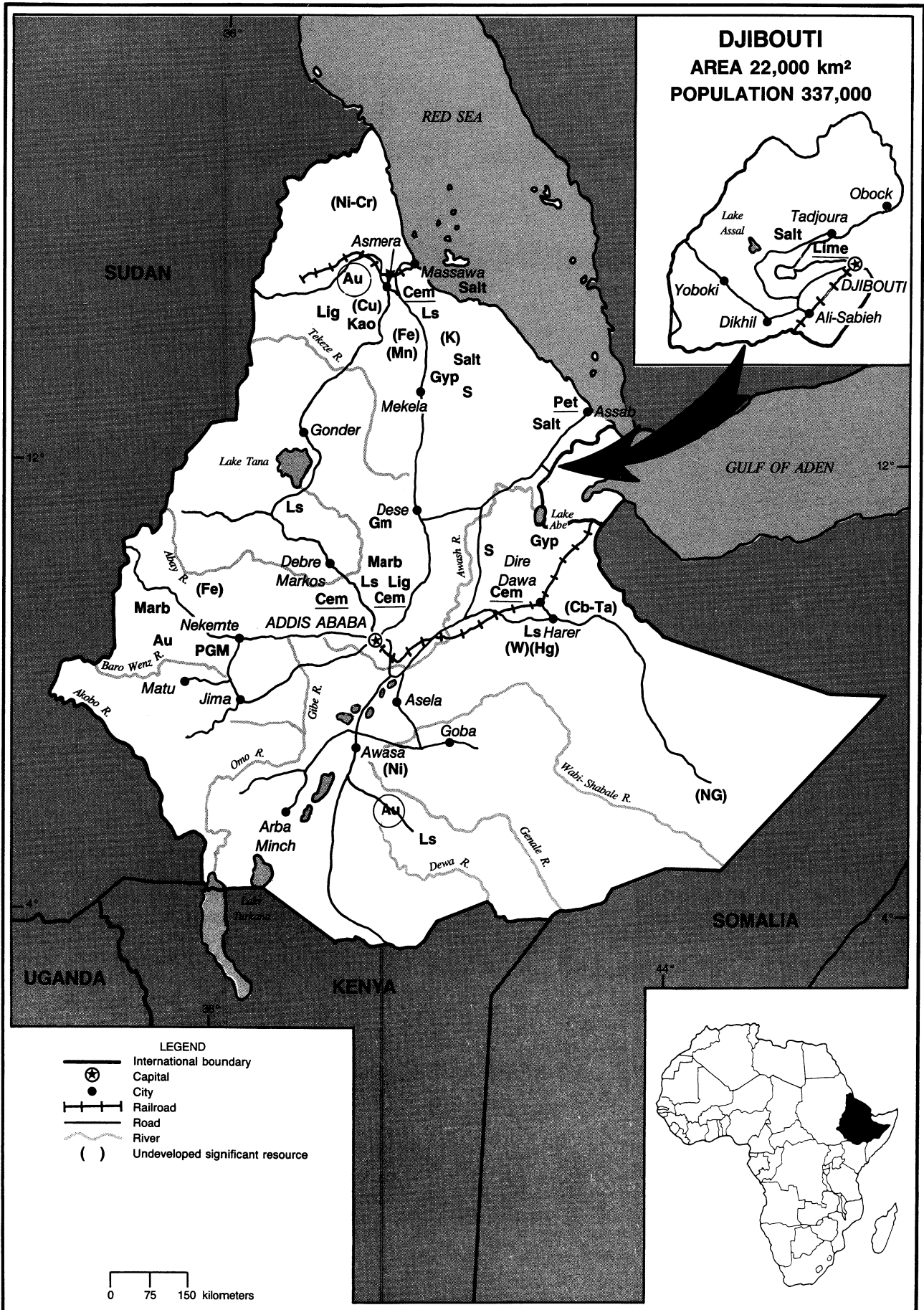
### Agencies

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 Tomè e Príncipe)

# ETHIOPIA AND DJIBOUTI

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

POPULATION 51.7 million



# THE MINERAL INDUSTRY OF ETHIOPIA

By Lloyd E. Antonides

## ETHIOPIA

Minerals remained a small part of Ethiopia's economy as measured by the GDP, which was estimated at just about \$6 billion<sup>1</sup> in 1990, about 1.5% higher than that in 1989. Construction materials, including cement, continued to be the most significant mineral commodity group both in value and quantity. Gold was the principal revenue-earning mineral commodity. A variety of other minerals were produced and many more known to occur in deposits of potentially economic size and grade throughout the country almost twice the size of Texas.

Most of the hard rock minerals were in the extensive mountainous high plateau that comprised the western two-thirds of the country. Cutting through that region was a prominent funnel-shaped rift valley area extending south-westerly from around Djibouti to Lake Turkana, which was the locale for known evaporites. The dry south-eastern sloping plain region was mostly limited to oil and gas possibilities. Such possibilities also exist in the Red Sea area in the far north.

Agriculture was the mainstay of the economy, one of the world's poorest per capita. Coffee was the major export revenue producer as it has been for many years, with most going to the Federal Republic of Germany and the United States. Livestock products were another principal export. Periodic droughts and continuing insurgencies, especially in the north, were major economic as well as political problems. During 1990, the military-controlled Government was accelerating a change to a less doctrinaire socialist state. Early in 1991, business regulations were drastically liberalized and taxes were reduced. Although in May 1991 the rebels finally succeeded in toppling the Government, indications were that movement toward democracy and a market economy would continue at an even faster pace, especially if regional differences could be resolved. Little effect on Government policies and organizations associated with minerals and energy was expected.

During 1990, the Government, with UN assistance, continued to promote both for-

eign and domestic private investment in mining. Petroleum exploration was also encouraged. The UN also assisted studies aimed at making the mining code more attractive to investors. The Government steadily increased its investment in mining from under \$10 million in 1984 to more than \$30 million in 1990, with more than one-half going toward exploration, according to official statistics. Government-owned or partially owned companies dominated the industry, but sizable production also came from artisans and small cooperatives. Programs were directed at helping this sector.

Production data show little change from previous figures except for dimension stone. Those figures probably indicate startup of the new cutting and polishing plant of the EthioLibyan Joint Mining Co. at Awash, 150 km east of Addis Ababa. The source of stone was not identified but presumably the marble, at least, came from quarries several hundred km to the west. Because cement production figures did not show an increase, the new 300,000-mt/a plant at Muger, about 50 km north of Addis Ababa, apparently was not yet in production. Although the 3,000 mt/d of ore gold recovery plant at Lega Dembi was commissioned in 1990, only a small portion of its expected output of 3,000 kg/a of gold was reflected in the 1990 data. The plant was at a new open pit lode gold mine of the Ethiopian Minerals Resources Development Corp. (EMRDC), in the Adola gold district about 350 km south-southeast of Addis Ababa. Production of some tantalite was reported for the first time, at least in recent years, but accuracy of stating that the deposit was in the Lega Dembi area could not be confirmed. An earlier report mentioned a pilot tantalum processing plant due on-stream in late 1989 at what was claimed as the world's largest deposit that also contained colubium as well as cesium and lithium minerals. Soda ash was another newly reported commodity being produced, although some lakes south of Addis Ababa were known for some time to have a high content.

Gold bullion was first poured at the Lega Dembi plant in April. It was melted from amalgamated free gold recovered in the

gravityprocessing section which is expected to contribute 50-60% of the total recovery at the plant. It was designed by and constructed under the supervision of Davy McKee Stockton Ltd. The facilities include cyanide tank leaching, carbon-in-pulp adsorption, hot pressure stripping, electrowinning, and calcining to recover the other 40-50% of the gold which is then melted to produce bullion.

Kaolin and feldspar processing facilities were reported being installed by EMRDC early in the year. Although location was not specified, earlier information indicates a deposit about 400 km east of Addis Ababa.

Potash mineralization about 600 km north-northeast of Addis Ababa in the Denakil Depression again was noted in the press when interest in development was broached by an Ethiopian representative after a meeting of a joint Ethiopian-Chinese economic commission. There have been several previous proposals to redevelop the deposit, most recently as an open pit, since an underground project was flooded-out more than 20 years ago.

Oil exploration efforts continued offshore and onshore in the Red Sea area and inland in the south. Amoco Corp. acquired a 60% interest in a 34,000 km<sup>2</sup> block onshore and offshore along the coast south of Massawa. International Petroleum Ltd. originally held 100%. BP Exploration planned work offshore from Massawa on 32,000 km<sup>2</sup> in which it holds a 75% share and a World Bank affiliate holds 25%. Maxus Energy Corp. of Dallas signed an agreement to spend \$3.5 million or more on studies and drilling, if indicated, in the northern Ogaden Basin in eastern Ethiopia. Hunt Oil also acquired a block in the south along the Kenya border, on the other side of which, near Lake Turkana, Shell Exploration BV planned some studies and drilling, if warranted.

Petroleum refining capacity was expected to increase by 6,500 bbl/d to 24,500 bbl/d at the Assab plant of Ethiopian Petroleum Corp. upon completion in 1993 of the planned expansion.

The outlook for the industry improved substantially with the end of hostilities in mid-1991. But many political questions



TABLE 1

**ETHIOPIA: PRODUCTION OF SELECTED MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>                                   | 1986                 | 1987                 | 1988                 | 1989 <sup>p</sup>    | 1990 <sup>r</sup>    |
|--|----------------------|----------------------|----------------------|----------------------|----------------------|
| Cement, hydraulic  | <sup>r</sup> 270,150 | <sup>r</sup> 350,321 | <sup>r</sup> 405,504 | <sup>r</sup> 370,000 | <sup>r</sup> 340,000 |
| Clays: <sup>e,4</sup>                                    |                      |                      |                      |                      |                      |
| Brick  | 43,000               | 17,000               | 23,000               | 8,000                | 17,000               |
| Kaolin (china clay)                                      | 90                   | 2,500                | 750                  | 390                  | 670                  |
| Diatomite <sup>e</sup>                                   | <sup>r</sup> 137     | <sup>r</sup> 40      | <sup>r</sup> 20      | <sup>r</sup> 10      | <sup>r</sup> 3       |
| Gold: Mine output, Au content kilograms                  | 923                  | <sup>r</sup> 643     | 728                  | 745                  | 850                  |
| Gypsum and anhydrite, crude <sup>e,4</sup>               | <sup>r</sup> 900     | 1,400                | 1,900                | 2,100                | 2,250                |
| Lime   | <sup>r</sup> 5,747   | <sup>r</sup> 5,623   | <sup>r</sup> 3,967   | <sup>r</sup> 4,000   | 4,000                |
| Petroleum refinery products: <sup>5</sup>                |                      |                      |                      |                      |                      |
| Liquid petroleum gas<br>thousand 42-gallon barrels       | <sup>e</sup> 69      | 75                   | 56                   | 74                   | 65                   |
| Gasoline do.   | <sup>e</sup> 913     | 1,059                | 865                  | 1,060                | 904                  |
| Jet fuel do.   | <sup>e</sup> 418     | 421                  | 382                  | <sup>r</sup> 503     | 400                  |
| Kerosene do.   | <sup>e</sup> 64      | 106                  | 95                   | <sup>r</sup> 82      | 40                   |
| Distillate fuel oil do.                                  | <sup>e</sup> 1,484   | 1,612                | 1,294                | 1,534                | 1,409                |
| Residual fuel oil do.                                    | <sup>e</sup> 2,051   | 2,269                | 2,056                | 2,412                | 2,271                |
| Other <sup>6</sup> do.                                   | <sup>e</sup> 525     | 550                  | 340                  | 50                   | 468                  |
| Total do.  | <sup>e</sup> 5,525   | 6,092                | 5,088                | 5,715                | 5,556                |
| Platinum: Mine output, Pt content grams                  | 2,400                | 1,040                | 1,485                | <sup>r</sup> 1,500   | 1,500                |
| Pumice and scoria <sup>e</sup>                           | <sup>r</sup> 49,000  | <sup>r</sup> 33,000  | 55,000               | 33,000               | 40,000               |
| Salt: <sup>e</sup>                                       |                      |                      |                      |                      |                      |
| Marine   | 120,000              | 120,000              | 120,000              | 100,000              | 100,000              |
| Rock and marine  | 135,000              | 135,000              | 135,000              | 110,000              | 110,000              |
| Stone, sand and gravel: <sup>e</sup>                     |                      |                      |                      |                      |                      |
| Construction stone, broken <sup>7</sup><br>thousand tons | <sup>r</sup> 960     | <sup>r</sup> 1,090   | <sup>r</sup> 1,230   | <sup>r</sup> 4,630   | 1,560                |
| Dimension stone <sup>8</sup>                             | <sup>r</sup> 4500    | <sup>r</sup> 4600    | 600                  | 600                  | <sup>r</sup> 3,300   |
| Limestone <sup>9</sup> thousand tons                     | 100                  | <sup>r</sup> 75      | <sup>r</sup> 145     | 150                  | 100                  |
| Sand <sup>4</sup> do.                                    | <sup>r</sup> 540     | 680                  | 990                  | <sup>r</sup> 775     | 1,250                |

<sup>e</sup>Estimated. <sup>p</sup>Preliminary. <sup>r</sup>Revised.<sup>1</sup>Data are for year ending July 7 of the year listed. Includes data available through July 1, 1991.<sup>2</sup>In addition to commodities listed, some lignite, semiprecious gem stones, soda ash (1,408 metric tons in 1990) and tantalite (6 metric tons in 1990) reportedly are produced; also some additional crude construction materials (clay, sand and gravel, stone, etc.) presumably are produced, but information is inadequate for making reliable estimates of output levels.<sup>3</sup>Reported figure.<sup>4</sup>Refinery fuel and losses are distributed across individual products except for 1986 and 1990, see footnote 6. Data 1990 reported in metric tons, conversion estimated; data does not add to total shown owing to independent rounding.<sup>5</sup>For 1986 and 1990, includes refinery fuel and losses estimated in thousand 42-gallon barrels: 1986—431; 1990—1394.<sup>6</sup>Presumably for aggregate or fill and not including dimension stone, limestone for industrial or agricultural use and probably limestone for aggregate and fill.<sup>7</sup>Includes blocks, slabs and/or tiles of granite, limestone, and/or marble as reported.<sup>8</sup>Presumably for agricultural and industrial use (including lime manufacture), and possibly for construction aggregate and fill; but not for cement manufacture (normally requiring 1.5 to 1.8 tons of limestone per ton of cement) or dimension stone.

remained to be resolved before economic expansion can occur.

**DJIBOUTI**

Mineral production remained an insignificant component of Djibouti's economy,

which saw little change in 1990. Small but unspecified quantities of mineral production continued to be reported: solar-evaporated sea salt near Tadjoura by a local entrepreneur, limestone and calcined lime just west of Djibouti city by a private operator; and construction prospects. A potential for marble, granite, gypsum, and perlite pro-

duction was also reported, and mineral water bottling was cited as a possible venture. Geothermal energy for electric power generation continued to be investigated under an International Development Association funding. The oil potential of the country remained untested in spite of possibilities indicated by developments in Aden across the strait to the northeast.

Gold investigations, rumored in 1989, apparently showed enough promise to justify drilling, reported underway in the west in late summer 1990.

The Massachusetts-size, officially French-speaking country's economy was based on its strategic location on the west side of the strait between the Red Sea and Indian Ocean, across from the Republic of Yemen. Its port provided general transshipment and resupply facilities and also was the railroad for shipments to and from Addis Ababa and other Ethiopian cities. More than 70% of the GDP was attributed to services involving maritime, railroad, and related financial-commercial activities. The country also offered a free trade zone and welcomed private investment with favorable laws. In spite of arid and mostly nonproductive soil, agriculture, especially animal husbandry, accounted for almost 30% of the GDP. The work force included a sizable expatriate component, but unemployment was more than 50%. The nation was heavily dependent on foreign aid to balance its payments and to develop projects. Little change in the economy or mineral industry was expected in the future.

<sup>1</sup>Where necessary, values have been converted from Ethiopia birr (EB) to U.S. dollars at the rate of EB2.070=US\$1.00.

**OTHER SOURCES OF INFORMATION****Ethiopia**

Ministry of Mine and Energy  
P.O.Box 486  
Addis Ababa, Ethiopia  
Telephone: 15 74 13 Telex: 21448

**Djibouti**

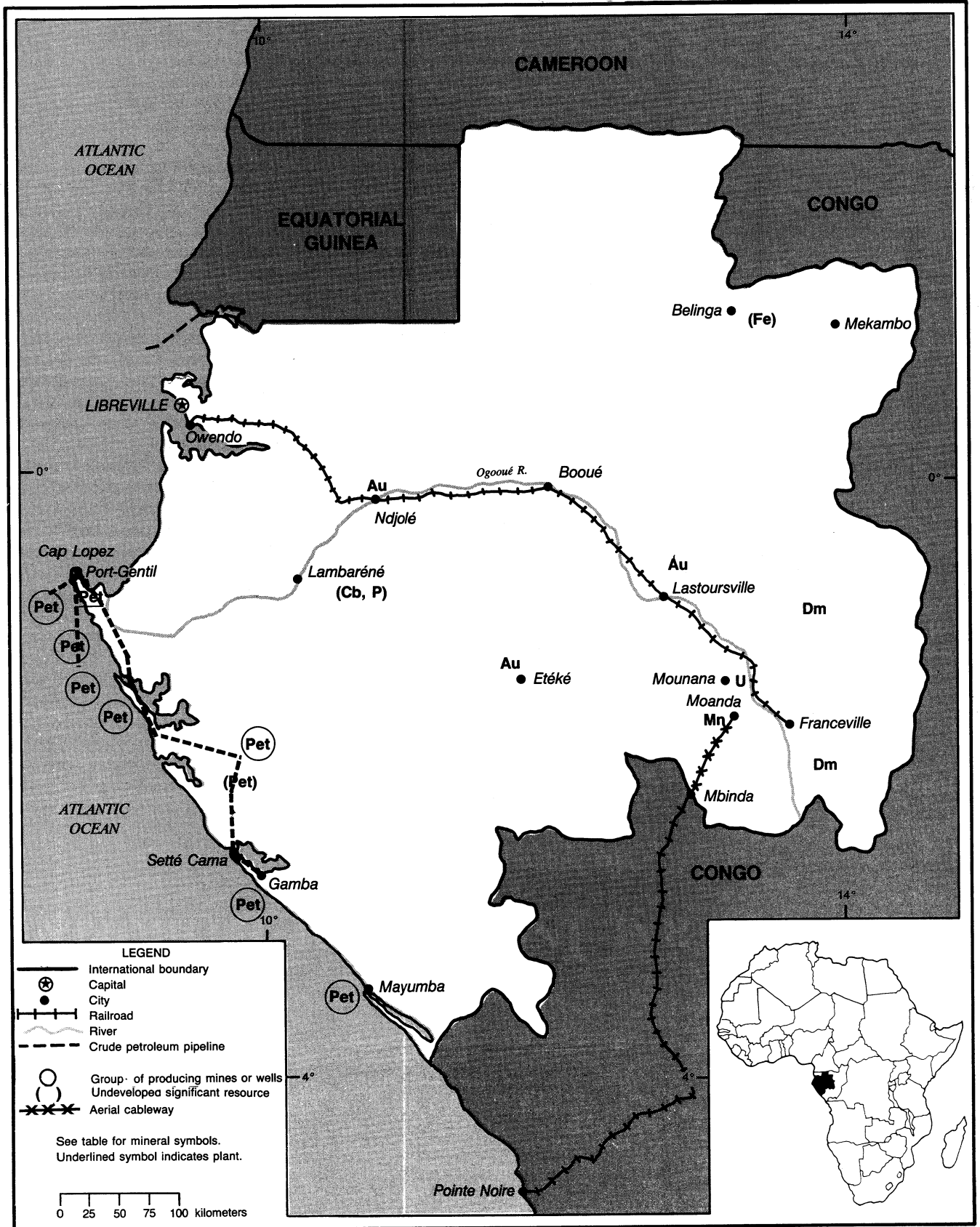
Ministry of Industry & Industrial Development  
P.O. Box 175  
Djibouti, Djibouti  
Telephone: 253-350340



# GABON

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

POPULATION 1.07 million



# THE MINERAL INDUSTRY OF GABON

By Audie L. King

**F**ueled by increased petroleum production from the Rabi Kounga Oilfield and higher world oil prices during the last part of 1990, Gabon's GDP grew by an estimated 13% to \$4.8 billion.<sup>1</sup> The nation's economy expanded by a similar 13% in 1989 following 3 years of deep depression. Gabon's economy remained highly dependent on its mineral industry, which accounted for about 38% of the nation's GDP and 89% of total exports. The production of crude oil and related products accounted for about 34% of the GDP and 80% of total exports. The nonfuel mining sector, which was dominated by manganese and uranium mining, accounted for 4% of the GDP and about 9% of total exports.

Gabon was the third largest oil producer in sub-Saharan Africa and was the smallest oil producer in OPEC. Thanks to continued high output at the Moanda Mine, the world's single largest producer of manganese, Gabon remained the world's fourth largest producer of manganese ore and the largest producer of battery grade manganese ore. Gabon was also a significant world producer of uranium.

A sedimentary basin that is the source of Gabon's oil production extends offshore along the Atlantic coast at least as far as Sao Tomé. Favorable trapping structures include faults related to the opening up of the Atlantic Ocean and salt diapirs. Gabon's largest oilfield, the Rabi-Kounga Field, onshore about 100 km north of Gamba, was discovered in 1985 and began production in 1989. In 1990, the Rabi-Kounga Field reached peak production of 150,000 bbl/d of 32° to 34° API crude oil.

Very high grade manganese and uranium deposits are about 50 km northwest of Franceville in the clastic sedimentary rocks of the Proterozoic Francevillian Series.

Gold occurs at many locations in the Precambrian granitic rocks that dominate the eastern two-thirds of Gabon, but total production, virtually all by artisanal miners, has been small.

Large itabirite type iron deposits occur west of Mekambo, in an east-west trending belt of Precambrian phyllites and gneisses. The Belinga iron ore deposit has been con-

sidered for exploitation, but the project is not currently economic because of the lack of infrastructure.

A large, potentially economic columbium and phosphate deposit, the Mabounié carbonatite, 40 km east-southeast of Lambaréné, was discovered in 1987 during an exploration program carried out by France's Bureau de Recherches Géologiques et Minières.

## GOVERNMENT POLICIES AND PROGRAMS

It is still uncertain how recent political reform will affect the significant role in equity ownership of the mineral industries and infrastructural services that the Government has traditionally taken. Prior to 1990's round of political unrest, the Government had already begun to relax its policy with respect to new ventures by dropping regulations requiring direct Government participation.

The Government invested in overseas mineral concerns, especially where doing so would benefit Gabon's mineral processing industry. The most notable example of this was the Government's 30% share of Société de Ferromanganèse de Paris-Outreau, the large French ferromanganese producer.

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.

The principal investment law is the 1961 Investment Act 55/61 as modified in 1967 by Ordinance 21/67.

## PRODUCTION

The major strength of the country's mineral industry was in the petroleum sector. Oil production increased to an average of 260,000 bbl/d from an average of 208,000 bbl/d in 1989. The expanded

production was due to increases in output at the Rabi-Kounga Field. The new field's production rate increased from 15,000 bbl/d to 120,000 bbl/d during 1989. By the end of 1990, the field's production leveled off at about 150,000 bbl/d, where it was expected to remain until the mid-1990's.

Gabon's only oil refinery continued to operate well below its capacity of 8 to 9 Mbbbl/a.

Despite the completion of the ore terminal at Owendo and the 650-km Trans-Gabon railroad link to the Moanda manganese mine that had greatly increased shipping capacity, manganese production decreased slightly to about 2.3 Mmt from 1989's peak production of 2.5 Mmt. This drop in production could be attributed to depressed world manganese market conditions.

Continued low world demand caused Gabon's uranium production to fall below 50% of its rated capacity, to an estimated equivalent of 828 tons of uranium oxide (U<sub>3</sub>O<sub>8</sub>) in 1990.

A small volume of gold production was reported; however, virtually all of the country's gold production is from artisanal operations. Because most of this is smuggled out of the country, the true output is unknown. Likewise, most of Gabon's modest diamond production is smuggled out of the country.

## TRADE

Gabon's total exports rose in 1990 as the Persian Gulf crisis increased demand and prices for its petroleum products. Favorable market conditions coincided with increased petroleum production at the Rabi Kounga Oilfield. Total exports amounted to about \$2.0 billion, a 25% increase over that of 1989. Gabon's imports increased by 9% to \$835 million owing to a slight recovery in domestic demand. France continued to be Gabon's most important trading partner, taking more than one-third of Gabon's exports and furnishing about one-half of its imports. The United States took about 25% of Gabon's exports, mostly petroleum and manganese and accounted for about 10%

TABLE 1

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

| Commodity <sup>2</sup>  | 1986             | 1987             | 1988             | 1989 <sup>a</sup> | 1990 <sup>a</sup> |
|---|------------------|------------------|------------------|-------------------|-------------------|
| Cement, hydraulic <sup>3</sup> metric tons  | 210,858          | 140,196          | 132,038          | 115,442           | 115,000           |
| Clinker do.   | 202,198          | 106,000          | 104,000          | 113,000           | 113,000           |
| Diamond, gem and industrial <sup>c</sup> carats                                       | 500              | 500              | 500              | 500               | 500               |
| Gas, natural <sup>4</sup> :   |                  |                  |                  |                   |                   |
| Gross million cubic meters  | 1,994            | 1,770            | 1,904            | 2,100             | 1,965             |
| Marketed <sup>c</sup> do.   | 85               | 113              | 127              | ( <sup>5</sup> )  | —                 |
| Gold, mine output, Au content <sup>6</sup> kilograms                                  | 62               | 79               | 138              | 81                | 80                |
| Manganese:  |                  |                  |                  |                   |                   |
| Metallurgical grade ore, gross weight (50% to 53% Mn) metric tons                     | 2,440,000        | 2,216,039        | 2,186,158        | 2,500,800         | 2,450,000         |
| Pellets, battery- and chemical-grade, gross weight (82% to 85% MnO <sub>2</sub> ) do. | 70,000           | 187,135          | 67,977           | 91,607            | 89,500            |
| Total do.   | <u>2,510,000</u> | <u>2,403,174</u> | <u>2,254,135</u> | <u>2,592,407</u>  | <u>2,539,500</u>  |
| Petroleum:  |                  |                  |                  |                   |                   |
| Crude thousand 42-gallon barrels  | 60,000           | 56,243           | 57,895           | 75,819            | 100,000           |
| Refinery products:  |                  |                  |                  |                   |                   |
| Gasoline do.  | 480              | 447              | 459              | 510               | 500               |
| Jet fuel and kerosene do.   | 530              | 485              | 499              | 943               | 1,000             |
| Distillate fuel oil do.   | 1,380            | 1,121            | 1,153            | 1,467             | 1,500             |
| Residual fuel oil do.   | 1,130            | 1,100            | 1,080            | 932               | 1,000             |
| Other <sup>c</sup> do.  | 100              | 100              | 100              | 100               | 100               |
| Refinery fuel and losses <sup>c</sup> do.   | 130              | 150              | 150              | 150               | 150               |
| Total <sup>c</sup> do.  | <u>3,750</u>     | <u>3,403</u>     | <u>3,441</u>     | <u>4,102</u>      | <u>4,250</u>      |
| Uranium oxide (U <sub>3</sub> O <sub>8</sub> ), content of concentrate metric tons    | 1,059            | 934              | 1,094            | 1047              | 828               |

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

<sup>1</sup>Table includes data available through June 10, 1991.

<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>Revised to zero.

<sup>6</sup>Gold production figures likely do not include production smuggled out of the country, for which there are no reliable data.

of its imports, which consisted mainly of machinery, chemicals, and food. The bilateral trade imbalance with the United States was \$343 million in Gabon's favor in 1989, the last year that data were available.

The economy of Gabon greatly improved during the last half of 1990, largely as a result of the Persian Gulf crisis escalating the world price of oil. Crude oil exports rose by an estimated 25% for the year. Revenues from the export of crude oil and related products were up an estimated 35% to \$1.6 billion. Manganese ore sales were estimated to have dropped almost 28% in 1990 to only 1.7 Mmt. Export revenues, however, remained constant at about \$200 million. Gabon accounted for more than 30% of the 7 to 8 Mmt of manganese ore traded in the world market. Products made from its ore also accounted for about 50% of the manganese derivatives on the world market. Gabon remained the leading supplier of

manganese ore to the United States. In recent years, it supplied more than 40% of U.S. manganese imports.

Uranium exports fell to an estimated 828 tons of contained U<sub>3</sub>O<sub>8</sub> in 1990, down from 1,047 tons in 1989. About 60% of Gabon's production went to France for use by the Commissariat à l'Énergie Atomique. The French Government had reduced import demand for fresh yellowcake to use its stocks. Some uranium shipments had been made to Belgium and Japan, but sales had been hurt due to unfavorable U.S. dollar and French franc exchange rates and low world prices.

### STRUCTURE OF THE MINERAL INDUSTRY

Gabon's oil production is from four producing companies, of which one ac-

counted for about 48% of the total output as an operator, but approximately 67% of the total output as owner. Other companies that produced mineral commodities during the year included an oil refiner, cement manufacturer, one manganese mine, and two uranium mines operators.

The Government of Gabon's equity participation in the country's petroleum and mineral producing companies ranged from 25% to 36.25%, with the exception of the cement company, where the Government's share was 90.54%.

Gabon's limited diamond and gold production was by private individuals using artisanal methods.

Gabon's total salaried labor force was estimated to number about 120,000, of which about one-third was in the industrial and commercial sectors. The mineral industries employed about 9,000 workers, of which about 5,000 were employed in the

TABLE 2

**GABON: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990**

(Thousand metric tons unless otherwise specified)

| Major commodity                     | Major operating companies                    | Location of main facilities  | Annual capacity       |
|-------------------------------------|--|--|-----------------------|
| Cement                              | Société des Ciments du Gabon                 | 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.           |
| Manganese                           | Compagnie Minière de l'Ogooué                | Open pit mine at Moanda  | 2,700.                |
| Petroleum, crude thousand barrels   | ELF-Gabon                                    | Mandji onshore and offshore field near Port Gentil                                   | 39,420.               |
| Do.                                 | Shell Gabon                                  | Lucina Marine offshore field, 15 kilometers south of Mayumba                         | 4,015.                |
| Do.                                 | do.  | Gamba-Ivinga Field, onshore at Gamba   | 4,380.                |
| Do.                                 | do.  | Rabi-Kounga Field, 100 kilometers north of Gamba                                     | 49,275.               |
| Do.                                 | AMOCO  | Oguendjo offshore field, 85 kilometers southeast of Port Gentil                      | 6,205.                |
| Do.                                 | British Gas Corp. United Kingdom             | Obando, Octopus, and Pelican offshore fields, 60 kilometers southwest of Port Gentil | 5,110.                |
| Petroleum products thousand barrels | Compagnie Gabon-ELF de Raffinage             | Refinery at Port Gentil  | 8,760.                |
| Uranium tons                        | Compagnie des Mines d'Uranium de Franceville | Two mines near Mounana   | 1,770. uranium oxide. |

petroleum sector. In addition, minerals-related employment in the transportation sector numbered several thousand. Gabon's low population had necessitated the extensive employment of expatriate labor, including workers from neighboring countries. Wages in Gabon are very high by African standards.

## COMMODITY REVIEW

### Metals

Compagnie Minière de l'Ogooué (COMILOG) experienced its second full year of manganese ore shipments via the Trans-Gabon Railroad to the minerals port of Owendo. The new port and rail system, which operated smoothly so far, would allow the shipment of the company's entire ore production or would allow the company

to double its output if the traditional route through the Congo were also fully utilized. Shipping costs were cut by \$20 million per year when the Trans-Gabon Railway opened its services to the new port at Owendo. An estimated \$9 million of the savings was in salaries and labor costs and \$11 million was in transportation costs. COMILOG was among the world's lowest cost manganese producers. The Government of Gabon estimates that the saving owing to transportation costs could be even higher if the remaining 40% of manganese ore that was still being shipped via the Congolese port at Pointe Noire were diverted to the closer port at Owendo. Manganese shipments via Pointe Noire were estimated to be 1 Mmt in 1990. Despite increased shipping capacity, COMILOG's production decreased slightly in 1990, to about 2,540,000 tons of manganese ore. In addition to ore, COMILOG produced a large

quantity of unsalable manganese oxide fines. It is estimated that stockpiles of this material at Moanda amounted to as much as 12 Mmt.

The construction of a new ore blending facility was nearing completion and could be operational by mid-1991. COMILOG hoped that the new blending project, in conjunction with a proposed reinvestment program that would allow for the upgrading of machinery and equipment, would result in reduced operating costs and better mining recovery. The improvements were expected to result in the production of an additional 110,000 tons of higher grade ore per year. Working conditions would also be improved. Annual savings from anticipated improvements were estimated at \$8 million per year.

The Government continued to investigate the feasibility of building a ferro-manganese plant to process stockpiled fines,

but the scheme was still considered to be uneconomic under current market conditions.

COMILOG maintained close financial ties to many of its customers. It was part owner of a number of manganese ferroalloy producers in western Europe and had announced plans to acquire all the stock in GEICHEM's SADACEM Group. GEICHEM is the chemical subsidiary of Belgium's Societe Generale de Belgique SA. The SADACEM Group accounted for 50% of the world market in manganese derivatives that were used in agriculture and electronics. It was also one of the world's four largest producers of manganese dioxide for dry batteries.

### Mineral Fuels

Gabon's crude oil production surged during the last half of 1990. It experienced the largest percentage increase in petroleum production of all the OPEC countries following the cartel's decision in August to "free" member nations of production quotas. Crude oil production increased by an estimated 25% in 1990 to an estimated 95 Mbbl. The expanded production was almost entirely from the massive Rabi-Kounga onshore field, which began production at the beginning of 1989. By the end of the year, the Rabi-Kounga Field was producing at its peak capacity of 150,000 bbl/d. This was well in excess of Shell-Gabon's, the field operator's, original plans that called for a target rate of 135,000 bbl/d for 1990. A 135-km pipeline from the Rabi-Kounga Field to Gamba was completed in 1988 and a 235-km line to Port Gentil was completed in early 1989. Gabon's other fields had been averaging a total of about 160,000 bbl/d, of which about two-thirds was from the Mandji field complex operated by ELF-Gabon near Port Gentil.

Gabon produced oil from almost 500 wells, located in 6 oilfield complexes, most of which were offshore. Approximately 65% of Gabon's oil acreage, much of it controlled by ELF-Gabon, will come open for bid in 1991; it was anticipated that record bid prices would be realized for these concessions. The Government intended to subdivide the plots it usually offers into tenths in the hope that it would attract small companies that could profitably exploit a find that would be too small for a major company.

The promise of new discoveries following the discovery of the Rabi-Kounga Field coupled with higher oil prices had led to a

renewed interest in oil exploration in Gabon. This was especially true onshore. High demand for drilling rigs and seismic equipment had led to shortages and increased exploration costs. Even though several onshore and offshore discoveries were announced in 1989 and in early 1990, by the end of the year, American companies' enthusiasm waned somewhat after 25 dry exploration wells in a row were drilled.

During a brief period in May 1990, rioting in Port Gentil forced the evacuation of expatriate oil workers, particularly those working for Shell and ELF-Gabon. Oil production was cut from 270,000 bbl/d to just 20,000 bbl/d—the minimum needed to prevent paraffin buildup in the pipes. By the end of the month, production had been largely restored.

On October 9, 1990, ELF-Gabon announced the discovery of new oil deposits in the Dianongo block of the Ogooué research permit. The new field is onshore 24 km north of the Rabi-Kounga Field and south of Port Gentil. Recoverable reserves based on exploratory drillings were estimated at 430 Mbbl. ELF-Gabon was the main operator of the Dianongo block with a 30% stake, ELF-Aquitaine held 20%, and Shell-Gabon 50%.

### Reserves

Gabon's manganese oxide ore reserves in the Moanda area were very large, amounting to in excess of 200 Mmt grading about 48% Mn according to COMILOG. About 25% of these reserves was in the immediate area of the existing mine. The Moanda area also had a large inventory of manganese carbonate, although no plans existed to mine this material.

Gabon's oil resources were large but are not well defined. The recently discovered Rabi-Kounga Field and its satellite deposits were widely reported to contain approximately 1 to 1.2 billion barrels of oil, with an estimated 400 to 600 Mbbl recoverable. Further exploration was expected to increase the reserves of this field. The other producing fields and new offshore discoveries were believed to have total reserves of about 700 Mbbl. The Rabi-Kounga discovery generated a great deal of interest in onshore exploration, and it was expected that future offshore and onshore exploration would significantly increase the country's known reserves.

Reserves of natural gas were likewise significant, being in excess of 16 billion m<sup>3</sup>, but again are poorly known. Very little of

the country's gas production was marketed.

Uranium reserves were only well defined for the Mounana area, where total reserves in 1982 were given by the Government as about 33,000 tons of uranium metal. The total reserves in 1982 were distributed among four deposits: Boyindzi, 3,000 tons; Oklo, 15,000 tons; Okélobondo, 5,000 tons; and Mikoulougou, 10,000 tons. Production subsequent to 1982 had all been from the Oklo and Boyindzi deposits and has amounted to about 9,000 tons of uranium metal. The 1982 reserves were based on more favorable economic conditions than existed in 1990. Recoverable reserves for yearend 1990 amounted to about 13,000 to 16,000 tons of uranium metal. Gabon had very high uranium production costs, but had traditionally received long-term contract prices for its uranium output. Given continued low world prices, it was uncertain how long Gabon would be able to maintain its current level of production and sales.

Gabon had numerous deposits of iron ore, the most significant of which were in the northeast part of the country. The largest, and best known of these was the Belinga deposit, 100-km west-northwest of Mekambo. According to the Government, the resource at Belinga amounted to 566 Mmt grading 64.24% Fe, 2.18% silica, and 0.122% phosphorus. Of this amount, approximately 345 Mmt was low phosphorus (<0.07% phosphorus) material. The Boka Boka deposit, 40 km southwest of Mekambo, had a resource of 194 Mmt grading 62.5% Fe, 3.57% silica, and 0.106% phosphorus. The Batouala deposit, 70 km southwest of Mekambo, had a resource of about 100 Mmt grading 65.7% Fe. Of these deposits, only the Belinga deposit had been seriously considered for mining. However, exploitation of the Belinga deposit would require the construction of a 235-km extension of the Trans-Gabon Railroad from Bououé to the deposit and the construction of suitable ship loading and storage facilities at the Port of Owendo. This construction, and hence the exploitation of the Belinga deposit, was considered uneconomic under current market conditions.

The Mabounié carbonatite, 40 km east-southeast of Lambaréné, had a columbium resource, according to the Government, of 15 Mmt grading 2% Cb<sub>2</sub>O<sub>5</sub>, with an additional 27 Mmt grading between 1.78% and 2.0% Cb<sub>2</sub>O<sub>5</sub>. It also contained a phosphate resource of about 85 Mmt grading 24% P<sub>2</sub>O<sub>5</sub> and some rare earths. Tests in 1987 and 1988 showed that the columbium resource was likely to be uneconomic except possibly as

a byproduct of phosphate mining, and the economics of mining the phosphate resource had yet to be demonstrated.

Gold occurrences were widespread, and diamonds were found in southeast Gabon. However, the reserves of gold and diamonds were not known with any certainty.

Potentially economic occurrences of barite, copper, lead, marble, phosphate rock, talc, and zinc had also been reported.

## INFRASTRUCTURE

Gabon's transport infrastructure was still underdeveloped. The only railroad in Gabon was the Trans-Gabon Railroad, which ran 669 km from Owendo to Franceville. The first segment, comprising the 183 km from Owendo to Ndjolé, was operational at yearend 1978, and the 156-km segment on to Booué was inaugurated in early 1983. The final segment to Franceville was inaugurated at yearend 1986. A short spur to the manganese mine at Moanda was completed shortly thereafter. The track was 1.437-m gauge. Plans to build a 235-km extension northeast from Booué to the Belinga iron deposit were on indefinite hold owing to unfavorable world market conditions for iron ore. The Trans-Gabon Railroad hauled general freight, lumber, passengers, and, especially, manganese ore. Shipment of the latter commenced in December 1988, following the completion of the ore shiploading facilities at the Port of Owendo. Manganese ore raiing capacity was at least 3 Mmt/a, utilizing trains of 70 to 96 rail cars hauling 6,000 to 8,000 tons per trip. The railroad was also used to export the country's uranium production. In addition, in 1988, the latest year that such data were available, the railroad carried 580,000 tons of lumber, 80,500 tons of cement clinker, 20,000 tons of fuel, about 150,000 tons of general freight, and about 250,000 passengers. Overall responsibility for running the railroad was with the Office de Chemin de Fer Transgabonais.

Prior to the completion of the ore port at Owendo, Gabon's manganese ore production was shipped out via a 76-km aerial cableway to Mbinda in the Congo and then by 296 km of railroad to the Congolese Port of Pointe Noire. This route also had a capacity of about 3 Mmt/a and still carried about 40% of Gabon's manganese production. Similarly, Gabonese uranium yellowcake was trucked to Mbinda for raiing to Pointe Noire.

Gabon had about 7,500 km of roads, of which only about 10% was paved, including city streets. Most of the roads were in poor condition. Gabon had about 1,600 km of navigable waterways, the most important of which is the 310-km stretch of the Ogooué River from Port Gentil to Ndjolé.

Gabon had a sophisticated satellite telecommunications network and a good electrical grid. Electricity production in 1988, the last year for which data were available, was 906,428,000 kW·h. Total installed generating capacity was about 310,000 kW. Of this capacity, 166,000 kW was installed in the country's three hydroelectric plants. These plants were the Kinguélé (72-MW capacity) and Tchimbélé (57-MW capacity) stations on the Mbéi River about 110 km east of Libreville, and the Poubara station (37 MW capacity) on the Ogooué River about 40 km south of Franceville. Both the manganese and uranium mines utilized power from the Poubara station. The bulk of the remainder of Gabon's electrical capacity was supplied by 24 thermal power stations. Much of the country's telecommunication system was solar-powered. A \$50 million manganese ore storage and shiploading facility at the Port of Owendo were inaugurated at yearend 1988 after 16 months of construction. Owing to oil revenue shortfalls in 1986 and continued low world iron prices, the project was scaled down from earlier plans to build a much larger manganese and iron ore shipping facility.

The mineral Port at Owendo could handle ships of up to 42,000 dwt, drawing 11 m. As the water depth was only 11 m, ships entered and left at high tide (12.5-m depth). Ore was loaded by a 900-m conveyor at a maximum rate of 3,000 tons per hour. There was storage at the port for about 700,000 tons of ore. The old port of Owendo was for general cargo, containers, and petroleum products and could handle about 55,000 mt/a. General port affairs were handled by the parastatal Offices des Ports et Rades. The mineral port was run by Société du Port Minéralier d'Owendo, the majority owner of which is COMILOG.

Gabon's petroleum infrastructure consisted of 643 km of crude oil pipeline, 14 km of refined products pipeline, several oil shipping facilities, and one refinery complex. The bulk of Gabon's petroleum production was shipped from the terminal at Cap Lopez, about 10 km northwest of Port Gentil. Tankers of up to 250,000 tons could

be handled. Port Gentil handled much of Gabon's international trade in general cargo and lumber. It was also the site of the country's only oil refining facilities. The oil terminal at Cap Lopez was fed by numerous pipelines leading to the surrounding offshore oil wells, some as far away as 110 km, and a new 238-km pipeline leading to the onshore Rabi-Kounga Field. Some of the offshore wells had their own tanker loading facilities. The oil terminal at Gamba could load tankers up to 140,000 dwt by means of a 6.3-km pipeline to an offshore floating station. Gamba serviced the nearby oilfields, but also was connected to the Rabi-Kounga Field by means of a new 135-km pipeline. The offshore oil terminal at Lucina could load tankers of up to 165,000 dwt, and the nearby Mayumba offshore terminal could handle ships up to 70,000 dwt.

## OUTLOOK

The recent discovery of the Rabi Kounga and other oilfields will ensure that the economy of Gabon will continue to be dominated by the petroleum sector for many years. Increased drilling and seismic activity will likely lead to further discoveries and increased petroleum production.

Gabon's manganese industry will continue to depend on fluctuations in the world market. With recent infrastructural improvements, Gabon is well prepared to increase its production to record levels if demand for its high-grade ore should increase.

The uranium industry will likely remain depressed for the foreseeable future, owing to the large oversupply worldwide.

The long-term potential for the development of a more diversified mineral industry is very good. Even though Gabon's geologic potential is good, the mining industry's progress will likely be slow because many recently discovered deposits await infrastructural improvements before they can be economically exploited.

<sup>1</sup>Where necessary, values have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate CFAF272.26=US\$1.00.

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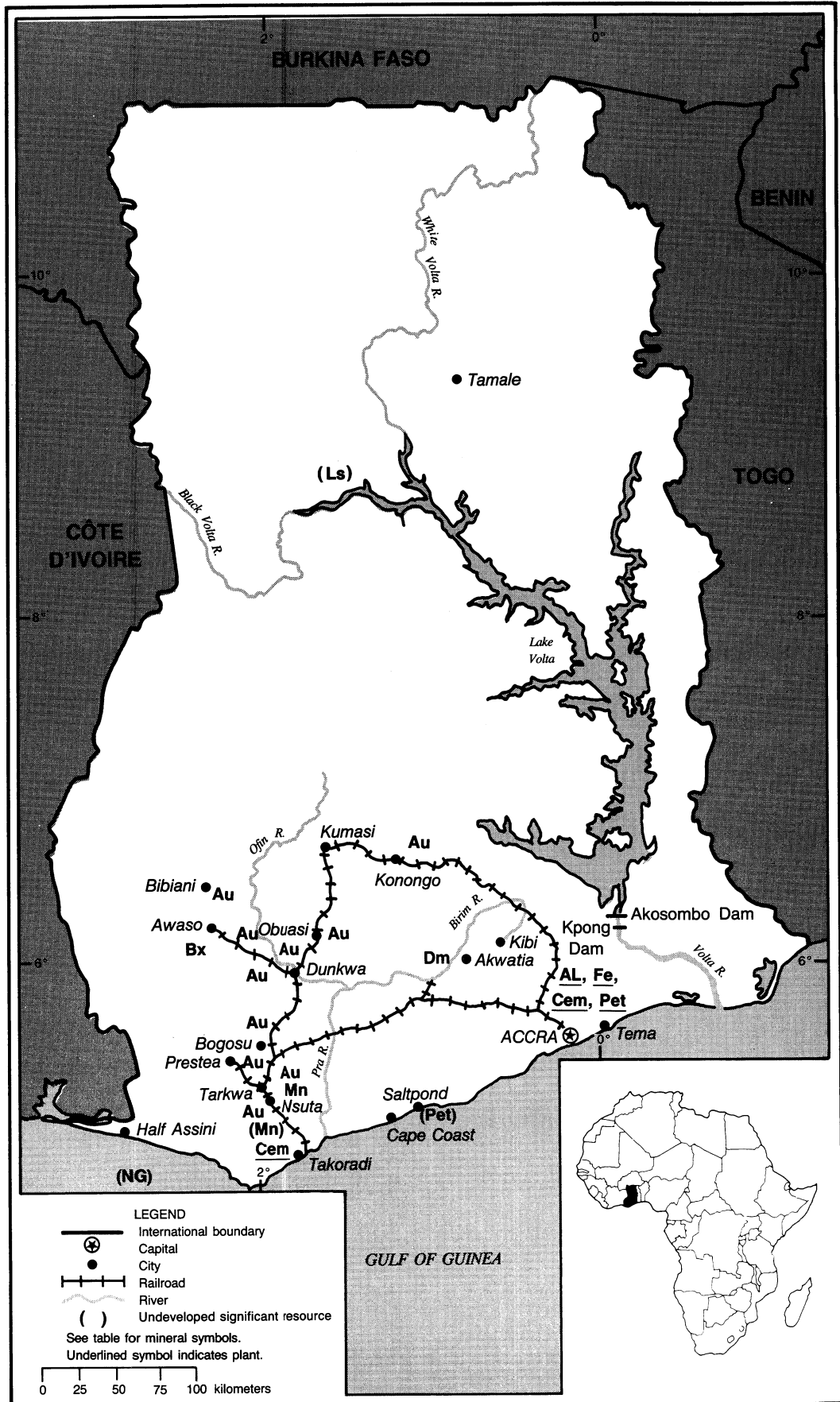
Ministère des Mines, de l'Industrie et de la Consommation: Direction Générale des Mines et de la Géologie, Libreville.



# GHANA

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

POPULATION 14.8 million



# THE MINERAL INDUSTRY OF GHANA

By Hendrik G. van Oss

**M**ining has been important to the economy of Ghana throughout the country's history and today is a critical factor in the country's industrial sector. Primary mineral production is dominated in value by gold, but the country is also a significant producer of bauxite, diamonds, and manganese ore. Output of most of these commodities increased in 1990; however, the potential increase in mining revenues was tempered by stagnant gold prices during the year. Apart from primary mineral production, Ghana is the second largest aluminum producer in Africa, and has a modest production of cement and refined petroleum products. Despite the contributions of the mining industry, Ghana's overall economy remained dominated by agriculture and, in 1990, suffered from low world agricultural prices and from drought.

Exports of primary mineral commodities produced in Ghana in 1990 were equivalent to about 5.4% of the country's estimated GDP of \$4.93 billion<sup>1</sup> and about 36% of total exports. In this respect, primary mineral exports were second only to cocoa and cocoa products. In addition to primary mineral exports, Ghana exported aluminum worth more than \$280 million; however, this material was toll refined from imported alumina. Sales of locally produced cement were worth approximately \$100 million.

As part of an ongoing privatization program, purchasers were sought for the Government-owned diamond and gold mines. Several companies expressed interest in investing in some of these properties. Encouraged by favorable mining and investment laws, and by the country's geologic potential, a number of domestic and foreign companies were conducting mineral exploration programs during the year, chiefly for gold.

In terms of economic importance, Ghana's geology is dominantly that of 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 Birimian belts contain 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. By far the dominant locus of gold mineralization has been the shear zone and vein system that hosts the Ashanti, Prestea, Bogosu, and Southern Cross Mines, as well as many others now closed.

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. In 1990, there were two mines exploiting Tarkwaian conglomerate gold ore, and a third mine was expected to be in production by 1992. Alluvial diamonds eroded from the Birimian Series, and gold from both the Birimian and Tarkwaian Series, form widespread placer deposits that are exploited by both formal and artisanal placer operations. 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

Although agriculture has long dominated Ghana's domestic and export economy,

agricultural revenues have suffered in recent years because of low world prices for the country's principal cash crops, periodic droughts, and, in the case of timber, recognition of the need to conserve the country's tropical forests. Accordingly, the Government has enacted policies to reduce the country's dependence on agriculture, chiefly by encouraging development in the mining sector. This has the additional goal of reducing the country's dependence on imported minerals, notably alumina, clincker, and petroleum.

The encouragement of growth of the minerals industry is a cornerstone of the continuing Economic Recovery Program, launched in 1983. This program is an attempt to overcome the effects of a period of inefficient management of state-owned companies, overly tight restrictions on the availability of foreign exchange, and unrealistic investment laws. These past policies had led to a major deterioration of the country's mines and transport infrastructure and an unfavorable climate for foreign investment in Ghana. In addition, low wages and a general decline in the economy had led to the emigration of a large number of skilled Ghanaian nationals. The Economic Recovery Program has sought to reverse the deterioration of 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 early 1980, a Committee on Gold Mining was appointed to review the Ghanaian mining industry and to recommend a solution to the severe decline in mine output. The committee's yearend 1980 report<sup>2</sup> identified the morass of more than 70 mining-related laws enacted since 1900 as being a significant contributor to the decline and 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, was a direct outcome of the 1980 report.

The 1980 report further recommended that the existing gold mines be rehabilitated. In 1984, rehabilitation work began at the Ashanti Mine, and in 1985, a similar pro-

gram started for mines owned by the State Gold Mining Corp. (SGMC). The goal of these ongoing programs is to increase the production of the mines through a combination of expanding the workings, purchasing new equipment, repairing old shafts and mine workings, improving mine safety, rehabilitating the mills, and improving mine management and cost accounting. Loans for the rehabilitation programs have been secured, by and large, from 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. Partly as a condition for the loans, but also in accord with its new privatization policies, the Government agreed to seek foreign investors in a number of wholly state-owned companies such as Ghana Consolidated Diamonds Ltd., and SGMC subsidiaries Dunkwa Goldfields Ltd., Prestea Goldfields Ltd., and Tarkwa Goldfields Ltd. The Government has also obtained loans to rehabilitate the country's railroad and shiploading infrastructure, particularly that serving the mining industry.

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 provide a purchase mechanism for the output of such mining.

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 minerals 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 must also be reported to the Ghana Chamber of Mines; the Chamber also provides information on Ghana's mining laws and negotiates with the mine labor unions on behalf of its member companies. All of the mining companies operating in 1990 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. In the fourth quarter of 1990, petroleum product prices were increased dramatically in response to the Persian Gulf crisis and to reduce smuggling. The effect on the Ghanaian economy was predicted to be severe.

## PRODUCTION

The production of most mineral commodities increased in 1990, with output of

aluminum, bauxite, cement, gold, and silver reaching their highest levels in more than 10 years.

In terms of formal production, Ghana appears to have tied Zimbabwe as Africa's second largest gold producer after the Republic of South Africa. In addition, Ghana has a very active artisanal mining sector, the true output of which is believed to have significantly exceeded the 536 kg sold to the PMMC. This additional production is believed to be smuggled out of the country, largely to Côte d'Ivoire and Togo. Ghana's increased official gold output in 1990 reflected the continuing benefits of ongoing expansion and rehabilitation of the country's largest gold mine, as well as the startup during the year of three new operations.

Production from Ghana's only formal diamond mine, Akwatia, increased significantly owing to the company being able to upgrade some of its equipment. Output, however, was still well below that needed for profitability. Sales to the Government, through the PMMC, of artisanally mined diamonds increased dramatically, apparently reflecting continuing confidence in the PMMC's diamond pricing, and efficiency on the part of its buyers. Unlike gold, the PMMC diamond purchases in 1990 probably represented the bulk of the country's artisanal production.

Production of bauxite increased, largely in response to improvements in the country's rail infrastructure and the company's upgrade of its shiploading facilities at Takoradi. Manganese ore production fell; however, this was offset by higher prices received for the product.

The production of finished cement continued to benefit from the increased availability of foreign exchange, which allowed an increase in the level of imports of clinker. Owing to the indefinite closure of the country's sole oil refinery in October, induced by labor problems, refinery products output declined significantly in 1990.

## TRADE

Ghanaian exports in 1990 totaled about \$795 million, about the same as in 1989. This performance was despite an increased level of mineral exports, and reflected poor world prices for cocoa and cocoa products—still the country's main export items, and stagnant gold prices. Official exports of primary mineral commodities totaled about \$254 million.

Official exports of gold were worth about \$209 million; this 26% increase paralleled

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

| Commodity <sup>2</sup>                                | 1986               | 1987               | 1988               | 1989 <sup>a</sup> | 1990 <sup>a</sup>    |
|---|--------------------|--------------------|--------------------|-------------------|----------------------|
| <b>Aluminum:</b>                                      |                    |                    |                    |                   |                      |
| <b>Bauxite:</b>                                       |                    |                    |                    |                   |                      |
| Gross weight metric tons                              | 204,047            | 196,255            | 284,500            | 347,065           | <sup>3</sup> 381,273 |
| Sales do.   | 226,461            | 229,415            | 299,939            | 374,646           | <sup>3</sup> 368,659 |
| Metal, smelter, primary do.                           | 124,570            | 150,316            | 161,392            | 168,581           | <sup>3</sup> 174,241 |
| Cement, hydraulic <sup>4</sup> thousand metric tons   | 219                | 274                | 477                | 565               | <sup>3</sup> 675     |
| <b>Diamond:</b>                                       |                    |                    |                    |                   |                      |
| Gem <sup>a</sup> thousand carats                      | <sup>3</sup> 88    | 65                 | 155                | 124               | 163                  |
| Industrial <sup>a</sup> do.                           | <sup>3</sup> 498   | 400                | 465                | 370               | 487                  |
| Total do.   | 586                | 465                | <sup>5</sup> 620   | <sup>5</sup> 494  | <sup>5</sup> 650     |
| Gold kilograms  | 8,931              | 10,201             | 11,601             | 13,358            | <sup>3</sup> 16,840  |
| Iron and steel: Steel, crude <sup>a</sup> metric tons | 5,000              | <sup>7</sup> 500   | 6,500              | 17,500            | 25,500               |
| <b>Manganese:</b>                                     |                    |                    |                    |                   |                      |
| Ore and concentrate, <sup>6</sup> gross weight do.    | 304,351            | 274,451            | 259,614            | 279,210           | <sup>3</sup> 246,869 |
| Mn content <sup>a</sup> do.                           | 110,000            | <sup>9</sup> 8,000 | <sup>9</sup> 7,000 | 110,000           | 96,000               |
| <b>Petroleum:</b>                                     |                    |                    |                    |                   |                      |
| Crude <sup>a</sup> thousand 42-gallon barrels         | —                  | —                  | —                  | —                 | —                    |
| <b>Refinery products:</b>                             |                    |                    |                    |                   |                      |
| Gasoline do.  | <sup>1</sup> 1,700 | <sup>1</sup> 1,309 | <sup>1</sup> 1,207 | 1,233             | 1,040                |
| Jet fuel do.  | <sup>2</sup> 200   | <sup>2</sup> 216   | <sup>2</sup> 200   | 200               | 165                  |
| Kerosene do.  | <sup>8</sup> 68    | <sup>7</sup> 13    | <sup>8</sup> 26    | 868               | 725                  |
| Distillate fuel oil do.                               | <sup>2</sup> 052   | <sup>1</sup> 641   | <sup>2</sup> 163   | 1,716             | 1,400                |
| Residual fuel oil do.                                 | <sup>5</sup> 99    | <sup>5</sup> 00    | <sup>4</sup> 46    | 466               | 390                  |
| Other <sup>a</sup> do.                                | <sup>2</sup> 50    | <sup>2</sup> 81    | <sup>2</sup> 85    | 323               | 270                  |
| Refinery fuel and losses <sup>a</sup> do.             | <sup>3</sup> 00    | <sup>3</sup> 00    | <sup>3</sup> 00    | 300               | 280                  |
| Total <sup>a</sup> do.                                | <sup>5</sup> 969   | <sup>4</sup> 960   | <sup>5</sup> 427   | 5,106             | 4,270                |
| Salt <sup>a</sup> metric tons 50,000                  | 50,000             | 50,000             | 50,000             | 50,000            |                      |
| Silver, Ag content of gold ore <sup>a</sup> kilograms | 447                | 510                | 580                | 668               | 840                  |

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

<sup>1</sup>Table includes data available through Aug. 20, 1991.

<sup>2</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, and available information is inadequate to make reliable estimates of output levels.

<sup>3</sup>Reported figure.

<sup>4</sup>All from imported clinker.

<sup>5</sup>Production includes that of Akwatia Mine (1988—225,200 carats; 1989—134,030 carats; 1990—151,627 carats), Precious Minerals Marketing Board purchases of artisanal production (1988—34,231 carats; 1989—151,606 carats; 1990—484,876 carats), and estimates of smuggled artisanal production.

<sup>6</sup>Manganese ore production for 1985-88 is processed ore output reported by Nsuta Mine. Production for 1989 is the reported mine production minus carbox fines, which were unsalable.

production. The level of gold smuggling was estimated to have been about the same as in 1989, or about \$20 million.

Official diamond exports were worth about \$20.5 million. This almost fivefold increase was largely the result of dramatically increased sales to the PMMC of artisanal production, and higher diamond prices. Sales to the PMMC in 1990 were believed to represent the bulk of artisanal production hitherto smuggled out of the country; the remaining illegal trade, however, probably also benefitted from improved prices and was worth an estimated \$3 to \$4 million. Apart from exporting its own production, Ghana appears to be an entrepôt for a significant number of dia-

monds from elsewhere in Africa. An indication of the magnitude of this trade is seen in U.S. Customs data, which credit Ghana as being the source of imports into the United States in 1990 of 1.14 million carats, worth approximately \$94 million.

Manganese ore exports declined 11% to 254,710 tons, but owing to higher world prices, the export value increased by 26% to almost \$15 million. Bauxite exports decreased slightly to about 369,000 tons, but revenues increased by about 10% to \$10 million. The most significant value-added mineral commodities exports were of aluminum and fuel oil, in 1990 worth about \$281 million and about \$13 to \$15 million, respectively.

Total imports into Ghana decreased slightly to approximately \$1.14 billion, and would have been lower still had not oil prices increased during the fourth quarter of 1990 in response to the Persian Gulf conflict. Imports reflected high levels of foreign aid to Ghana and the general ease of access to foreign exchange enjoyed since the relaxation of fiscal controls early in 1988 and in early 1989; the latter was tempered somewhat by the imposition of higher import duties on certain consumer goods.

As in 1989, the dominant import commodities in 1990 were crude oil and refined petroleum products, worth about \$166 million and an estimated \$150 million, respectively, the latter based on 1989 import

levels. Alumina imports for the Volta Aluminum Co. (VALCO) aluminum smelter totaled about \$100 million, and petroleum coke for the same operation totaled about \$18 million. Clinker imports for the country's grinding plants were worth an estimated \$45 million. A major proportion of Ghana's machinery imports were for the mining industry.

In 1990, Ghana's biggest trading partner continued to be the United Kingdom, followed by the United States. The United States took about 21% of Ghana's exports and supplied about 12% of its imports. Other important trading partners for Ghana were the Federal Republic of Germany, Japan, Spain, Romania, and Nigeria.

Ghana's mineral exports to the United States were mostly of fuel oil (\$11.9 million), although \$94 million in diamonds reported to be from Ghana were also imported into the United States, probably via Belgium. Aluminum from the VALCO reduction plant has in some years been exported to the United States, but in 1990, most of this material was shipped to Rotterdam for sale to the London Metal Exchange. Ghana's bauxite exports were to the United Kingdom. In 1989, the latest

year for which data were available, Ghana's manganese exports were mainly to Norway, Spain, Romania, and Japan; the United States took only about 2% of the shipments. Ghanaian gold was toll refined in Switzerland before being sold on the world market, and Ghana's diamonds officially were sold in Belgium.

Nigeria was the source of Ghana's imports of crude oil and much of its refined petroleum products. Jamaica has commonly supplied the bulk of Ghana's imports of alumina, although in 1990, the United States supplied about 23% of this commodity and all of the petroleum coke for the aluminum operation.

### STRUCTURE OF THE MINERAL INDUSTRY

The mineral industry of Ghana in 1990 was dominated in value by the production of gold. In 1990, gold was produced by 10 formal mines, of which 7 were lode operations, 2 were placer gold mines, and 1 was a placer diamond mine that recovered a modest quantity of gold. One of the lode mines, a world-class operation, accounted

for 80% of the country's total formal gold output. There was also artisanal production of gold, largely from placer deposits.

Diamonds were produced by one formal mine and by artisanal miners. During the year, one bauxite mine and one manganese ore mine were in operation. Two cement clinker-grinding plants were in operation in 1990, as were three small steel mills. One small oil refinery was in operation, using imported crude oil; and one aluminum smelter, using imported alumina.

In 1990, Ghana's labor force comprised about 5.8 million workers. Almost 20% of the workers were in industry, and about 55% were in agriculture. The formal primary mining sector employed about 25,000 workers, about 20,000 of whom worked for gold-mining companies. These numbers included workers directly employed in the mining and ore milling operations, and in company-owned shiploading facilities, farms, lumber mills, and other captive service industries. Apart from the mining operations, an estimated 400 to 600 persons were employed on various mineral exploration projects. The value-added mineral industries employed about 4,000 persons, about one-half of whom worked for the

TABLE 2  
GHANA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

(thousand metric tons unless otherwise specified)

| Major commodity                                | Major operating companies   | Location of main facilities   | Annual capacity                                  |
|--|---|---|--|
| Aluminum                                       | Volta Aluminum Co. Ltd. (VALCO)   | Aluminum smelter at Tema  | 200  |
| Bauxite  | Ghana Bauxite Co. Ltd.  | Bauxite mine at Awaso   | 500  |
| Cement   | Ghana Cement Works Ltd.   | Clinker grinding plants at Takoradi and Tema  | 700  |
| Diamond<br>thousand carats                     | Ghana Consolidated Diamonds Ltd.  | Placer mine at Akwatia  | *250   |
| Gold<br>kilograms                              | Ashanti Goldfields Corp. (Ghana) Ltd.   | Underground and surface mine at Obuasi  | 12,500   |
| Do.  | Canadian Bogosu Resources Ltd.  | Open pit mine at Bogosu.  | 4,043  |
| Do.  | Goldenrae Mining Co.  | Placer mine at Kwabeng, 16 kilometers north of Kibi                                     | 684  |
| Do.  | Precious Minerals Marketing Corp.   | Accra. Purchases artisanal production   | NA   |
| Do.  | Southern Cross Mining Ltd.  | Open pit mine at Obenemase, near Konongo  | 1,250  |
| Do.  | State Gold Mining Corp.   | 5 gold dredges near Dunkwa<br>Underground mine at Prestea<br>Underground mine at Tarkwa | 315<br>800<br>800                                |
| Do.  | Teberebie Goldfields Ltd.   | Open pit mine near Tarkwa   | 2,177  |
| Manganese ore                                  | Ghana National Manganese Corp.  | Open pit mine at Nsuta  | 350  |
| Steel  | Steelworks Co. subsidiary of Ghana Industrial Holdings Co.<br>Wahome Steel Ltd. | Steel mill at Tema<br>do.   | 2,500<br>(rebar)<br>18<br>(rod, rebar, and wire) |
| Petroleum products<br>thousand barrels per day | Ghanaian-Italian Petroleum Co.  | Refinery at Tema  | 27   |

\*Estimated. NA Not available.

VALCO aluminum smelter. 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 7,000 employees of Ghana Railway Corp. was tied to the raiiling 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. Some 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.**—Ghana's hydroelectric potential has been recognized since early in the century, and in 1915, it was proposed that by damming the Volta River enough electricity could be generated to power an aluminum smelter. In 1961, Kaiser Engineers of the United States was awarded the contract to build a dam and hydroelectric plant on the Volta River at Akosombo and an aluminum smelter at Tema. The dam and power station were completed in 1965. The VALCO aluminum smelter, the first in Africa, was completed in 1966, and the first potlines were put into operation in 1967. The smelter is run as a tolling operation and to date has used only imported alumina.

The VALCO reduction plant increased output slightly in 1990, but still operated below the operational capacity of 180,000 mt/a based on the use of 4 of the plant's five potlines. Net salable output increased 2.8% to 172,409 tons.

Bauxite in Ghana was discovered in 1914 and has been found in several parts of the country. The Awaso Mine, which opened in 1940, has been the only bauxite mine to date, but several other deposits have been drilled. Ghana Bauxite Co. Ltd. (GBC), operator of the Awaso Mine, continued to increase output during the year. Exports fell slightly, however, largely because of shiploading interruptions brought on by the company's ongoing upgrading and expansion of its loading infrastructure at the port of Takoradi. GBC has plans to increase exports to 500,000 mt/a within a few years and, given adequate

railing capacity, ultimately plans to produce at a rate of 1 Mmt/a.

**Gold.**—Artisanal mining of placer and lode gold deposits in Ghana has occurred for centuries. Gold mining by Europeans in Ghana started in the 1620's, but the major gold boom started in the 1880's. The number of active formal gold mines declined precipitously after World War II; despite this, gold output reached its highest level—28,470 kg—in 1960, after which it declined fairly steadily until 1983. Production since 1983 has increased dramatically.

Ghana's official gold production in 1990 was the highest since 1974, largely as a result of the ongoing rehabilitation and expansion project at the Ashanti Mine, which more than compensated for the lackluster output of the operations controlled by the State Gold Mining Corp. (SGMC) and by the Southern Cross Mine. Mining commenced during the year at the Teberebie, Goldenrae, and Bogosu Mines, all of which had their first gold pours during the fourth quarter. In addition, a significant but undocumented amount of gold was produced by artisanal miners. Traditionally; the artisanal production and gold stolen from the formal operations has been smuggled out of the country, largely to Togo and Côte d'Ivoire. It is estimated that almost 2,000 kg of gold is so traded annually. In an effort to encourage both artisanal production of gold and its legal sale to the Government, a licensing system for small-time miners was set up in 1989, and a pricing formula, averaging 93% of the world price, was enacted by the PMMC. The PMMC purchased 536 kg of gold in 1990; this modest response to the purchasing program, although an 86% increase over 1989 purchases, continued to reflect an inefficient network of buyers.

The Ashanti Mine at Obuasi is a world-class gold mine that began production in 1895 and which has produced about 635,000 kg of gold since that time from ore having an average gold grade of about 20 g/mt. About 80% of Ghana's gold production in 1990 came from the Ashanti Mine. Production in 1990 increased 28% to 13,475 kg, the highest level since 1973. The \$156 million expansion and rehabilitation program for the mine, which began in 1984, was ongoing during the year. This program has the goal of increasing the mine's output to about 18,700 kg in 1991 and, eventually, to about 31,000 kg. This is to be achieved through a combination of developing rela-

tively shallow (underground) quartz and sulfide ores toward the south end of the mine, a large sulfide ore body at moderate to deep levels in the central part of the mine, deep mixed ores toward the north end, and large surface ore bodies to the south of the underground workings. In addition, a large volume of old tailings will be reprocessed, and the mine's ore processing facilities will be modernized and expanded.

Ongoing rehabilitation and expansion of the underground workings has mainly involved improving ore access and haulage, and air flow, by deepening certain existing shafts, developing new shafts, and installing rapid ore conveyance infrastructure underground. The target of the new shafts (George Cappendell and Kwesi Mensah) are the southern and central ore bodies; deepening the main ore hoisting shafts to the north will allow improved ore haulage from the more southern ore bodies, and access to deep portions of the northern ore body.

The rehabilitation program has allowed the rehabilitation of the Pompora Treatment Plant, which handles all of the underground and part of the surface ores. Work on this plant has included the installation of a new ball mill, the replacement of some flotation banks, and the upgrading of the gravity circuit. In addition, the roasting furnaces are being converted from wood to oil-fired. Future work will include the installation of sulfur and arsenic oxides emissions scrubbers for the roaster. Early in 1990, a second tailings retreatment plant was commissioned; this has doubled the tailings throughput capacity to about 3,600 mt/d.

A major component of the company's efforts to increase gold production from the Ashanti Mine is the Sansu Project. This \$93 million project involves the open pit mining of large reserves of relatively low-grade, largely oxide ores. In early 1990, the company signed a \$70 million finance package for the project, coordinated through the International Finance Corp. Depending on grade and metallurgy, the Sansu ore was to be processed either at the Pompora Treatment Plant, at a new oxide ore treatment plant to be constructed, or by a 3,000 mt/d heap leach. Surface mining commenced around midyear 1989; the ore was either sent to the Pompora plant or stockpiled pending completion of the heap-leach facility. By yearend 1989, the heap-leach pads were being loaded and the modular cyanide plant, built in the United States by Kappes, Cassiday & Assoc., was being assembled on-site. Heap-leaching com-

menced March 1, 1990, and the first gold was poured on March 20. For the remainder of the fiscal year, gold recovery from the heap leach averaged about 100 kg/month. The oxide plant was expected to be commissioned about March 1991 and was expected to process about 200,000 mt/month. The Sansu operation is expected to produce about 5,000 kg/a once all facets are operating at full capacity.

Reserves at the Ashanti Mine are large and are likely to be significantly increased through the company's ongoing underground and surface exploration program. According to the company, underground reserves as of September 30, 1990, were about 7.71 Mmt grading about 17.5 g/mt. The surface (Sansu) reserves (all classes) were about 12.6 Mmt grading about 4.5 g/mt. Tailings reserves are about 12 Mmt grading about 3.3 g/mt. In recent years, a significant proportion (about 11% in 1990) of the tonnage mined has come from material not included in the reserves, such as old backfill, certain pillars, and hitherto below cutoff-grade material adjacent to old workings that has proved to be amenable to modern bulk mining and processing methods. The company, through its new Ashanti Mines Expansion Project, has begun to evaluate these resources throughout the existing workings. It is believed that a significant proportion of these resources, estimated to contain almost 250,000 kg of gold, may yet be added to the mine's reserves.

SGMC operated the Prestea and Tarkwa underground mines and the Dunkwa gold dredging operation during the year. Rehabilitation work, financed by loans from various international banks, continued at the mines, with the goal of raising total SGMC production to about 4,000 kg by the early 1990's. Most of the work outstanding by yearend 1989 was to be done at the underground mines and was to involve major rehabilitation of the underground workings, including repairs to the main shafts, replacement of the winders, dewatering of workings, and the purchase of mining machinery. The mills at both mines, but especially at Prestea, were to be rehabilitated. The rehabilitation program also aimed at increasing the reserves at both underground mines.

Total gold production by SGMC increased 9% in 1990 to 1,593 kg. The bulk of the increase was from the Tarkwa Mine, whose output increased 20% to 764 kg. This appears to have been the result of improved mill throughput, but the mine continued to

suffer from deteriorating equipment and infrastructure. The Prestea Mine produced 639 kg of gold—a 6% increase, but still well below the 1988 production of 730 kg. The mine in 1990 continued to be plagued by problems with its roasting circuit, by generally deteriorating mill equipment, and by declining grades. The five gold dredges comprising Dunka Goldfields Ltd. similarly were beset by mechanical problems, and gold output for the year fell 12% to 190 kg. All three mines operated at a loss for the year.

The reserve picture at both the Prestea and Tarkwa mines continued to be bleak, largely because of lack of exploration effort rather than of geologic potential. Reserves at yearend 1990 were not available, but were believed to have changed little from those of yearend 1988. At that time, total gold ore reserves of the Prestea Mine 1988 were given by the company as 7.162 Mmt grading 7.88 g/mt, of which about 30% was proven. However, much of the proven reserves was in pillars or was otherwise not available for mining. Reserves available for mining amounted to only 680,000 tons grading 5.7 g/mt. 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. 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.

As part of the Government's privatization program, buyers were sought for the SGMC mines. The most interest was shown in the Prestea Mine concession, which was considered to have excellent reserve potential. By yearend, a number of international companies had made offers for the mine; the Minerals Commission recommended to the Government that the offer of ARIMCO of Australia be accepted. Relatively little interest was shown in the Tarkwa Mine. The Minerals Commission was negotiating at yearend with Billiton International Metals BV of the Netherlands regarding Dunkwa.

The Southern Cross Mine experienced a disappointing year in 1990. The mine, 7 km northeast of Konongo, was Ghana's first heap-leach gold operation, and at its startup in 1988, was the first new mine in the country in more than 40 years. After a highly successful 1989 production year, the mine began to experience problems in 1990. Its 70% owner, North Queensland Co. of Australia, was beset with cash-flow prob-

lems at home, and this resulted in inadequate funding of the Ghanaian operation. Operating costs at the mine were high, largely owing to the high cost of cement needed to agglomerate the clay-rich ore. In addition, it was reported that metallurgical problems began to be experienced with the dwindling oxide reserves. The company lacked the money needed to build a facility to process its sulfide ore reserves. The mine produced 833 kg of gold in 1990 from its oxide reserves; this was a 22% decline from 1989 output.

Reserve data for the Southern Cross Mine for 1990 were not available, but as of April 30, 1989, proven reserves for the currently mined A-Pit were given by the company as 650,000 tons of oxide ore grading 5.28 g/mt. Given the mining rate of almost 600,000 mt/a, it is likely that little of this ore remained at yearend 1990. The A-Pit's proven sulfide reserves were given as 234,000 tons grading 11.68 g/mt, and probable reserves were 170,000 tons of sulfide ore grading 9.6 g/mt. A neighboring ore body ("B-Pit"), as yet unmined, had proven plus probable gold ore reserves of 200,000 tons grading 1.34 g/mt. However, given the company's financial and the ore's metallurgical problems, it was not clear at yearend 1990 what proportion of the unmined inventory was actually economic, and the same question applied to resources at other prospects on the company's concession.

Mining and stockpiling of oxide ore at the Bogosu Mine commenced in May 1990, pending completion of the mine's carbon-in-leach facility. This plant was completed in October, and the first gold was poured in late November. Throughput was less than the 250,000 tons expected, owing to problems with the semi-autogenous grind mill that necessitated diversion of the ore, albeit at a lower rate, through the ball mills. The company, Canadian Bogosu Resources Ltd. (CBR), processed the remainder of its oxide ores and commenced production of gold from its higher grade sulfide reserves early in 1991. However, startup problems were also experienced processing the sulfide ore, mainly with the mill's flotation circuit and fluidized bed roaster. Production in 1990 was only 127 kg, less than 50% of that expected. Production in 1991 was to include especially high-grade sulfide ores and had been expected to be about 4,500 kg, but the startup problems were expected to reduce this significantly. Long-term output, involving lower grade material, was expected to be 3,500 kg annually.

Owing to the early production problems,

especially those experienced late in 1990, the operating and minority shareholder in CBR, Sikaman Gold Resources Ltd. of Canada, sold its 14% share in the operation to its joint-venture partners. Billiton International Metals BV of the Netherlands thus increased its overall share in the operation by 11.5%, giving it 74% of the total, while the International Finance Corp.'s share increased from 13.5% to 16%. The Government's share remained at 10%.

At yearend 1990, total reserves (all classes) at Bogosu amounted to about 18 Mmt grading about 3.4 g/mt. Most of this inventory was sulfide ore. Mining will involve a series of open pits, and the concession was considered to have good potential for the discovery of additional reserves.

Goldenrae Mining Co., a joint venture of ITM International of Luxembourg, 51%; Sikaman, 34%; the Government, 10%; and private Ghanaian investors, 5%, announced that gold production commenced in mid-October at the Goldenrae placer mine. The mine is on the Kwabeng concession, about 16 km north of Kibi, and was designed to process about 50,000 m<sup>3</sup> annually using a floating plant.

Annual gold production was expected to be about 400 kg, but mechanical problems, mostly with the plant, limited output in 1990 to 26 kg only, and that for the first 6 month's of production to only about 95 kg. Faced with unacceptable performance of the washing plant, the company commissioned a feasibility study of the economics of installing a new washing plant, which would allow the processing of 1.5 Mm<sup>3</sup> annually to produce 750 to 1,050 kg of gold per year. The feasibility study was expected to be completed by mid-1991. It was hoped to eventually bring on stream a smaller operation on the adjoining Pameng concessions; this would be with the goal of a total output for the two concessions of 1,050 to 1,400 kg of gold annually. Total reserves on the Kwabeng and Pameng mining concessions were given by Sikaman as 9 Mm<sup>3</sup> grading 0.55 g/m<sup>3</sup>.

Teberebie Goldfields Ltd. announced that it had poured its first gold in mid-October from its open pit, heap-leach operation 5 km southwest of Tarkwa. Mining had commenced in June. The mine exploits Tarkwaian conglomerates, and owing to the need to move a village that was on top of the better grade ore, initial production was from relatively low-grade material. This, together with minor startup problems with the grinding circuit and with the agglom-

eration medium, restricted 1990 gold production to 214 kg. The company expected to mine about 1 Mmt of ore in 1991 to produce about 2,200 kg of gold, and expected to reach an annual output of about 3,100 kg of gold after a few years. Proven plus probable reserves were given by the company as about 72,000 kg of gold in ore grading about 2 g/mt.

A 178-hole second phase drilling program was completed in 1990 on the Iduapriem Project, owned by Ghana Australian Goldfields Ltd., a joint venture among Australian companies Golden Shamrock Mines, 51%; and Titan Resources NL, 12%; the IFC, 20%; the Government, 10%; and private Ghanaian and British investors, 7%. This work reportedly confirmed minable reserves of almost 14 Mmt grading about 2 g/mt, in addition to which are lower grade reserves of about 5 Mmt grading about 1 g/mt. The Iduapriem concession is 11 km southwest of Tarkwa. Like the Teberebie Mine on the adjoining concession, the Iduapriem Mine will be an open pit operation exploiting Tarkwaian conglomerate ore. A carbon-in-pulp circuit will be used rather than heap-leach extraction of the gold, as this will allow a higher gold recovery than would be possible in a heap-leach, and will mitigate the deposit's initial high stripping ratio. Further, the low-grade reserves form part of the strip burden and will be stockpiled for later treatment. Mining was expected to commence in 1991 or 1992, and the first gold production was expected in the following year.

A number of advanced gold exploration projects were underway during the year. One of the most encouraging of these was the Bokitsi Project, owned by Cluff Resources PLC of the United Kingdom. The Bokitsi concession, 15 km west of Dunkwa, centers around the old Bokitsi Mine. Four prospects have been identified in Birimian greenstones and, relatively unusual for Ghana, weathered granites intruding the Birimian. A 126-hole reverse circulation drilling program was completed in 1990; this drilling, together with earlier work, formed the basis of a mining prefeasibility study that was expected to be completed early in 1991. At yearend 1990, minable proven and probable open pit oxide reserves were given by the company as 3.86 Mmt having a recoverable grade of 2.0 g/mt. The oxide ore, while amenable to heap leaching, would require extensive agglomeration, and given the high costs of cement, the company felt that heap leaching would not be very profitable. Apart from the oxide reserves,

the deposit was believed to have minable sulfide ore, but evaluation of this resource was not well-advanced.

**Manganese.**—Manganese ore has been mined in Ghana since 1916. The Nsuta Mine has been the only significant producer of manganese ore in the country, although there has been some small production, on a sporadic basis, of low-grade material from other deposits in the area. One of these, Kwesikrom, was the object of exploration during the year.

Manganese production from the Nsuta Mine, operated by Ghana National Manganese Corp. (GNMC), fell significantly in 1990. This was evidently the result of an increasing ratio in the output of carbonate plus mixed carbonate-oxide ("carbox") ore to oxide ore. Although the carbox lump ore is salable, the carbox fines are, currently, not. Exports also decreased in 1990, but this decline was offset by improved world manganese ore prices. Oxide ore of various grades made up 27% of the shipments, down from 54% in 1989. Carbonate ore sales made up 27% of the 1990 shipments, up from 24% in 1989. Carbox (lump) shipments in 1990 were 31% of the total, compared with 22% in 1989.

GNMC continued to explore for additional reserves during the year, particularly of carbonate ore at depth between the old oxide ore bodies. Exploration for oxide and carbonate ore was focused 1 to 4 km to the south and southeast of the existing pit area. The results of these efforts during the year were not available, but the company announced that their work in 1989 had added almost 330,000 tons of oxide ore to the reserves.

The \$18 million calcining plant completed in 1982 remained uncommissioned at yearend, although the Government was studying the feasibility of putting it into operation to realize higher prices for the mine's carbonate ores. The incentive to commission the plant was lessened by the company's ability to sell its carbonate output to Japan.

A number of other manganese deposits are known in Ghana, many of which are in the area between Nsuta and the coast. Few have had their resources delineated in detail, although one, the Yakau deposit about 22 km west of Takoradi, was mined in a minor and intermittent way in the 1940's and 1950's. Work by Soviet geologists in the early 1960's delineated a few million tons of, in general, low-grade manganese oxide scattered among several deposits in the area.



During 1990, Brem-Wilson Mining Ltd. drilled the Kwesikrom manganese deposit, about 27 km south of Nsuta, with a view to opening a small manganese mine. Results of the drilling had not been announced as of yearend.

### Industrial Minerals

**Diamond.**—Alluvial diamonds were discovered in Ghana in 1919 and have been exploited by a number of companies since that time. Of these, only one was still in operation in 1990. Total formal-sector diamond production in Ghana peaked in the 1970's, when production exceeded 2.5 million carats, but has declined severely since that time. The Akwatia Mine, the only formal diamond mine in Ghana in 1990, 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, Ghana Consolidated Diamonds (GCD).

Production of diamond from the Akwatia Mine increased significantly in 1990, but was still only about one-third that needed for profitability. Owing to the exhaustion of the high-grade terrace gravel deposits that had been the traditional source of production for the mine, and for which the mill was designed, production since 1987 has been increasingly from gravels along the Birim River. Reserves there were delineated during the early 1980's by the UN, and although the grades are satisfactory, development of the deposits is made uneconomical by the excessively long haulage to the mill and the fact that the mill, in chronic disrepair, was not designed for this feed. GCD felt that the mill should be abandoned in favor of several small semi-mobile plants that would be located on the Birim gravels. These plants would process about 1 Mm<sup>3</sup> of gravel annually to produce about 1.1 million carats per year. A feasibility study of this plan was completed in September 1989, and concluded that the project was viable given the UN-delineated reserves, which were adequate for 15 years of production. In addition, GCD had realistic expectations of increasing these reserves. The Government was seeking equity investment and other financing for the semi-mobile plant project through its plan, announced early in 1990, to privatize GCD. A number of international companies were reported to have expressed interest in purchasing GCD, and the Minerals Commission was studying their bids at yearend.

Apart from the Akwatia Mine, there has

traditionally been significant artisanal production of diamonds from placer deposits. Despite Government efforts to purchase this production, before 1989, most of it was being smuggled out of the country, largely to Togo. The Government estimated that this smuggling involved 30,000 to 50,000 carats per month. Sales to the Government through the Diamond Marketing Corp. (DMC) in 1988 were only about 34,000 carats. In 1989, the PMMC was set up to replace the DMC in an effort to improve the level of diamond purchases. Although the response was initially disappointing, purchases began to pick up toward midyear 1989 as confidence in the PMMC pricing system improved. In 1990, the PMMC purchased 484,876 carats, a threefold increase over 1989 purchases, and a level believed to account for the bulk of the artisanal production.

### Mineral Fuels

Atlantic Richfield Co. (ARCO), operating in 1990 on behalf of Royal Dutch/Shell Group, Unocal Corp., and the GNPC, drilled three offshore wells in the Tano Basin, south of Half Assini. The first well was to test the structure between the North and South Tano discoveries made by Phillips Petroleum in 1978. The other two wells were to test shallower targets. The results were negative—one hole was dry and the other two showed only sub-commercial gas flows; nevertheless, the companies felt that the North Tano Basin likely had commercial gas potential.

GNPC was planning a horizontal drilling program in 1991 in the South Tano Basin, about 32 km offshore, with the aim of proving sufficient natural gas reserves there to justify a minimum flow of 1.4 Mm<sup>3</sup>/d to a new thermal power station at Half Assini. The power station was planned by the Volta River Authority to come on-stream in 1993. GNPC also planned to drill a wildcat to test a seismic target just north of the old Saltpond offshore field, and was planning to integrate old and newly acquired seismic data for the field.

The Ghana-Italian Petroleum Co. refinery at Tema, the country's sole oil refinery, experienced severe labor disputes early in October, and this led to an indefinite closure of the facility. Output for the year was believed to have suffered accordingly. Earlier in the year, the company commenced the second phase of its rehabilitation program, which was expected to last until 1992. This program involved installation and

improvement of various electronic equipment in the refinery's processing unit, and the construction of a number of storage tanks and pipes. It was planned to expand the refinery to refine the 300,000 tons of residue it produced annually; the residue is presently sold. The company also planned to begin selling its excess LPG production, rather than flaring it. Local demand was only 6,000 mt/a, about one-third of the refinery's output. The GNPC was promoting the domestic use of LPG as a substitute for woodfuel.

A consortium of international oil companies and the GNPC was constructing a lubricating oil-blending plant at Tema that was supposed to start operations in mid-1991, and was expected to meet 90% of the country's requirements.

### Reserves

GBC claims that it has 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>3</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.

Proven and probable gold reserves of the country's operating gold mines and advanced gold projects amounted to about 570,000 kg. The Ashanti Mine had 41% of this inventory. However, if current estimates of the resource within the Ashanti Mine Expansion Project prove to be correct, the mine's (and Ghana's) reserves would increase by 250,000 kg. Ghana's total gold resources are undoubtedly much larger than this, based on the known extent of host rocks, the widespread artisanal production of gold, and the encouraging results of a number of recent exploration programs. In addition, there are a large number of closed old mines, many of which shut down with-

out having depleted their gold resources and which have not yet been evaluated under a modern economic scenario.

Although several manganese deposits are known in Ghana, the only significant known 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 1.4 Mmt, sufficient for about 10 more years of production at 1990 levels. Direct-shipping carbonate ore reserves, calculated in 1964 by the Ghana Geological Survey Department,<sup>3</sup> 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. The bulk of current production, and the 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 per cubic meter. However, because of access difficulties in marshy areas, the U.N. drilling program was restricted to only about one-half of the area of interest. It appears likely that GCD's current drilling in the marshy areas will greatly increase the total reserves.

Ghana's oil and gas resources are not well known, although there have been numerous drilling programs both onshore and offshore. To date, Ghana's only oil production has 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,<sup>3</sup> were approximately 8.9 million barrels. Earlier tests of the South Tano Field indicate that oil resources there may total about 82 million barrels, although recovery would be difficult. Indications are that there are economic resources of natural gas offshore, but these have still to be proved. Recoverable resources of natural gas in the North Tano Field have been estimated at about 1.7 billion m<sup>3</sup>; chances are considered good that this inventory can be doubled. The South

Tano Field gas resources are estimated to be about 2.8 billion m<sup>3</sup>.

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## INFRASTRUCTURE

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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 1990, Ghana had about 36,000 km of roads, of which about 6,400 km were paved. Many of the paved roads remained in very 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. Because of severe deterioration of the rail lines in the early 1980's, Ghana has embarked on a major railroad rehabilitation project. Priority has been 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 1990, significant improvements had been made to the western line; however, the eastern and central lines remained in very poor condition, and the entire system suffered 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. The company expected to rail more than 900,000 tons of freight in 1991.

Ghana's major ports are Takoradi and Tema, each of which can handle ships up to about 30,000 deadweight tons. 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 1990, in common with many countries in Africa, the dominant energy source in Ghana was fuelwood, which accounted for about 70% of the country's total energy use. Electrical generating capacity was reported to be 1,185 kW, of which 1,072 kW was from hydropower, installed in the Akosombo Dam (912 KW) and the Kpong Dam. Ghana produced 5,721 MWh in 1990, a 9.4% increase over 1989 production. Approximately 60% of Ghana's electrical output is consumed by VALCO. Excess from the remainder is sold to Togo, Benin, and Côte d'Ivoire. Ghana's domestic grid is being rehabilitated and expanded. The grid was extended to the northern part of the country in 1989 and was further extended in that area in 1990. Although the major mines all are connected to the national grid, most have backup oil- or wood-fired generators.

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## OUTLOOK

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Ghana's export economy will continue to be dominated by the export of cocoa and minerals. Gold will remain by far the most important primary mineral export. Expanded output from the Ashanti Mine, together with a full year's production from the country's new mines, should dramatically increase Ghana's gold output in 1991 to approximately 27,500 kg. The output should further increase as new mines come on-stream as the Ashanti Mine expands further; it is estimated that Ghana could reach a gold output of about 31,000 kg or 1 million troy ounces by 1995.

Slightly mitigating this scenario, however, is the current lackluster price for gold and predictions of relatively stagnant prices for the near future. This will likely somewhat reduce the available financing for new exploration in Ghana, particularly by small venture-capital companies—entities that have had much success in Ghana in recent years. Further, it will increase the cutoff grades needed for new mines, and may reduce the cost advantages of heap leaching for certain deposits.

If the Akwatia Mine is able to enact its expansion and rehabilitation plans, Ghana's diamond output will likely increase significantly in the near-term. Because of declining reserves and infrastructural problems, any increases in manganese ore output are likely to be minor, unless new deposits are opened. Ghana has the potential to increase

its exports of bauxite, both through the expansion of output from the Awaso Mine and by the development of new deposits. However, most of the latter are only of modest grade and have high silica contents, and future world market demand for this bauxite is uncertain. In addition, the country's raiiling and shiploading infrastructure is inadequate for exporting this material. The development of an integrated aluminum industry is subject to raiiling and power constraints that make questionable the economics of such a project under 1990 market conditions.

<sup>1</sup>Where necessary, values have been converted from Ghanaian cedis (C) to U.S. dollars at a rate of C326.2=US\$1.00.

<sup>2</sup>Quashie, L. A. K., et al. Report of the Committee for Increased Gold Output in Ghana, United Nations document DP/UN/GHA-78-003/, 1980, 78 pp.

<sup>3</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

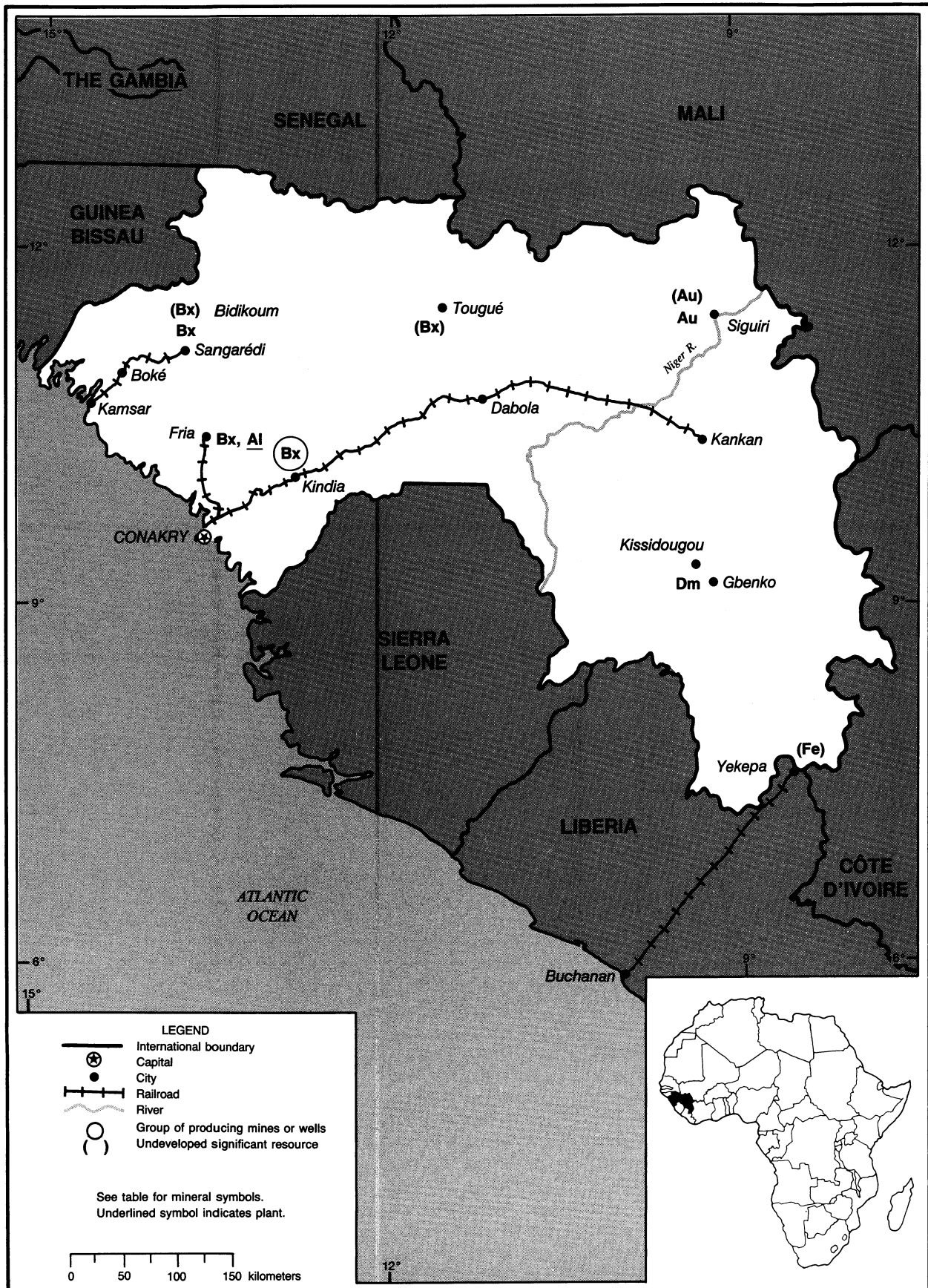
Accra, Ghana



# GUINEA

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

POPULATION 7.3 million



# THE MINERAL INDUSTRY OF GUINEA

By David Izon

**G**uinea was the second largest producer of bauxite in the world in 1990 after Australia. The mining sector dominated the economy of Guinea mainly through the production of bauxite, diamond, and gold. Alumina and bauxite were the country's principal foreign exchange earners. Guinea has the largest and richest known deposits of bauxite in the world, with alumina contents of between 50% and 60%. The minerals sector accounted for about 25% of the GDP of about \$2.9 billion in 1990. The main foreign exchange earners, alumina and bauxite, accounted for about 88% of all mineral exports and mineral export accounted for about 90% of the country's total exports. Although the annual export volume of bauxite remained relatively constant, the export contract price declined somewhat. This was due to the pricing formula negotiated in 1986 that has builtin lags. The discovery and exploitation of other minerals such as diamond and gold have diversified the mineral economy of the country. Production of diamonds remained steady, while gold production saw a significant increase. Artisanal production and trade in diamonds were not officially reported. Artisanal gold production was mostly accounted for because the Central Bank bought nearly all of the gold. There was a slight growth in agricultural exports in 1990, and Guinea was the only country in the central region to increase production of cocoa.

The MIFERGUI-Nimba iron ore mining project has not blossomed owing to delays stemming from lack of financing and inadequate infrastructure. These were compounded by the outbreak of the civil war in Liberia. The latter resulted in the deterioration of the Liberian infrastructure, a massive refugee problem, and difficulty in attracting investors for the necessary financing of the project.

There was no major change in investment patterns except that individual Guineans were now permitted to buy and sell gold in 1990. Guinea and Iran established a new joint venture to ship bauxite to the Port of Bandar Abbas in Iran.

## GOVERNMENT POLICIES AND PROGRAMS

Government policy in Guinea generally was to encourage mineral exploration and exploitation. The Government continued on existing reform programs that were particularly designed to encourage inflow of foreign assistance and investment, but has been very slow in realizing any benefits from such programs. To this end, the Government has embarked on a policy analysis and review program that was intended to restructure the mining and investment codes, making them more attractive to foreign investors. 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 as adopted in code No. 001/PRG/87 of January 1987.

Although the Government's structural adjustment program has established an incentive framework required for the revitalization of the economy, domestic economic management problems have continued to hinder the effectiveness of such programs. This has, at times, led to certain administrative difficulties and a disappointing flow of revenues to the Government. The Government, in an effort to increase revenue on future mining ventures, was exploring financial alternatives to current high-equity Government participation in mining ventures.

TABLE 1

### GUINEA: PRODUCTION OF MINERAL COMMODITIES FOR 1990<sup>1,2</sup>

(Thousand tons unless otherwise specified)

| Commodity                         | 1986    | 1987    | 1988   | 1989 <sup>p</sup> | 1990 <sup>p</sup> |
|-----------------------------------|---------|---------|--------|-------------------|-------------------|
| <b>Alumina:</b>                   |         |         |        |                   |                   |
| <b>Production:</b>                |         |         |        |                   |                   |
| Hydrate                           | '571    | '542    | 593    | 627               | 642               |
| Calcined                          | 556     | 543     | 589    | 619               | 631               |
| Shipments; Calcined               | '567    | '539    | 593    | 624               | 631               |
| <b>Bauxite:</b>                   |         |         |        |                   |                   |
| <b>Mine production:</b>           |         |         |        |                   |                   |
| Wet basis                         | '14,961 | '16,413 | 17,859 | 17,547            | 17,524            |
| Calcined <sup>5</sup>             | '117    | '114    | 130    | 143               | 140               |
| <b>Shipments (dry basis):</b>     |         |         |        |                   |                   |
| Metallurgical                     | '12,146 | '13,829 | 14,524 | 14,750            | 13,835            |
| Calcined                          | 122     | '124    | 136    | 136               | 133               |
| <b>Diamond:<sup>3</sup></b>       |         |         |        |                   |                   |
| Production thousand carats        | 204     | 175     | 146    | '147              | 127               |
| <b>Gold:</b>                      |         |         |        |                   |                   |
| AuG's production kilograms        | —       | —       | 324    | 1,202             | 1,745             |
| Total production <sup>4</sup> do. | —       | 864     | 1,996  | 2,118             | 6,341             |

<sup>p</sup>Preliminary. <sup>r</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 June 28, 1991.

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

<sup>3</sup>Figures do not include undocumented artisanal production believed smuggled out of the country.

<sup>4</sup>Figures include undocumented artisanal production.

<sup>5</sup>Figures represent Compagne Bauxite de Guinée mines only.

## PRODUCTION

In general, mineral production remained stable in 1990. Guinea, the second largest producer of bauxite in the world, was also involved in alumina refining. Reported gold production in 1990 from the Koron Mine reached about 1,745 kg, an increase of about 45% over that of 1989. Although production from the Aredor diamond mine decreased slightly in 1990, it nevertheless made a profit owing to the quality of the diamonds found. Artisanal miners were involved in the production of diamond and gold. Legal artisanal gold sales to the Government were estimated to be approximately 1,000 kg.

## TRADE

Guinea's mineral trade was dominated by exports of bauxite. According to the Bureau de Stratégie et de Marketing Minier of Guinea, the total value of mineral exports for 1990 was approximately \$588 million. Alumina exports increased significantly by about 27% to \$166 million in 1990, which was 28% of the total mineral export value. The trade value of bauxite was \$364 million, and the remaining value consisted of about \$38 million for diamond and \$20 million for gold. Although there was a decline in diamond production in 1990, the revenues increased owing to the quality and size of the

diamonds sold. The total amount of revenues generated from gold sales was 3% of the total minerals export value. The gold and diamond revenue figures do not, however, include the value of smuggled artisanal production. The value of this smuggled production was unknown. Major import goods were petroleum products, construction materials, fertilizer, vehicles, and industrial machines. About 50% of the total imports involved supplies and equipment for the minerals industry. Major trading partners included France, the U.S.S.R., the United States, and neighboring West African countries. Guinea's main exports to the United States were bauxite, coffee, and diamonds. The value of exports to the United States for 1990 was about \$141 million versus an import value of about \$43 million for the same period.

## STRUCTURE OF THE MINERAL INDUSTRY

The mineral industry was dominated by the production of bauxite by three companies, one of which was entirely state-owned. There was one diamond mine and one gold mine in operation in 1990. In addition, there was widespread artisanal production of diamond and gold for which official estimates were not available.

Guinea's labor force is estimated to number about 2.6 million workers, an estimated 20% of whom are in industry.

Guinea's formal mining industry employs about 8,000 workers. About 75% of these is in the bauxite and alumina sector. As a result of the Government's policy of encouraging the training of Guinean staff to replace expatriates, the latter make up only about 6% of the mining labor force.

Guinea has a large informal or artisanal mining sector. In an effort to protect large-scale investors, the Government banned artisanal mining in areas where major companies were holding concessions.

## COMMODITY REVIEW

### Metals

**Bauxite and Alumina.**—The capacity upgrade of the Friguia alumina refinery that began in 1989 was on schedule. Alumina production at Friguia increased slightly from 626,800 tons in 1989 to about 642,100 tons at yearend 1990.

Compagnie des Bauxites de Guinea's (CBG) bauxite production from the Sangarédi Mine was reported to be about 12.255 Mmt, wet basis, for 1990. Total exports from CBG operations for the year amounted to 10.991 Mmt, dry basis, 132,500 tons of which was calcinated. The Government planned to gradually phase in the Bidi-Koum deposit in 1992, while production in Sangarédi is decreased. This will postpone the exhaustion of Sangarédi's

TABLE 2

### GUINEA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

(Million metric tons unless otherwise specified)

| Major commodity     | Major operating companies                     | 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.<br>.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> | Aredor placer mine and mill are at Gbenko, 475 kilometers east of Conakry   | 200,000.                    |
| Gold, kilograms     | Aurifère de Guinée                            | Koron placer mine near Siguiiri, about 540 km northeast of Conakry  | 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 (U.K.) Ltd., 3.52%; Industrial Diamond Co. (Holdings) Ltd. (United Kingdom), 6%; and the International Finance Corporation, 11.28%.

high-grade ore. The Bidi-Koum ore averages about 55% alumina and has a higher iron and titanium content than the ore at Sangarédi, which grades about 62% alumina. A limited amount of calcinable bauxite was found at Sangarédi.

**Gold.**—Aurifère de Guinée (AuG) experienced its second full year of production at the Koron Mine 25 km north of Siguiri. The 1990 output of 1,745 kg from the placer mine was an increase of about 45% over the 1989 production. AuG's anticipated production in 1991 would approach the designed capacity of about 2,000 kg from about 1 Mm<sup>3</sup>/a of gravel. Official artisanal gold production data were not available, but according to other sources, total industry output could be about 3,500 kg. The output figures could surpass 5,000 kg if the amount of smuggled gold was added to reported figures and artisanal production. A number of companies held concessions in the Siguiri and Dinguiraye areas and were active in the exploration and mining of the Koron alluvial project or the Dinguiraye gold occurrence. Operators having joint-venture activities in the Siguiri area were Pan-Continental of Australia and Union Minière of Belgium. The Bureau de Recherches Géologiques et Minière (BRGM) of France and Kenor of Norway were in the Dinguiraye area operating as Delta Gold Mining Co. The Government bought gold from artisanal producers offering competitive market prices but was reluctant to buy small quantities of gold. Because of this, a substantial amount of Guinea's artisanal production was smuggled out of the country.

**Iron Ore.**—The civil war in Liberia, that began in December 1989, halted the construction of bridges and connecting roads to the Nimba area of Guinea since May 1990 and has ultimately delayed the MIFERGUI-Nimba Project near the Guinea-Liberia border. Reports indicated that the iron ore project and infrastructure suffered no significant damage. Completion of the Mifergui-Nimba iron ore mining project will depend on the political situation in Liberia and the ability of the consortium of companies to attract investors. The Nimba International Mining Co. (NIMCO) was still trying to raise the development cost of \$200 million. Construction of required infrastructure was also held up owing to the insurgency in Liberia. When completed, the project was expected to produce about 6 Mmt/a, subsequently increasing to about 10 Mmt/a.

## Industrial Minerals

The Aredor diamond mine at Gbenko near Kissidougou reported an 18% decline in production in 1990. According to Bureau de Stratégie et de Marketing Minier of Guinea, production for 1990 was about 127,200 carats. Despite this decline in production, Aredor registered a net profit of about \$209,231 for the year. This was attributed to an increase in the average size and quality of stones produced at the mine and a general strengthening of diamond prices. Bridge Oil Ltd. of Australia wrote off its total debt of about \$100.8 million against its investment in Aredor because it calculated that performance of the company in its primary activity areas was being hindered by delay in recovering its original investment in Aredor. The Guinean Government reached an agreement with Bridge Oil that would defer payment of management fees or interest on loans until after 1992. However, Bridge Oil still had shares worth about \$7.7 million in Aredor and construction and development loans worth about \$43 million plus accrued interests on loans of about \$31.54 million. The Aredor Mine Project was also required to pay syndicated banking loans before commencing repayment of loans to Bridge Oil. Repayment of loans were not scheduled to start until after 1992, and this was expected to depend on cash-flow. Guinea's artisanal diamond production was smuggled out of the country. There were no official estimates of this production.

## Reserves

Guinea's official reserve 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. The highest grade reserves at Sangarédi were about 75 Mmt grading about 62% alumina. Reserves at Bidi-Koum 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 reported to be 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. Other bauxite deposits in Guinea include the Ayé-Koyé deposit 30 km northwest of Sangarédi, with reserves of about 195 Mmt grading about 50% alumina; the Dabola deposit with reserves of about 450 Mmt grading 42% alumina; and the

Tougué deposit, with reserves in excess of 1 billion tons grading about 41% alumina.

No official estimates exist for Guinea's total diamond or gold reserves, although they were both believed to be significant. AuG initially estimated reserves at the Koron placer gold mine to be about 9 million cubic meters containing about 18 tons of gold. Additional gold resources discovered near Didi and Nankoba contained an estimated 11 to 12 tons of gold in gravel grading about 1.3 g/m<sup>3</sup>.

Iron ore reserves on which the MIFERGUI-Nimba Project is based were estimated to be about 350 Mmt grading 66.5% iron. There are additional lower grade iron ore resources in the region and elsewhere in Guinea, but these are currently uneconomic.

## INFRASTRUCTURE

Guinea's transportation infrastructure has deteriorated considerably over the years, being barely adequate for its existing mining operations. In 1990, Guinea had 1,045 km of railroads. The mining railroads totaled 239 km of standard 1.435-m line, and 806 km of 1-m line. A 135-km standard 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. These railroads were considered to be in adequate condition for the present ore and equipment raiiling demands. In addition to the mine railroads, there were 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.

In 1990, Guinea had a total of about 30,100 km of roads. About 1,145 km was paved, 12,955 km was gravel or laterite, and 4,500 km was all-weather roads. The remaining were unimproved earth roads.

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 about 1,300 km of rivers navigable by small boats.

## OUTLOOK

Guinea will continue to be a major producer of bauxite for the foreseeable future. It is likely that output levels will be increased, largely through the opening of new



deposits. The Government has plans to increase the country's alumina output and to construct an aluminum smelter. Both of these projects would require a major hydroelectric project. However, existing and projected market conditions do not favor the implementation of such plans.

Guinea's gold and diamond resources would be sufficient to sustain production above current levels. Several companies were already engaged in exploration for these commodities, and this activity is likely

to increase, especially if the Government takes further measures to encourage foreign investment in Guinea.

Assuming a rapid restoration of political stability in Liberia, it is likely that the MIFERGUI-Nimba Project will become feasible. Exploitation of lower grade iron ore reserves in the Nimba Mountains, or elsewhere in Guinea, will depend on much stronger future market conditions for iron ore, funding for the project, and regional stability.

<sup>1</sup>Where necessary, values have been converted from Guinean francs (GF) to U.S. dollars at the rate of GF623=US\$1.00, which was the exchange rate for Dec. 1990. As the GF floats against the US\$, it is likely that the average exchange rate in 1990 was approximately GF630=US\$1.00.

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

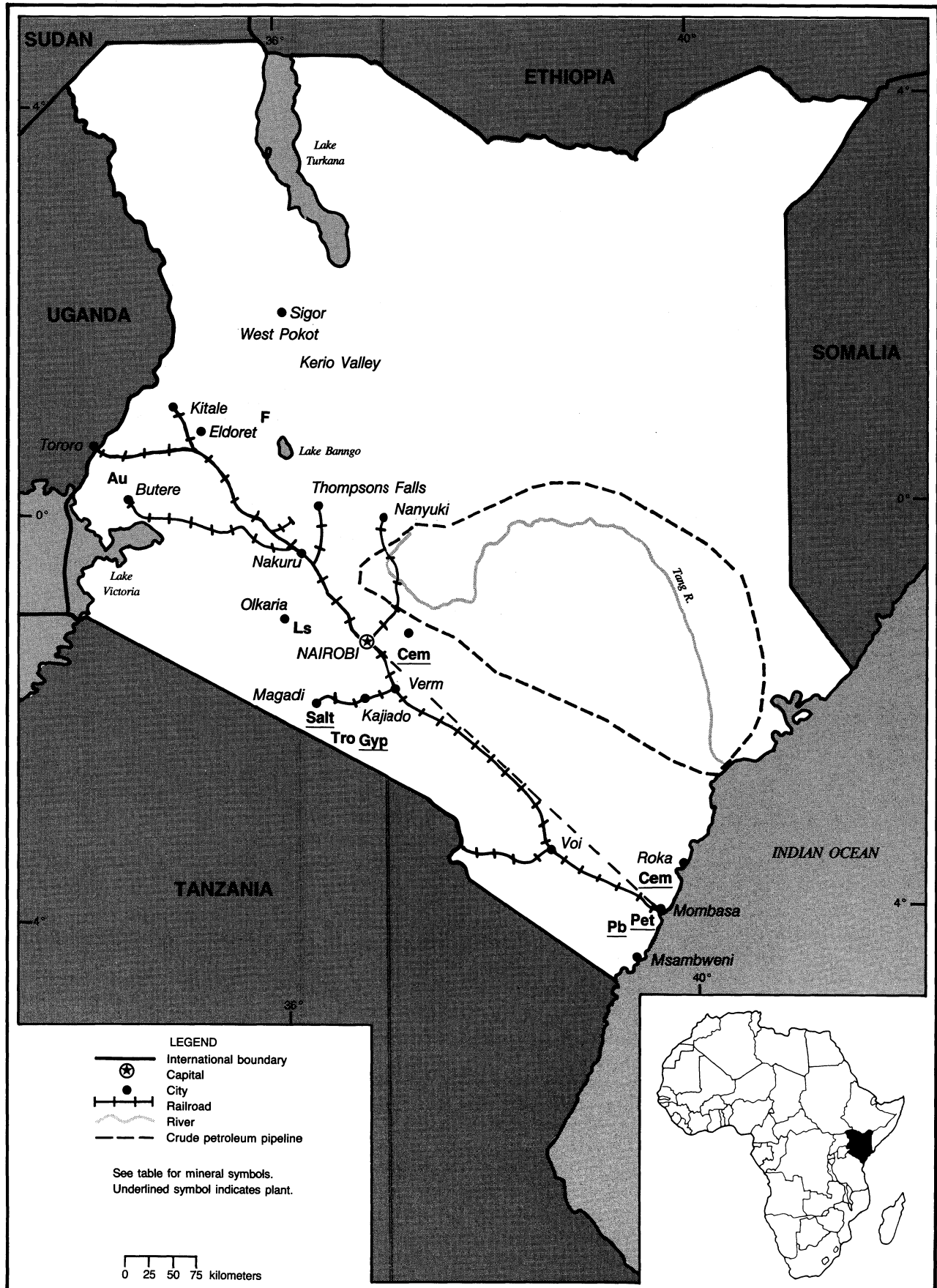
Ministry of Natural Resources and the  
Environment  
P.O. Box 295  
Conakry, Republic of Guinea



# KENYA

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

POPULATION 24.6 million



# THE MINERAL INDUSTRY OF KENYA

By David Izon

In 1990, Kenya's mineral production was not a significant factor in the mineral economy of Africa or the world and the industry accounted for less than 1% of the country's GDP. Mining was based primarily on the extraction of trona (soda ash), fluorspar, and limestone. Although Kenya's mineral resources were minimal, it was considered a well developed industry in eastern Africa. The country's overall real GDP recorded an annual growth rate of 4.5% in 1990. However, the formal industrial sector, both public and private, though relatively small, accounted for 15% of GDP in 1990. Mineral export earnings increased in 1990, accounting for about 17% of total earnings. Higher quantities of agricultural exports and rising prices of minerals were responsible for the rise in total export earnings. The production of three industrial mineral commodities, limestone, fluorspar, and soda ash, accounted for 70% of the total value of Kenya's mineral output. Soda ash was one of the more important mineral foreign exchange earners as were petroleum products. The total import bill increased significantly by 44% from \$324 million<sup>1</sup> in 1989 to \$467 million in 1990. Kenya exported most of its minerals to the United Kingdom, Europe, and neighboring African countries. U.S. companies had no significant investments in the country's mineral industry.

Kenya recorded an adverse balance of trade against most of the areas of the world except Africa. The balance of trade deficit grew by about 7% in 1990. There were no significant changes in investment patterns in the country in 1990.

## GOVERNMENT POLICIES AND PROGRAMS

Kenya actively encouraged foreign investment in the oil and mineral sectors. An export promotion program instituted by the Government was aided by a \$100 million credit line provided by the World Bank's International Development Assistance. In 1990, the Government announced the establishment of two Government-owned Export Processing Zones at Athi River and

Mombasa as well as other incentives to simplify the tariff structure, liberalize interest rates, decontrol prices, and improve the investment climate. Early in 1990, the Government also embarked on programs aimed at reducing the country's trade deficits to 3.5% and the inflation rate from 10.6% to about 7%. At yearend 1990, both of these goals were unmet as the deficit grew by 6.8% and the inflation rate also increased to 12.6%.

Kenya's 4 year old oil exploration agreements with major international companies including Amoco Oil Co., Marathon Oil Co., Mobil Oil Co. of the United States, and Petro-Canada ended in 1990 with no discovery of commercially viable reserves. In April 1990, the Government signed an additional 2 year exploration agreement with Amoco Kenya Petroleum Co. and Shell Oil Exploration of Britain. The Olkaria geothermal power project was also being developed jointly by Finland and Kenya.

The new 5 year development plan (1989-93) envisaged an annual 5.4% real growth in GDP. The Government was determined to achieve this goal by exercising measures to contain inflation. The new policy allowed investors to deduct all foreign exchange losses on their investments. The Government's public sector reform program, announced earlier in the year, was directed toward the privatization, liquidation, or restructuring of about 250 parastatals.

## PRODUCTION

In general, mineral production remained relatively stable except for cement, fluorspar, and salt. Industrial minerals were the main mineral commodities produced. Cement, fluorspar, and salt output increased owing to higher demand.

## TRADE

Kenya expended about 40% of its export earnings on importation of oil for its refinery operations at Mombasa. It also depended on the Middle East as its sole source for crude oil imports. Imported oil is refined in

Kenya for domestic consumption or export to eastern and southern African countries. Considerable changes have occurred in the source of Kenya's crude oil imports on a country basis. The country stopped importing Arabian Light, Iranian medium, and Qatar Durkhan crude oils. United Arab Emirates became the only source of crude oil imports in the Middle East and supplied 79% of total oil imports to Kenya in 1990. Other major mineral commodities traded were cement, soda ash, and fluorspar. Rising prices of these commodities accounted for a significant increase in export earnings for 1990. 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, phosphate rock, and processed nonferrous minerals. The value of total exports increased by 22% to about \$1.03 billion while the value of total imports grew slightly by 14% to about \$2.11 billion. The depreciation of the Kenya Shilling by 19% in 1990, encouraged exports while at the same time it discouraged imports.

## STRUCTURE OF THE MINERAL INDUSTRY

At yearend 1990, the Government owned at least 51% of all mining companies including the cement plants and oil refinery.

## COMMODITY REVIEW

### Metals

The development of gold resources in Kenya has been a Government priority. Prospects have indicated that there was a sufficient amount of commercially viable deposits to enable production of gold by openpit methods in the near future. Bureau de Recherches Geologiques Miniere of France was prospecting for gold, copper, lead, and zinc in the Kerio Valley in northwest Kenya, on a 3-year contract by the Ministry of Environment and Natural Resources. San Martin of Switzerland conducted under-

TABLE 1  
**KENYA: PRODUCTION OF MINERAL COMMODITIES FOR 1990<sup>1</sup>**  
(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>                          | 1986             | 1987             | 1988             | 1989 <sup>p</sup> | 1990 <sup>p</sup> |
|---|------------------|------------------|------------------|-------------------|-------------------|
| Barite  | 420              | 50               | 48               | 210               | 105               |
| Carbon dioxide gas, natural                     | 4,093            | 4,386            | 5,182            | 5,231             | 5,622             |
| Cement, hydraulic<br>thousand tons              | 1,312            | 1,321            | 1,239            | 1,216             | 1,512             |
| Clays, kaolin                                   | 2,000            | 40               | 42               | —                 | —                 |
| Diatomite                                       | 1,450            | 616              | 712              | 783               | 944               |
| Feldspar  | —                | —                | —                | 1,112             | 1,290             |
| Fluorspar (acid grade)                          | 50,851           | 60,190           | 99,000           | 95,181            | 112,295           |
| Gem stones, precious and semiprecious:          |                  |                  |                  |                   |                   |
| Amethyst<br>kilograms                           | ( <sup>3</sup> ) | ( <sup>3</sup> ) | ( <sup>3</sup> ) | ( <sup>3</sup> )  | ( <sup>3</sup> )  |
| Aquamarine<br>do.                               | ( <sup>3</sup> ) | ( <sup>3</sup> ) | 97               | 99                | 117               |
| Garnet<br>do.                                   | 44               | 408              | 835              | 127               | 90                |
| Cordierite (Iolite) <sup>e</sup><br>do.         | 20               | 20               | 20               | 10                | 10                |
| Ruby<br>do.                                     | 66               | 70               | 1,420            | 36                | 201               |
| Sapphire<br>do.                                 | 100              | 222              | 1,390            | 37                | 20                |
| Tourmaline<br>do.                               | 5                | 11               | 23               | 1                 | 9                 |
| Gold, mine output, Au content<br>do.            | 73               | 278              | 17               | 15                | 25                |
| Gypsum and anhydrite                            | 11,060           | 38,819           | 37,965           | 36,478            | *38,000           |
| Lead: <sup>e</sup>                              |                  |                  |                  |                   |                   |
| Mine output, Pb content                         | 550              | 545              | 562              | —                 | —                 |
| Metal:  |                  |                  |                  |                   |                   |
| Smelter   | 2,000            | 2,000            | 2,000            | 1,000             | 1,000             |
| Refined   | 2,000            | 2,000            | 2,000            | 1,000             | 1,000             |
| Iron and steel: Steel, crude <sup>e</sup>       | ( <sup>3</sup> ) | ( <sup>3</sup> ) | ( <sup>3</sup> ) | ( <sup>3</sup> )  | ( <sup>3</sup> )  |
| Kyanite <sup>e</sup>                            | ( <sup>3</sup> ) | ( <sup>3</sup> ) | ( <sup>3</sup> ) | ( <sup>3</sup> )  | ( <sup>3</sup> )  |
| Lime  | 12,300           | 26,482           | 27,326           | 32,167            | 13,941            |
| Magnesium compounds: Magnesite <sup>e</sup>     | 300,000          | —                | —                | 4—                | 4—                |
| Petroleum refinery products:                    |                  |                  |                  |                   |                   |
| Liquefied petroleum gas                         |                  |                  |                  |                   |                   |
| thousand 42-gallon barrels                      | 303              | 304              | 300              | 320               | 330               |
| Gasoline<br>do.                                 | 2,832            | 2,869            | 2,920            | 3,087             | 2,856             |
| Jet fuel and kerosene<br>do.                    | 3,095            | 3,261            | 3,285            | 3,587             | 3,391             |
| Distillate fuel oil<br>do.                      | 3,916            | 4,333            | 4,015            | 4,190             | 4,202             |
| Residual fuel oil<br>do.                        | 4,234            | 4,178            | 4,380            | 4,201             | 4,422             |
| Other <sup>5</sup><br>do.                       | 721              | 844              | 400              | 766               | 956               |
| Total including refinery fuel and losses<br>do. | 15,101           | 15,789           | 15,300           | 16,151            | 16,157            |
| Salt: Crude, rock                               | *91,000          | 72,000           | 94,682           | 103,220           | 102,100           |
| Sodium compounds, n.e.s.:                       |                  |                  |                  |                   |                   |
| Soda ash  | 237,650          | 228,650          | 220,000          | 240,880           | 244,480           |
| Soda, crushed, raw                              | 5,882            | 1,557            | —                | —                 | —                 |
| Stone, sand and gravel:                         |                  |                  |                  |                   |                   |
| Calcareous:                                     |                  |                  |                  |                   |                   |
| Coral<br>thousand tons                          | 175              | 1,331            | 1,352            | 1,427             | 1,650             |
| Limestone<br>do.                                | 2,069            | 400              | 416              | 16                | 18                |
| Sand, industrial (glass)                        | 255              | *3,000           | *7,000           | 10,841            | 12,344            |
| Shale   | *750,000         | 142,428          | *130,000         | 118,459           | 115,000           |
| Vermiculite                                     | 2,544            | 3,887            | 3,707            | 2,436             | 2,655             |
| Wollastonite                                    | 298              | —                | —                | 142               | 97                |

<sup>e</sup>Estimated <sup>p</sup>Preliminary <sup>r</sup>Revised

<sup>1</sup>Includes data available through Aug. 27, 1991.

<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>Less than 1/2 unit.

<sup>4</sup>Reported figure.

<sup>5</sup>Includes refinery fuel and losses through 1985. Starting in 1986, refinery fuel and losses are included in output of individual products, but totaled as follows, in thousand barrels: 1986—525; 1987—625; 1988—470; 1989—653; 1990—700.

TABLE 2

## KENYA: STRUCTURE OF THE MINERAL INDUSTRY

(Thousand metric tons unless otherwise specified)

| Major commodity      | Major operating companies            | Location of main facilities   | Annual capacity |
|----------------------|--------------------------------------|-------------------------------|-----------------|
| Cement               | The East African Portland Cement Co. | Athi River 30 km S.E. Nairobi | 350             |
|                      | Bamburi Portland Cement Company Ltd. | Mombasa                       | 1,156           |
| Fluorspar            | Kenya Fluorspar Co. Ltd.             | Eldoret                       | 80              |
| Gypsum and anhydrite | Athi Rivers Mining Ltd.              | Nairobi                       | 2               |
| Soda ash             | Magadi Soda Co. Plc                  | Maqadi                        | 300             |
| Salt                 | Magadi Soda Co. PLC                  | do                            | 55              |

ground operations on quartz horizons in the Lake Victoria Basin, and Kenor explored concessions in the north of the country and in the Nyanza greenstone belt bordering Lake Victoria. Current gold production in Kenya is limited to small-scale artisanal works.

### Industrial Minerals

Mining operations were largely confined to minerals such as fluorspar, limestone (for cement), and soda ash. A wide range of other industrial minerals were produced on a small scale. These included barite, diatomite, feldspar, clay, gypsum, marble, salt, dimension stone, vermiculite and wollastonite. Silica sand was also mined at Msambweni and Roka on Kenya's southern and northern coasts respectively, and shipped for bottle glass manufacture in Nairobi by Central Glass Industries.

**Cement.**—Most of the limestone was produced by Bamburi Portland Cement Co; East African Portland Cement Co. accounted for much of the remainder. When the third cement plant proposed for West Pokot in the Rift Valley province is built, combined total capacity of the three plants will increase to 1.6 Mmt/a. Cement consumption rose by 179,000 tons from 1,003,000 tons in 1989. The sector generated 2,700 new jobs, representing a growth of about 4% in 1990.

**Fluorspar.**—Production remained relatively high at about 93% of plant capacity in 1990. The main producing company was the Kenya Fluorspar Co. Acid-grade fluorspar productions benefited recently from the development of an economically feasible process for reducing phosphate in the concentrates.

**Soda Ash.**—The Magadi Soda Co. Plc increased production to about 83% of capacity at its mining and processing complex south-east of Nairobi. The Magadi operation, Kenya's largest source of crude salt, has also seen a significant increase in production to over 100,000 mt/a.

### Mineral Fuels

Kenya is not a petroleum producer nor has recent ongoing exploration been successful. While its refinery has been a major source of income for the country, its dependence on imported crude is a significant drain on the national budget.

### Reserves

There were no officially reported reserves data.

### INFRASTRUCTURE

Mineral commodities are transported on the country's only railway system, which roughly parallels Kenya's southern border. 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 Mombasa 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. Principal airports are located at Mombasa and Nairobi. The main seaport is at Mombasa. Plans are underway to develop the local Eldoret airport to international standards. Plans were also underway to upgrade the port at Mombasa to standards similar to that of the Republic of South Africa's port of Durban.

### OUTLOOK

Kenya has had sufficient investment for several development projects which will continue in the near future. In the energy sector, the longterm industrial energy conservation program that is being implemented could save the country more than \$15 million a year. The energy future of Kenya is bright if expected expansion projects using hydro and geothermal sources are completed. Development of an industrial center in the Kerio valley, after the completion of the Turkwell Valley hydroelectric scheme, will increase labor force in the mineral industries. Successful completion of the proposed railway system will ease transportation problems for the industrial sector and allow for further expansions. Also, expansion of the country's telecommunication network will improve business activities in the country.

Oil and gas exploration is a priority and is expected to continue. Government policies which are directed towards 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 KSh24.084=US\$1.00, which was the exchange rate for Dec. 1990.

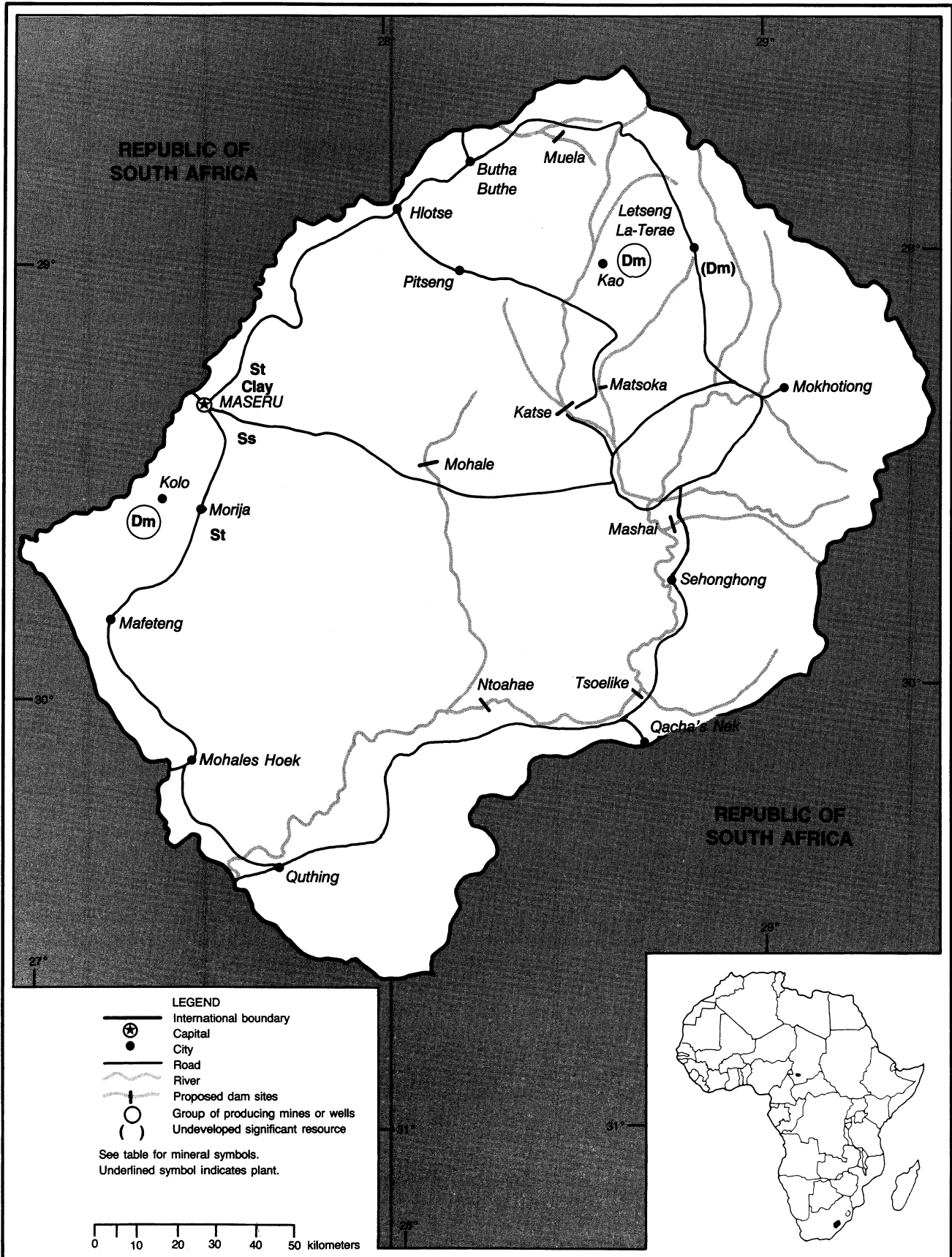
### OTHER SOURCES OF INFORMATION

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

# LESOTHO

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

POPULATION 1.7 million



# THE MINERAL INDUSTRY OF LESOTHO

By Audie L. King

Since 1982, when declining reserves and a recession in the world diamond market caused De Beers Consolidated Mines Ltd. (De Beers) to close the only commercial diamond mine in Lesotho, mining has constituted a minor part of the country's economy. A small number of gem-quality diamonds are still being mined by about 500 individuals with license to operate as diamond diggers, but their output is mostly unreported and thought to be very small. Except for minor amounts of stone, sand and gravel, and other materials for the local construction industry that accounted for less than 1% of the GDP, no minerals were mined in 1990. Coal, limestone, phosphate, and uranium deposits have also been identified and may be exploited in the future.

Following a period of slow growth in the early 1980's, Lesotho's economy has grown at about 5% per year during the past 5 years. This growth can be attributed to recent policy changes that have stimulated foreign investment in the industrial sector. The industrial sector, dominated by textiles, light manufactures, and construction, grew by 12% per year for the past 5 years and now composes 10.2% of the economy. The economy may also be reaping the initial benefits of the giant Lesotho Highlands Water Project (LHWP) that is in the beginning stages of construction and promises to greatly improve economic conditions for the next 50 years. The project will involve the construction of seven dams, three pumping stations, a hydroelectric powerplant, and a total of 225 km of water transfer tunnels. When completed, the LHWP will improve Lesotho's trade deficit by selling a large portion of Lesotho's water resources to the Republic of South Africa. The construction project already employed 2,000 local workers and will hopefully relieve some of the serious unemployment problems that Lesotho is facing. Unemployment was estimated at between 35% and 50% of the population. This high unemployment rate made it necessary for many of the country's young men to leave Lesotho to find work in the Republic of South Africa's coal and gold mines.

Lesotho's Government actively promotes and encourages foreign investment in the manufacturing sector. Recent modifications to the governmental structure include the establishment of an export finance facility, a trade promotion unit, and the expansion of the role of the Lesotho National Development Corp. (LNDC). The LNDC makes investing easy by acting as a one-stop service center. It provides low-interest loans, guarantees loans made by other financial institutions, provides grants that cover 75% of eligible costs related to the training of local employees, and assists investors in all official administrative matters that fall outside its domain. New investors are also entitled to 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. Furthermore, the country has a relatively low corporate tax rate of 15%, and products manufactured in Lesotho have favorable access to many different world markets.

Mineral production in 1990 was limited to small amounts of crushed stone, sand and gravel, clay, and a small number of diamonds. According to Government figures, the total value of minerals produced in the country was less than 1% of the GDP. However, the LHWP was expected to increase consumption of basic building materials. Projects involving the production of construction materials such as crushed stone for roads and dam construction, washed sand, and sandstone blocks was expected to be developed by the LNDC with the status of satellite industries of the LHWP. Initial plans call for all of the LHWP's cement to be imported; however, concrete products would be produced in Lesotho using domestic sand and crushed stone.

Stone quarries at Ha Faso, 15 km north of Maseru and Morija, 30 km south of Maseru, continued to produce crushed diabase for road construction and building purposes. A quarry at Thuathe, 10 km east of Maseru, produced sandstone blocks. New permits were issued for additional stone production at Bokong, 10 km north of the proposed Katse dam, and at Pitseng and

Moteng, near the proposed Muela Dam. Clay, for brick manufacturing, was mined by Loti Brick Co. at Thetsane, near Maseru.

Lesotho's Department of Mines and Geology reported that more than 500 diamond diggers were active at a number of sites near Kao and Kolo. It was reported that four more areas would be opened up to diamond digging during the 1989-90 fiscal year by Swissbrough Diamond Mines. The company was granted mining leases covering a total of 367 km of alluvial diamond-bearing sediments in the area around Kao. Diamond exports from 18 licensed dealers amounted to 4330 carats for the fiscal year ending March 1989, the latest year that data were available. It was suspected, however, that most diamonds never reached the legal market and went unreported. The Mountain Diamonds Co. and Senqu Diamond Cutting Works were the country's only active diamond cutting factories. Together they employed a total of 10 persons.

Lesotho remained highly dependent on trade with the Republic of South Africa, though it recently made some progress in expanding its markets into Europe and the United States. In 1988, the latest year that such data were available, the United States accounted for only 1% of Lesotho's \$425 million worth of imports. The country's principal imports included petroleum products, building materials, clothing, motor vehicles, machinery, pharmaceuticals, and corn and other food products. The percentage of exports going to the United States increased from 5% of Lesotho's total exports in 1985 to 25% in 1988. Lesotho's main exports were baskets, cattle, hides, mohair, vegetables, wheat, and wool. It exported cotton apparel, rugs, textiles, and tapestry to the United States.

During the past few years, many companies relocated to Lesotho primarily to take advantage of the country's preferential access to world markets. Lesotho had negotiated markets in the EC as a signatory to the Lome Convention, the European Free Trade Association, the Southern African Customs Union, the Preferential Trade Area, and of the Southern African Development Coordination Conferences. Lesotho



also had trade advantages with the United States under the general system of preference and most-favored-nation status.

Since the 1982 closing of De Beers' Letseng-La-Terai diamond mine, small deposits of crushed stone and other crude building materials were worked by private individuals. Independent diamond diggers had also taken part in small-scale pick and shovel mining. Laws requiring that all mining operations be licensed by the Government were stringently enforced in recent years.

More than one-half of Lesotho's labor force worked in the Republic of South Africa. Mines centered around the Republic of South Africa's Orange Free State were the primary employers of Basotho (individuals from Lesotho) miners, with 80% concentrated in the area around Welkom, north of Bloemfontein. It was estimated that 60% of the Lesotho's families owed their support to wages earned in these mines. Income derived from migrant miners was the principal way Lesotho's Government financed its trade deficit. Figures from the Republic of South Africa's Chamber of Mines reveal a downward trend in the number of Basotho mine workers employed in the Republic of South Africa. An average of about 103,000 Basotho migrant workers were employed in South African mines in 1990 compared with an average of 106,605 in 1989. Of the 1989 total, 100,529 worked in gold mines and 6,076 worked in coal mines. By the end of January 1991, the number of Basotho mine workers employed in the Republic of South Africa had dropped to only 95,000.

In recent years, with the help of foreign aid, a road system that would open up the country's interior to development began to take shape. In 1989, there were 508 km of paved roads and more than 2,500 km of improved-earth or gravel roads. In conjunction with the LHWP, 650 km of new or improved roads into the interior was planned or under construction. A paved road that runs roughly around the perimeter of the country was recently completed with the help of U.S. construction firms and U.S. Government funds.

The LHWP is a massive infrastructural project that will take 30 years to complete. The scheme calls for the construction of six dams, three pumping stations, and a network of connecting tunnels to be used primarily for the storage and rerouting of water. Plans call for the Katse, Mohale, Mashai, Tsoelike, and Ntoahoe Dams to be between 126 m and 180 m in height and the Matsoku

Dam to be somewhat smaller. The project will provide Lesotho with royalties from the export of surplus water from Lesotho's Maloti Mountains to areas around Johannesburg and Pretoria. A seventh dam, the 55-m-high Muela Dam, would act as the tail pond for the proposed Muela hydroelectric plant that would make Lesotho self-sufficient in the generation of electricity.

The water transfer portion of the project will consist of six dams that will capture a major portion of Lesotho's unused water resources and reverse the southerly direction of their flow. Through a system of underground tunnels, up to 70 m<sup>3</sup>/second of water will be channeled into the Republic of South Africa's Ash River, where it will be captured by the Vaal Dam, 70 km south of Johannesburg. When completed, Lesotho will earn between \$20 and \$40 million per year in royalties. This could amount to as much as 6% of the country's GDP. Projected earnings will be indexed for inflation and will not be affected by cost overruns from the construction phase of the project. The project will be supervised by the Lesotho Highlands Development Corp., however, under treaty, the Republic of South Africa will assume full responsibility for the costs and debt service for any part of the project dealing with water transfer.

Financing for infrastructural improvements and planning was provided by the World Bank, the EC, the European Investment Bank, and various bilateral sources, including France, the Federal Republic of Germany, the United Kingdom, and the United States. Construction of the Katse Dam and two tunnels constitutes the first portion of phase 1 of the LHWP (phase 1A).

The environmental assessment portion of phase 1A was completed in June 1990. It addressed soil and water conservation, terrestrial and aquatic biology, water quality control, public health, environmental monitoring, and cultural heritage issues. A compensation resettlement program was also approved by the Government.

By the end of 1990, LTA Bloemfontein, a South African construction company, and Dumez, a French company, nearly completed a \$63 million road from the Republic of South Africa to the site of the Katse Dam. Meanwhile, engineers from the Republic of South Africa's Murray and Roberts were completing the site preparation work for the Katse Dam. The 180-m-high, 500 m-wide, double curvature concrete arch dam will be the largest in sub-Saharan Africa. It was scheduled to begin construction in January

1991 and was expected to begin filling in September 1994. The first water was to be delivered to the Republic of South Africa in August 1996. A \$111 million contract for the construction of the Katse Dam was awarded to the Highlands Water Venture group, a consortium that consisted of Group Five of the Republic of South Africa, Concor Impregilo of Italy, Hochtief of the Republic of Germany, Bouyges of France, and Stirling and Kier of the United Kingdom. Contracts for a 48-km transfer tunnel and a 37-km delivery tunnel were still to be awarded.

The second portion of phase 1 will involve the construction of the Mohale Dam and a delivery tunnel. In phase 2 of the LHWP, the Mashai Dam will be built, along with another transfer tunnel. In phase 3, the Tsoelike Dam will be constructed, and finally the Ntoahoe Dam will be constructed in the 4th phase. The proposed dams range in height from 126 m to 180 m and have a total storage capacity of 6.5 billion m<sup>3</sup>.

When operational, the LHWP's proposed hydroelectric power stations were expected to be highly beneficial to the Basotho economy since the Lesotho Electricity Corp. had been importing more than 80% of the nation's electric power from the Republic of South Africa at a cost of about \$8 million per year. The Muela hydroelectric project will require the construction of the 55-m-high Muela Dam that will form the tail pond for the hydroelectric power station. The power scheme will go to tender in 1992. When the two power stations slated for construction at the Muela powerplant, 45 km north of Katse, are completed in 1996, they will generate 260 GW-h/a of power. This is enough power to make Lesotho virtually self-sufficient in electricity. Lesotho will carry all financial responsibilities for the portion of the project dealing with power generation.

The LHWP will play an important part in improving the economy of Lesotho during the next 50 years. Besides the obvious economic gains derived from water transfer royalties and the reduction of the trade deficit by reducing energy imports, many positive secondary benefits will be realized. For example, major infrastructural projects promise to open up the interior to tourism, fishing, and modern agriculture.

If Lesotho's positive investment climate persists, along with its preferential access to world markets, the introduction of inexpensive electrical power could be extremely significant to growth in the manufacturing sector.

Lesotho will continue to depend heavily on the wages its citizens derive in the Republic of South Africa. The relative importance of these wages to the economy may diminish somewhat, however, as new jobs open up in manufacturing and in other sectors affected by the LHWP.

There will be an increase in the quantity of building materials, such as sand and

gravel, produced in Lesotho. Besides materials that will be used in the construction of roads and dams in conjunction with the LHWP, the demand for raw materials in tile and brick manufacturing and for other construction purposes will likely increase.

<sup>1</sup>Where necessary, values have been converted from Basotho maloti (M) to U.S. dollars at the rate of M2.59=US\$1.00.

## **OTHER SOURCES OF INFORMATION**

### **Agency**

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

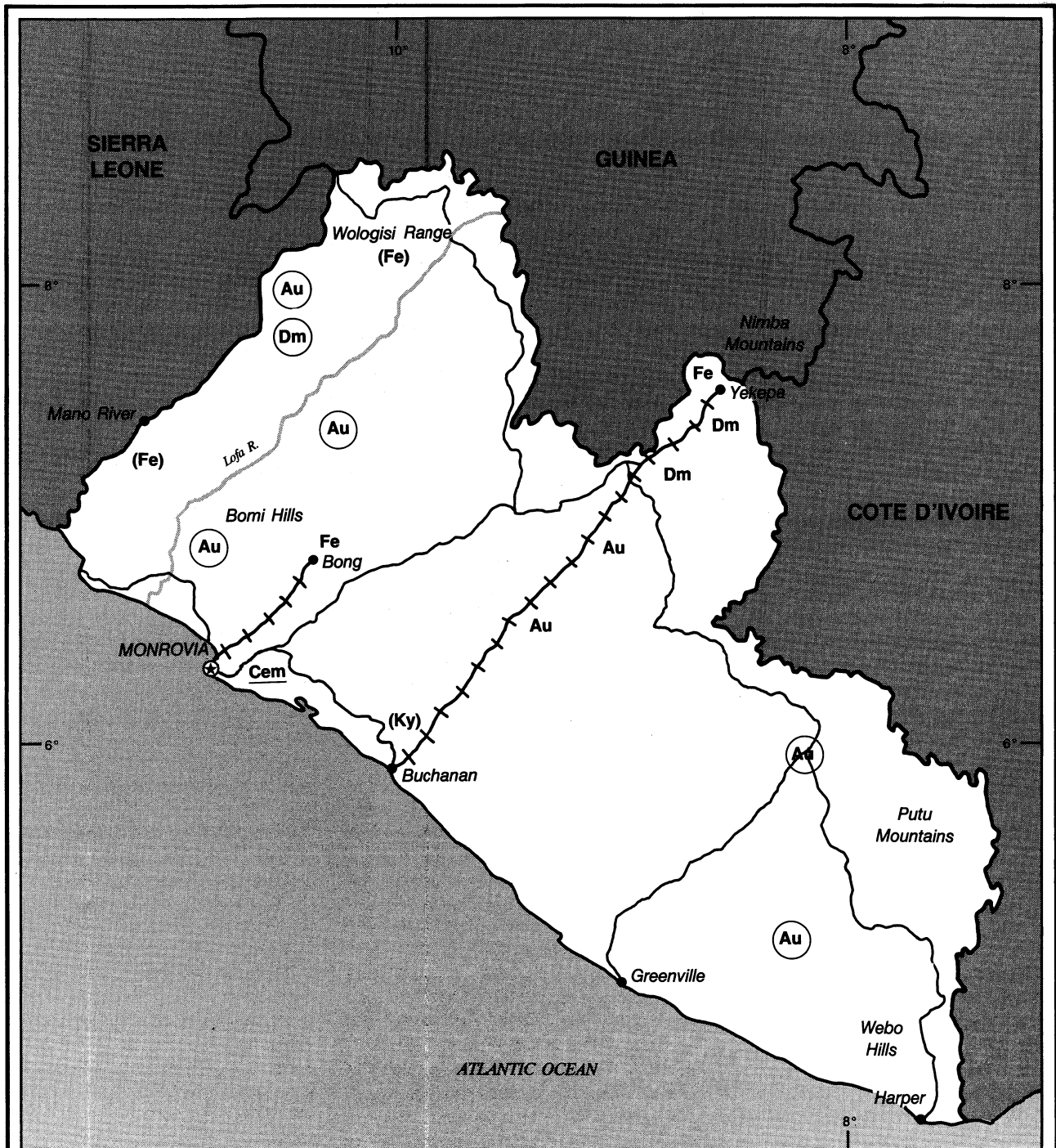
### **Publication**

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

# LIBERIA

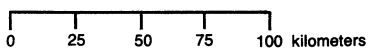
AREA 111,370 km<sup>2</sup>

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

**T**he economy of Liberia was decimated in 1990 as a result of the civil war begun in December 1989. By about midyear, fighting had destroyed or brought to a halt all formal mining operations and virtually all other industrial production, as well as many Government services and much of the country's agricultural output. Despite the overthrow of the Government in September, fighting among rival groups was still ongoing at yearend. About one-half of the population was displaced or became refugees, including about 400,000 in Guinea and 250,000 in Côte d'Ivoire, straining the economies of these and other neighboring countries.

Traditionally, the economy of this heavily forested, well-mineralized country has been dominated by the export of mineral commodities, timber, and rubber, and by revenues from license fees from the world's largest merchant fleet. In 1989, the latest year for which data were available, about 22% of the country's reported GDP of about \$1 billion<sup>1</sup> was contributed by mining, mostly of iron ore.

In 1990, Liberia's formal mining sector comprised two iron ore mines and a small silica sand operation. There was a modest output of alluvial diamonds and gold by artisanal miners, the true extent and value of which was not known because of smuggling. In March 1990, Western Mining Corp. of Australia was formally awarded a large exploration and mining concession covering about 18,000 square kilometers in western and northern Liberia. The exploration program was halted later during the year for security reasons.

As of yearend 1989, only about 4% of the total Liberian work force of about 700,000 was employed in industry. Of industrial workers, about 20,000 worked in mining; however, an estimated 15,000 of these were artisanal miners. The iron ore industry employed about 3,000, a one-third decline from levels in 1985.

Liberia's geology is dominated by a complex of Archean migmatitic and granulitic gneissic rocks. These contain several northeast-trending narrow zones containing iron formations. In the south-

east third of the country there are north-east-trending Proterozoic belts containing volcanosedimentary rocks, similar to those of the Birimian series found to the east in Côte d'Ivoire.

The best known Liberian ore deposits are the iron deposits found scattered throughout the country. High-grade iron deposits near Yekepa in the Nimba Mountains were put into production in 1963, and low-grade iron ore at Bong was put into production in 1965; both of these mines were in operation through part of 1990. Diamond-bearing kimberlites are known to exist near the Sierra Leone border, but have never been proven economic. Alluvial diamonds, however, are known from many parts of the country, particularly along the Lofa River and its tributaries in western Liberia. Gold is likewise widespread in alluvial deposits. Apart from silica sand and construction materials, Liberia's resources of other minerals have not yet proven economic. These include barite, chromium, kyanite, nickel, titaniferous sands, and uranium.

Two iron ore mines, operated by Bong Mining Co. (BMC) and the Iron Mining Company of Liberia (LIMCO), were in production during part of the year. Until the forced closures of the mines, production was at relatively normal levels. Liberia's only cement plant was reported to have closed at midyear. Demand for cement early in the year was reported to have been surprisingly heavy, believed due to optimism of an early end to the fighting. Artisanal output of gold and diamonds is estimated to have fallen, but the major producing areas in western and eastern Liberia were apparently not severely affected by the fighting until after September.

Following the cessation of mining operations at the Nimba Mine near Yekepa by the LAMCO Joint Venture (LJV) in October 1989, a new consortium was formed between the parastatal Liberian Mining Corp. and the African Mining Consortium Ltd. (AMCL) to resume and maintain operations at the mine. This was primarily to keep operational the mine's 267-km railroad to Buchanan and the shiploading facilities there. This infrastructure is key to the de-

velopment of the MIFERGUI-Nimba high-grade iron ore body in Guinea, because a connection from this deposit to the LJV railroad at Yekepa requires the construction of just 17 km of new track, as opposed to a much lengthier railroad to Conakry, Guinea. AMCL, through its operating subsidiary Iron Mining Co. of Liberia, was to maintain a Liberian bridging operation to the MIFERGUI project by shipping a blend of the small amount of high-grade iron ore remaining at the Nimba Mine, with more abundant, but higher phosphorus material from the nearby Mount Tokadeh deposit. Blending ore reserves of about 12 million tons were adequate for a 3-year bridging operation, a period considered just sufficient for the construction of the MIFERGUI mine and connecting railroad.

Although the bridging operation began in late 1989, insecurity in the Nimba region led to shutdown of mining operations on April 4, 1990. Shipments continued from Buchanan until May 24, when security concerns forced their curtailment as well. AMCL reported mining 1 million tons of ore in 1990 and shipping 700,000 tons. It is believed that the major customer for this material was France.

Because of their interdependence, it was recognized that a significant delay in either the bridging or MIFERGUI projects could threaten the development of the MIFERGUI-Nimba deposit. The possibility of war-related damage to the infrastructure was of concern, particularly that caused by the aerial bombardment of Buchanan; the extent of damage was unclear at yearend 1990. The status of the 1989 MIFERGUI agreement between the Governments of Liberia and Guinea and other interested parties was uncertain as a consequence of the overthrow of the Liberian Government in September 1990, and the fact that a new Government had not yet been formed as of yearend. Despite these concerns, a number of parties, including Cyprus Minerals Co. of the United States, have expressed interest in the project.

Because of the Bong Mine's distance from the early fighting, mining, ore processing, and shipping were able to continue at a fairly normal rate beyond the closure of

TABLE 1

## LIBERIA: PRODUCTION OF MINERAL COMMODITIES

| Commodity <sup>1</sup>   |                      | 1986    | 1987    | 1988                 | 1989 <sup>p</sup> | 1990 <sup>e</sup>  |
|--------------------------|----------------------|---------|---------|----------------------|-------------------|--------------------|
| Cement, hydraulic        | metric tons          | 95,845  | 105,374 | 105,800              | 85,300            | 50,000             |
| Diamond: <sup>2</sup>    |                      |         |         |                      |                   |                    |
| Gem                      | thousand carats      | 63,322  | 112,113 | <sup>e</sup> 66,812  | 61,822            | 40,000             |
| Industrial               | do.                  | 188,830 | 182,921 | <sup>e</sup> 100,218 | 92,732            | 60,000             |
| Total                    | do.                  | 252,152 | 295,034 | 167,030              | 154,554           | 100,000            |
| Gold <sup>2</sup>        | kilograms            | 625     | 467     | 677                  | 734               | 600                |
| Iron ore                 | thousand metric tons | 15,295  | 13,742  | 12,767               | 11,700            | <sup>3</sup> 4,050 |
| Silica sand <sup>e</sup> | metric tons          | 5,000   | 5,000   | 6,600                | 10,000            | 5,000              |

<sup>e</sup>Estimated. <sup>p</sup>Preliminary. <sup>r</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 May 1, 1991.

<sup>2</sup>Data do not include smuggled production.

<sup>3</sup>Reported figure.

TABLE 2

## LIBERIA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

(Thousand metric tons unless otherwise specified)

| Major commodity | Major operating companies                   | Location of main facilities   | Annual capacity                  |
|-----------------|---|---|----------------------------------|
| Cement          | Liberia Cement Corp.                        | Bushrod Island, off Monrovia  | Cement: 200.                     |
| Diamonds        | Artisanal production                        | Placer operations throughout country, especially near Lofa River                    | NA. <sup>2</sup>                 |
| Gold            | do.   | Placer operations throughout country  | NA. <sup>2</sup>                 |
| Iron ore        | Bong Mining Co.                             | Mine and pelletizing plant in Bong Range, 80 kilometers north-northeast of Monrovia | Pellets plus concentrate: 7,300. |
| Do.             | Iron Mining Company of Liberia <sup>3</sup> | Yekepa, Nimba Mountains, 250 kilometers northeast of Buchanan                       | Iron ore: 4,200.                 |

NA Not available.

<sup>1</sup>Capacity figures are as of yearend 1989 and do not reflect possible, but as yet unevaluated, damage sustained during the civil war in 1990.

<sup>2</sup>Diamond and gold artisanal production capacity is unknown because of varying number of workers and smuggling of both local and foreign production.

<sup>3</sup>From its startup, the mine was operated by the LAMCO Joint Venture (LJV) until it ceased mining on July 29, 1989, and shipping in Oct. 1989. LJV was 62.5% owned by the Government of Liberia, and 37.5% by Liberian Iron Ore Ltd. controlled by Gränges AB & Co. of Sweden. Newly formed Iron Mining Company of Liberia resumed the mining operations in Nov. 1989.

the LIMCO operation. Nevertheless, by early June, fighting was threatening the mine and its 78-km railroad to Monrovia. On June 6, BMC suspended mining, and the company notified the Government of force majeure conditions shortly thereafter. Reportedly, the mine produced and shipped about 1.45 million tons of pellets and 1.6 million tons of sinter feed concentrate in 1990. The exports, as usual, went to the German and Italian steel companies that own the mine. BMC was awaiting a return of secure conditions before making a decision whether or not to resume operations at Bong. Only 5 years of reserves remain in the immediate vicinity of the mine, and although an additional 10 years of reserves exist 7 km away, exploiting these larger re-

serves will require the construction of a new conveyor system. The company had secured financing for the new conveyor, but believes that the loan may require renegotiation because of the civil war. Further, the remaining ore is very hard and processing it is energy-intensive. The company reported that war-related damage to its facilities was largely to the powerplant; the cost of repairs was not yet known.

The restoration of Liberia's economy hinges on the return of political and social stability to the country. Given this favorable development, it is likely that minerals will play a key role in the country's future, particularly as a generator of foreign exchange. If the MIFERGUI-Nimba project comes to fruition, Liberia will receive

revenues for transshipping the ore. Iron ore mining in Liberia beyond the limited reserves at Bong will require the exploitation of the country's large resources of moderate-grade material, the best of which are near Yekepa. However, direct export of this material is unlikely because of poor world market conditions, and the fact that the Port of Buchanan can only handle ships up to about 80,000 deadweight tons. A long-proposed plan to concentrate and/or pelletize this material at Bong, which would have the advantage to BMC of providing a large tonnage of higher quality ore than the company has in its own inventory, would require the construction of about 112 kilometers of track to link Bong with the Yekepa-Buchanan railroad, and some up-

grading of existing BMC facilities. The economics of this project were uncertain. Gold and diamond occurrences are sufficiently widespread in Liberia to augur well for the potential development of mines for these commodities.

<sup>1</sup>Most official economic data for Liberia are reported in U.S. dollars. Although the Liberian dollar (L\$) remained at official parity with the U.S. dollar in 1990, most unofficial transactions utilized an unstable parallel currency market where the L\$ traded at large discounts. Toward yearend, the U.S. dollar traded for well in excess of L\$1,000.00 on the parallel market, compared with about L\$2.50 at yearend 1989.

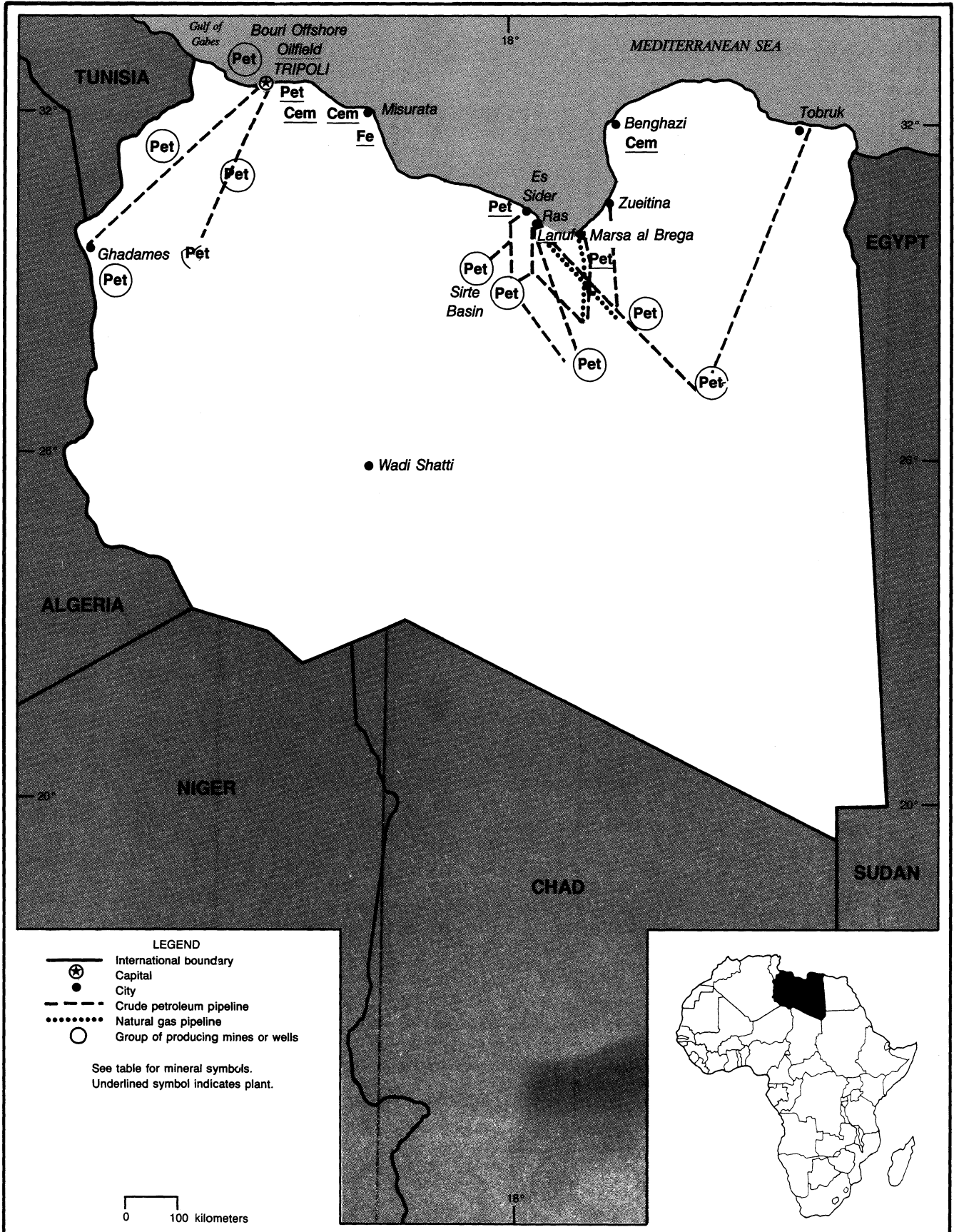
#### **OTHER SOURCES OF INFORMATION**

Liberian Geological Survey  
Ministry of Lands, Mines and Energy  
P.O. Box 9024  
Monrovia, Liberia

# LIBYA

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

POPULATION 4.0 million



# THE MINERAL INDUSTRY OF LIBYA

By Thomas P. Dolley

**T**he petroleum sector remained the most important component of the country's mineral industry in 1990. Production increased and higher revenues were generated. Conflict in the Persian Gulf contributed to a global rise in crude oil prices to include Libya's benchmark Es Sider 37° API gravity crude oil. Es Sider crude rose in price from \$15.40 per barrel on January 1, 1989, to \$20.40 per barrel on January 1, 1990. In September 1990, the international petroleum price rose to more than \$36 per bbl, giving added impetus to increased Libyan crude oil output. Crude oil output averaged 1.37 million bbl/d, with a marked increase occurring in the last quarter of the year. Nonfuel mineral production was almost nonexistent with the exception of some cement, clay, fertilizer, gypsum, limestone, salt, and steel production.

Libya maintained second place in crude petroleum production among African nations in 1990. Additionally, Libya possessed the largest hydrocarbon reserves in Africa. Libya was the third largest producer in Africa of natural gas, after Algeria and Egypt. Average monthly natural gas production was approximately 500 million m<sup>3</sup>.

The gross domestic product (GDP) for Libya in 1990 was approximately \$27.3 billion, up 9.4% from 1989.<sup>1</sup> Revenue from oil production totaled \$9.7 billion and represented 28.2% of the 1990 GDP.

Libya continued to suffer from a lack of skilled technical personnel, a problem encompassing many of its mineral industry projects from steel production to hydrocarbon exploration, production, and refining.

## GOVERNMENT POLICIES AND PROGRAMS

The Libyan National Oil Corp. (NOC) maintains complete control of the oilfields and investments, including selling all the oil produced. The NOC had an operating budget of approximately \$3 billion for 1990/91, an 8% rise in funding from the previous fiscal year. The money was allocated for 23

petroleum exploration wells, 56 development wells, and 16,678 km of seismic geophysical surveying. The funding also covered various studies on secondary, tertiary, and enhanced oil reservoir recovery and general maintenance. Approximately one-half of the budget was prioritized for investment in the developmental Murzuk oilfield, approximately 600 km south of Tripoli, plus the Bouri offshore oilfield, and the parastatal Sirte Oil Company's Attahaddy natural gas field in the Sirte Basin.

## PRODUCTION

Total crude petroleum production for 1990 was the highest since 1980, when production totaled 669.7 million barrels. In 1989, the U.S. Government informed W. R. Grace & Co., Conoco, Marathon Oil Co., Amerada Hess, and Occidental Petroleum Corp. that they could operate their Libyan assets only through non-U.S. subsidiaries, and any petroleum produced from Libyan oilfields could not be exported to the United States.

Additional mineral activity was minimal with the exception of salt harvesting from coastal pans, quarrying of clay, gypsum and limestone, cement, and ammonia production, which is utilized in the fertilizer and explosives industries. Iron and steel production was minimal and relied upon imported feed materials.

## TRADE

Hydrocarbons accounted for 95% of all exports in Libya. Italy imported approximately 122.5 million barrels of Libyan crude in 1990, which accounted for 27.7% of Italy's total crude imports. Trade continued to be nonexistent between the United States and Libya during the year. Prior to 1986, trade between the countries was significant. Owing to the threat of international terrorism, the United States first imposed trade sanctions on Libya in 1986, and these sanctions have been renewed annually up to and including 1990. Additionally, members of the European Com-

munity (EC) also imposed trade sanctions on Libya in 1986. The U.S. sanctions included the banning of U.S. exports to Libya and prohibition of lines of credit. Five U.S. oil companies had been affected by the sanctions: W. R. Grace & Co., Conoco, Marathon Oil Co., Amerada Hess, and Occidental Petroleum Corp. These companies had a total of \$2 billion worth of assets in Libya. The five U.S. companies involved have been subject to a standstill agreement since the imposition of sanctions. The standstill agreement allows the U.S. companies to maintain their equity interests in projects with the NOC, but they cannot obtain their share of the oil produced. Additionally, they cannot participate in daily operations or make new investment agreements with the NOC.

Enagas of Spain imports approximately 35% of its natural gas from the LNG plant at Marsa al Brega. Enagas's contract is for 760 kmt of LNG per year with the contract terminating in 1991. Turkey has a pending agreement with Libya for 1.5 billion m<sup>3</sup> of natural gas per year commencing in 1992.

## STRUCTURE OF THE MINERAL INDUSTRY

Libya possessed a predominantly state-run economy and the mineral industry sector is no exception. In general, 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. This legislation was amended in 1980 with new production-sharing patterns 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. 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 through its 11 wholly

owned subsidiaries. AGIP was the largest producer of the foreign producers by virtue of its Bouri oilfield production, but other significant foreign operators included

France's Société National Elf Aquitaine and the Federal Republic of Germany's Veba AG and Wintershall AG.

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

| Commodity <sup>2</sup>  | 1986                 | 1987                 | 1988                 | 1989 <sup>3</sup>    | 1990 <sup>4</sup>    |
|---|----------------------|----------------------|----------------------|----------------------|----------------------|
| Cement, hydraulic thousand metric tons                          | 2,077                | 2,700                | <sup>2</sup> 2,700   | 2,700                | 2,700                |
| Gas, natural: <sup>5</sup>                                      |                      |                      |                      |                      |                      |
| Gross million cubic feet  | <sup>1</sup> 455,000 | <sup>1</sup> 424,000 | <sup>3</sup> 420,000 | 420,000              | <sup>4</sup> 420,000 |
| Marketed <sup>4</sup> do.                                       | <sup>2</sup> 240,000 | <sup>2</sup> 202,000 | <sup>3</sup> 194,200 | 194,200              | <sup>3</sup> 203,000 |
| Gypsum <sup>5</sup> thousand metric tons                        | 180                  | 180                  | 180                  | 180                  | 180                  |
| Iron and steel: Crude steel <sup>6</sup> do.                    | 10                   | 10                   | 10                   | 10                   | 500                  |
| Lime <sup>6</sup> do.   | 260                  | 260                  | 260                  | 260                  | 260                  |
| Nitrogen: N content of ammonia do.                              | <sup>3</sup> 352     | <sup>3</sup> 350     | <sup>3</sup> 217     | <sup>3</sup> 212     | 212                  |
| Petroleum:  |                      |                      |                      |                      |                      |
| Crude thousand 42-gallon barrels                                | 389,090              | 367,555              | 374,125              | <sup>3</sup> 412,450 | <sup>3</sup> 501,510 |
| Refinery products:  |                      |                      |                      |                      |                      |
| Gasoline do.  | 5,110                | 7,000                | <sup>1</sup> 10,220  | 10,000               | 10,000               |
| Kerosene and jet fuel do.                                       | 6,935                | 11,000               | <sup>1</sup> 4,015   | 4,000                | 4,000                |
| Distillate fuel oil do.   | 17,885               | 15,000               | <sup>1</sup> 17,155  | 17,000               | 17,000               |
| Residual fuel oil do.   | 20,805               | 15,000               | <sup>1</sup> 14,600  | 14,000               | 14,000               |
| Other do.   | 3,285                | 1,000                | <sup>3</sup> 3,285   | 3,000                | 3,000                |
| Refinery fuel and losses do.                                    | 2,190                | 2,000                | <sup>2</sup> 2,000   | 2,000                | 2,000                |
| Total do.   | <u>56,210</u>        | <u>51,000</u>        | <u>51,275</u>        | <u>50,000</u>        | <u>50,000</u>        |
| Salt thousand metric tons                                       | 12                   | 12                   | 12                   | 12                   | 12                   |
| Sulfur, byproduct of petroleum and natural gas <sup>6</sup> do. | 14                   | 14                   | 14                   | 14                   | 14                   |

<sup>5</sup>Estimated. <sup>6</sup>Preliminary. <sup>7</sup>Revised.

<sup>1</sup>Table includes data available through May 15, 1991.

<sup>2</sup>In addition to the commodities listed, a variety of construction materials (sand and gravel, crushed 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>Reported figure.

<sup>4</sup>Excludes gas reinjected into reservoirs.

TABLE 2  
LIBYA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

(Thousand metric tons unless otherwise specified)

| Major commodity                               | Major operating companies                  | Location of main facilities  | Annual capacity   |
|---|--|--|-------------------|
| Cement  | Libyan Cement Company                      | Hawari, near Benghazi  | 1,500             |
|   | National Cement and Building Materials Co. | El Margueb and Lebda   | 1,400             |
|   | El Fataiah Cement                          | Derna  | 1,000             |
| Iron and steel, crude                         | Misurata Iron and Steel Complex            | Misurata   | 1,100             |
| Petroleum, crude million 42-gallon barrels    | Libyan National Oil Corporation            | Mainly Sirte Basin   | 657               |
|   | Agip-North Africa Middle East              | Bouri offshore oilfield,<br>Bu Attifel onshore oilfield,<br>Rimal Katib onshore oilfield | 19.3<br>50<br>2.3 |
|   | Elf Aquitaine-Libya                        | El-Meheiriga onshore oilfield  | .3                |
| Petroleum, refining million 42-gallon barrels | Azzawiya Oil Refining Company              | Azzawiya   | 44                |
|   | Ras Lanuf Oil and Gas Processing Company   | Ras Lanuf  | 73.4              |
|   | Sirte Oil Company                          | Marsa al-Brega   | 3.1               |

## COMMODITY REVIEW

**Metals.—Iron and Steel.**—The Misurata steel complex, which depends on imports of iron ore, operated at approximately 50% of capacity in 1990. Misurata utilizes two Midrex direct reduction modules, built by Japan's Kobe Steel, each of which have a 550 kmt/a capacity. However, only one module was being used in early 1990 owing to the lack of demand from downstream mills since production started in early 1989. A hot strip and cold rolling mill on-site at Misurata commenced operations in January 1990 utilizing 70 kmt of slab steel imported from Brazil.

Owing to marketing problems, company officials estimated that 40% of sectional steel products and 30% of flat products from Misurata were to be exported. A subsidiary of Misurata was reported to be seeking markets in Europe. A \$16 billion venture to date, Misurata also continued to suffer from the lack of skilled personnel, and the company has relied on expertise and labor from both China and Egypt. Affirming the need for skilled personnel, the Egyptian Iron & Steel Co. announced in March 1990 that the company would send 450 technicians to operate the plant's meltshops, augmenting the 285 Egyptians already on-site at Misurata. China also has 450 engineers working at Misurata.

The Wadi Shatti magnetite deposit, estimated to contain 782 million tons of ore grading 51% Fe, may be developed. However, it would require 550 km of railroad to connect Wadi Shatti to Misurata. The ore would be processed to sinter fines, but the project's viability was doubtful due to insufficient capacity at Misurata.

### Mineral Fuels

**Natural Gas.**—Libya made a high priority of the development of its mostly untapped natural gas reserves in 1990. Natural gas infrastructure upgrading and expansion will be in response to the growing demand for private and industrial users. Estimated demand within Libya was increasing by approximately 10% per year. A multimillion-dollar contract is expected to be awarded in early 1991 for the construction of a 132-km pipeline for natural gas condensate from the Bu Attifel field in the Sirte Basin, approximately 300 km southeast of Marsa al Brega. The proposed pipeline will connect with the already existing coastal pipeline. AGIP is the point of contact for the project with South Korea's Daewoo Corporation and Italy's

Saipem also expressing interest. AGIP has also issued a tender for the construction of an accompanying natural gas plant to be built at the Bu Attifel oilfield. Additionally, AGIP and the NOC have agreed to study the feasibility of transporting the natural gas from the offshore Bouri oilfield and other offshore hydrocarbon structures north of Tripoli to treatment and gathering plants onshore. The estimated 21.2 million m<sup>3</sup> of gas per day would be utilized domestically and for export and could be piped to Italy within a 570-km pipeline. Capitalization was estimated at \$13.5 billion, making the project's future doubtful.

NOC's annual budget included an additional \$156 million to upgrade the liquefied natural gas (LNG) plant at Marsa al Brega. The plant has been in operation for 20 years and its aging combined with an explosion in 1988 has reduced its capacity to 10.7 billion m<sup>3</sup> per day. The plant must also be converted from producing wet gas to producing dry gas, which its export customers such as Italy's Snam prefer.

Natural gas deposits within Libya predominate in the Sirte Basin. The basin will be the primary focus of development of Libya's gas resources. The Attahaddy field is the Sirte Basin's largest natural gas accumulation and was slated for development to begin in 1990. Exploitable resources at this field are estimated at 283 billion m<sup>3</sup> of natural gas.

The Sirte Oil Company contracted Italy's Compagnia Tecnica Internazionale Progetti (CTIP) in March 1990 to supply engineering material and equipment for a natural gas pipeline to connect the 103A gas field to a compressor station at Sahl, adjacent to Marsa al Brega. The project centers on the construction of a 78-km pipeline with a 30-inch diameter. The project is slated for completion in November 1991.

**Petroleum.**—In the latter half of 1990, average petroleum production was 1.5 million bbl/d. By mid-1991, petroleum production could rise to 2 million bbl/d, according to Government estimates. This assumed the completion of the Bouri offshore oilfield and natural gas pipeline infrastructure on the Libyan coast. According to the latest data available, Libya had 696 producing oil wells. The most prolific field in Libya, the Bu Attifel field, had 33 producing wells and is within the Sirte Basin.

The Bouri offshore oilfield, approximately 150 km northwest of Tripoli and operated by Italy's Azienda Generali Italiana Petroli S.p.A. (AGIP), remained the largest hydrocarbon accumulation in that

region of the Mediterranean Sea. The latest available information indicated that the Bouri oilfield produced an average of 30,000 bbl/d. AGIP announced in June 1990 that oil was discovered adjacent to the Rimal field in the Sirte Basin. Estimated reservoir potential was 60 to 70 million bbl. Additionally, in August 1990, AGIP announced another offshore discovery at the Bouri field with the estimated potential of 670 million bbl. In August 1990, Rompetrol of Romania made an estimated 2 billion bbl discovery at their Murzuk concession.

The Arabian Gulf Oil Company (Agoco), operator of Libya's Kebir oilfield near the Tunisian border, submitted tenders for interested contractors by yearend 1990 for an estimated \$60 to \$80 million project to upgrade the field. Pending the acceptance of a bid by an interested contractor, the project included sinking new wells and connecting them to existing wells. Additionally, the construction of a natural gas gathering station was included in the project. A major problem confronting the potential contractor for the project will be its long distance from the center of Libyan petroleum activity in the Sirte basin.

**Petrochemicals.**—Total throughput refining capacity within Libya was 347,600 bbl/d at three operating refineries. By yearend 1990, Yugoslavia's Hemijska Industrija Pancevo (HIP) relinquished its management and operations contract for the Ras Lanuf petrochemicals complex, according to industry sources. The client, Libya's Ras Lanuf Oil and Gas Processing Company (Rasco), originally awarded the contract in 1986. The contract called for the construction of petrochemical processing units which produce methyl tertiary butyl ether (MTBE), butadiene, benzene, and butene.

Global prices for petrochemical feedstock soared in the fourth quarter of 1990, due to the Persian Gulf War. Analysts predict that worldwide petrochemical markets will suffer in the early 1990's due to stagnating economies coupled with growing inventories of feedstock owing to perceived increases in feedstock prices. Despite these forecasts, installed capacity for the production of petrochemicals is increasing worldwide and Libya is no exception. Libya has also been increasingly more interested in expanding its overseas refining capacity.

### Reserves

Libya possesses the largest hydrocarbon reserves in Africa. The NOC stated in early

1990 that a study on petroleum reserves in Libya resulted in a doubling of prior estimates. The study indicated proven oil reserves at 45 to 50 billion bbl and natural gas reserves at 1.2 trillion m<sup>3</sup>.

Libya possessed other industrial mineral resources including gypsum, magnetite, phosphate rock, potash, sodium chloride, and sulfur, for which reserves have not been officially reported. These resources remained largely untapped due to high costs for development coupled with a lack of ready markets.

## INFRASTRUCTURE

Yearend 1990 reports indicate that Libya's most capitalized infrastructure project, the \$25 billion Great Manmade River (GMR), was experiencing delays to GMR Phase 1 due to water well contamination by gravel, soil, and other debris. Probable recasing of the wells was indicated. GMR Phase 2 called for the construction of a 1,100-km waterway, designed to convey 2 million m<sup>3</sup> of water a day from the Fezzan artesian fields in the south of

Tripoli to northwestern coastal regions. GMR Phase 2 was to be completed by 1998.

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.

Agreements signed between Libya and Egypt in December 1990 will help to establish three Libyan/Egyptian joint venture companies for the purpose of building approximately 1,375 km of road both within Libya and connecting roads with Egypt.

## OUTLOOK

Industry projections indicate that natural gas, desired as an environmentally pristine resource, will experience a 50% growth rate in use by southern European countries. Consumption could grow to 350 billion m<sup>3</sup> per year by 2010. Libya is geographically suited to increase its natural gas exports to southern Europe.

Economic concerns for Libya as it moves into the decade of the 1990's are directly related to the health of the mineral indus-

try, specifically petroleum production. Three central themes of concern for Libya would be to: #1) increase oil and petrochemical production and markets; 2) improve political ties with nations that consume or could be target markets for Libyan hydrocarbons; and 3) the GMR, considered a fiscal priority by the Government, and its effects on the Libyan economy as a whole.

<sup>1</sup>Where necessary, values have been converted from Libyan dinars (LD) to U.S. dollars at the rate of LD0.36019=US\$1.00.

## OTHER SOURCES OF INFORMATION

### Agency

Secretariat of Petroleum  
Sadoon Sweheli Street  
Tripoli, Libya

### Publication

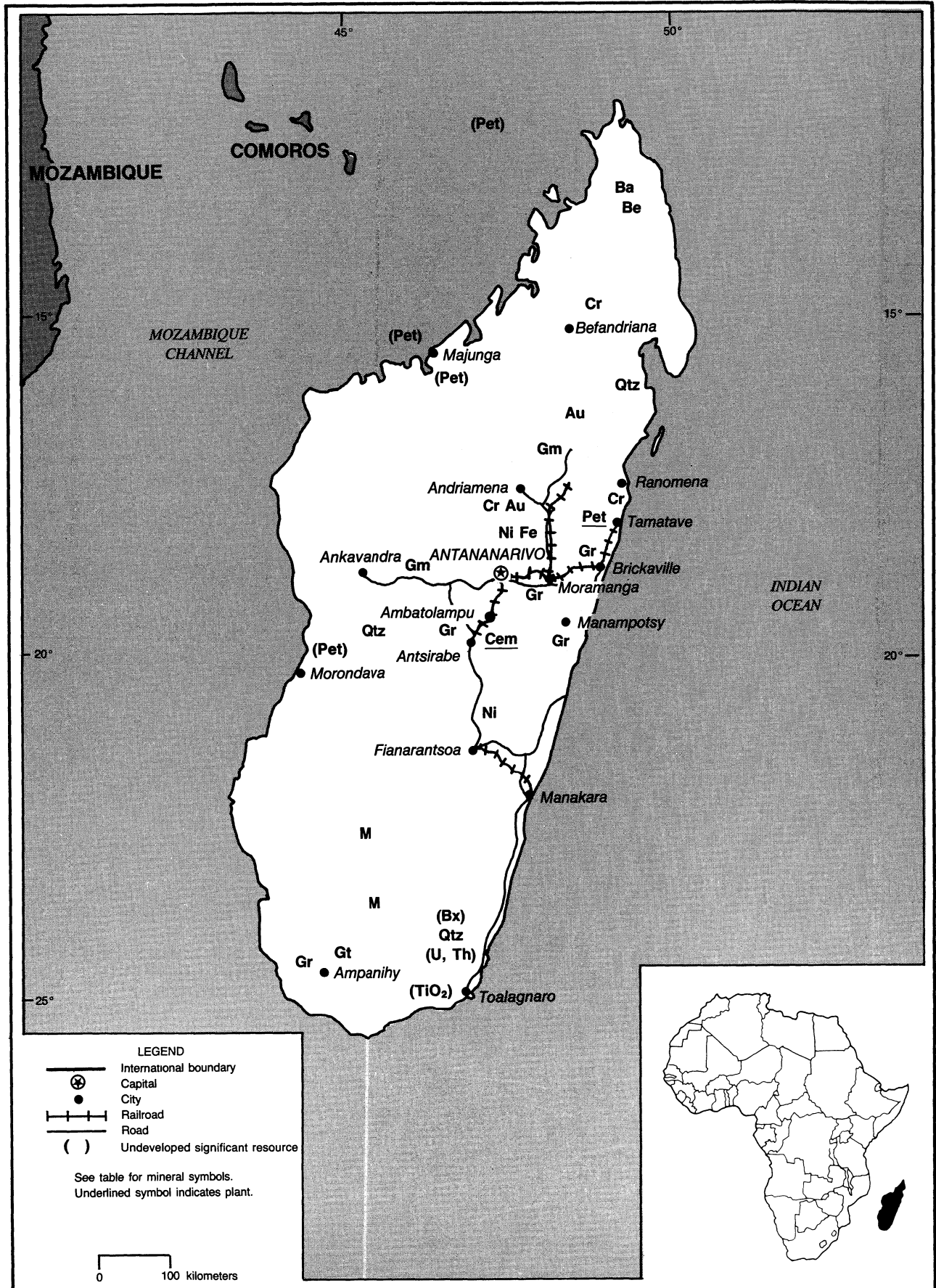
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# MADAGASCAR

AREA 581,540 km<sup>2</sup>

POPULATION 11,800,524



# THE MINERAL INDUSTRY OF MADAGASCAR

By Thomas P. Dolley

**C**hromite and graphite remained the two dominant mineral commodities produced in the Democratic Republic of Madagascar for 1990. However, mineral production in Madagascar continued to show mixed results in 1990. The mineral resources of Madagascar remained under-exploited owing to domestic political upheaval and lack of significant foreign investment.

The most important mineral industry development of the year was the revision of the Mining Code, ratified in August 1990. Primarily to attract foreign investment, the new law helps to streamline existing mining legislation.

The GDP for Madagascar in 1990 was estimated at \$2.1 billion.<sup>1</sup> The mining industry accounts for a small percentage of the GDP. Chromite and graphite production represent the bulk of the industry or about \$18 million in 1990. Agriculture remained the most important industry in Madagascar, employing 80% of the work force and accounting for an estimated 40% of the GDP.

## GOVERNMENT POLICIES AND PROGRAMS

The Government nationalized all mineral resources, with the exception of graphite and mica, in 1975. However, private foreign mining interests are active in the country, and participation by foreign mineral producers is encouraged by the Government. In August 1990, the Government, in cooperation with the Federation of Mine Associations (FEDMINES), ratified the new Mining Code law No. 90-017. The revision of the mining code follows and augments law No. 89/007 of December 12, 1989, concerning industrial-free zones in Madagascar. Additionally, it also complements law No. 6 of December 14, 1989, legislating the new investment code.

The new mining code is meant to streamline existing legislation and to make the investment environment more favorable to foreign operators. The new law stipulates three types of mining permits. The permits are further subdivided into exploration and

exploitation permits. Type I permits are for exploration and exploitation. Granted to individuals or groups of Malagasy nationality, it is valid for 2 years before renewal is required. The duration of validity of type II and type III exploration permits is 3 and 5 years, respectively. The duration of validity of types II and III exploitation permits is 10 and 20 years, respectively. Types II and III permits are designed for small to large mining companies that have been incorporated under Malagasy law. Under the new code, the size covered by the permit is stipulated as type II and type III exploration permits at 75 km and 1,000 km, respectively. Type II and type III exploitation permits stipulate 100 km and 200 km, respectively.

Additionally, in mid-1990, the Government removed certain regulations concerning gold mining. The targeted regulations prohibited private companies or individuals from mining gold and exporting it. However, the Government maintains the right of priority for the purchase of gold mined in Madagascar. Recent gold mining was in the form of artisanal, individual-operated mines. France's Bureau de Recherches Géologiques et Minières (BRGM) and the Government's Office Militaire National pour les Industries Stratégiques (OMNIS) have explored for alluvial gold in the east-central rivers of Madagascar. The region is south of Antananarivo and west of Manampotsy, where gold was once mined in the 19th Century.

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 was 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.

The Government continued to seek multilateral and bilateral cooperation to aid in controlling the degradation of the environment incurred during the past few years. Uncontrolled slash and burn cultivation, overgrazing, and massive erosion threaten Madagascar's agricultural and hydroelectric potential.

## PRODUCTION

Production of the mineral industry in Madagascar remained mixed in 1990. Chromite and graphite showed modest increases in production; however, mica production declined. Chromite production figures have been fairly stable in the late 1980's and early 1990's despite a worldwide chromite glut. However, current chromite production levels represent less than 50% of the production levels of the 1970's. The precious and semiprecious stone industry showed mixed results, but owing to black-market activity, accurately reported production figures remain elusive. Early in 1991, the Government sought technical assistance from foreign sources in setting up an organized and monitored gem stone industry.

## TRADE

Total export earnings for Madagascar in 1990 were estimated at \$290 million. U.S. imports from Madagascar account for about \$40 million of the latter figure. The U.S. share of Malagasy exports is about 14%. Agriculture accounts for 80% of Malagasy export earnings.

Chromite exports for 1990 were 75,269 tons valued at \$7.8 million. Additionally, an important mineral import of the United States is Malagasy graphite, valued at approximately \$4 million in 1990. Madagascar exported 12,751 tons of graphite worldwide in 1990.

## STRUCTURE OF THE MINERAL INDUSTRY

The chromite industry is controlled by the parastatal Société Kraomita Malagasy.

TABLE 1

**MADAGASCAR: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>**

(Kilograms unless otherwise specified)

| Commodity <sup>2</sup>  | 1986    | 1987               | 1988               | 1989 <sup>p</sup>  | 1990 <sup>e</sup>    |
|---|---------|--------------------|--------------------|--------------------|----------------------|
| <b>METALS</b>   |         |                    |                    |                    |                      |
| Beryllium: Beryl in quartz concentrates,<br>industrial and ornamental | 50      | 35                 | 3                  | 154                | <sup>3</sup> 3,345   |
| Chromium: Chromite concentrate, gross weight<br>metric tons           | 82,910  | 106,600            | 64,177             | 62,540             | 73,000               |
| Gold, mine output, Au content <sup>e</sup>                            | 4       | <sup>3</sup> 40    | 90                 | 45                 | <sup>3</sup> 216     |
| Rare-earth minerals: Bastnasite <sup>e</sup>                          | 10,000  | 10,000             | 10,000             | 10,000             | 10,000               |
| <b>INDUSTRIAL MINERALS</b>  |         |                    |                    |                    |                      |
| Abrasives, natural: (industrial only) <sup>e</sup>                    | 10,000  | 10,000             | 10,000             | 10,000             | 10,000               |
| Cement, hydraulic <sup>e</sup> metric tons                            | 35,000  | 35,000             | 35,000             | 35,000             | 35,000               |
| Clay, kaolin do.  | 6,000   | 1,427              | 365                | 1,315              | <sup>3</sup> 485     |
| Feldspar <sup>e</sup>   | 5,000   | 5,000              | 5,000              | 5,000              | 5,000                |
| <b>Gem stones:</b>  |         |                    |                    |                    |                      |
| Amazonite   | 5,500   | 3,783              | 525                | 23,885             | <sup>3</sup> 2,185   |
| <b>Amethyst:</b>  |         |                    |                    |                    |                      |
| Gem   | 10      | 11                 | 1,700              | 3                  | <sup>3</sup> 1,713   |
| Geodes <sup>e</sup>   | 9,000   | 9,000              | 9,000              | 9,000              | <sup>3</sup> 86      |
| Citrine   | 400     | 6                  | 112                | 754                | <sup>3</sup> 50      |
| Cordierite  | 800     | 387                | 886                | 4,051              | <sup>3</sup> 1,556   |
| Garnet  | 1,500   | 1,500              | 6                  | 23                 | <sup>3</sup> 6,905   |
| Tourmaline  | 2,000   | 2,000              | 2,367              | 97                 | <sup>3</sup> 54      |
| Graphite, all grades metric tons                                      | 16,187  | 13,169             | 14,106             | 15,863             | <sup>3</sup> 18,036  |
| <b>Mica, phlogopite:</b>  |         |                    |                    |                    |                      |
| Block do.   | 100     | 25                 | 5                  | 7                  | <sup>3</sup> 93      |
| Scrap do.   | 1,300   | 300                | 605                | 899                | <sup>3</sup> 538     |
| Splittings and sheet do.  | 194     | 77                 | 8                  | 162                | <sup>3</sup> 90      |
| Total do.   | 1,594   | 402                | 618                | 1,068              | 721                  |
| <b>Ornamental stones:</b>   |         |                    |                    |                    |                      |
| Agate   | 8,000   | 14,034             | 13,886             | 9,005              | <sup>3</sup> 4,696   |
| Apatite   | 3,500   | 1,948              | 2,090              | 9,016              | <sup>3</sup> 1,139   |
| Aragonite metric tons   | 1,000   | 500                | <sup>e</sup> 500   | 2,187              | <sup>3</sup> 786     |
| Calcite do.   | 1,000   | 2,934              | 1,243              | 1,373              | <sup>3</sup> 3,757   |
| Celestite   | 30,000  | 4,365              | 34,511             | 28,398             | 26,000               |
| Jasper  | 16,000  | 19,730             | 21,030             | 30,137             | <sup>3</sup> 23,560  |
| Labradorite   | 15,000  | 24,320             | 27,748             | 23,015             | 24,000               |
| Other gem and ornamental <sup>e</sup> metric tons                     | 250     | 250                | 250                | <sup>e</sup> 250   | 250                  |
| <b>Quartz:</b>  |         |                    |                    |                    |                      |
| Crystal   | 32,500  | 32,500             | 22,136             | 40,875             | 32,000               |
| Geodes  | 3,000   | <sup>e</sup> 3,000 | 2,700              | <sup>e</sup> 2,700 | 2,700                |
| Hematoid  | 15,000  | 6,825              | 9,089              | 5,795              | <sup>3</sup> 3,157   |
| Piezoelectric   | 150     | <sup>e</sup> 150   | 153                | 163                | 160                  |
| Rose quartz   | 50,000  | 77,980             | 360,290            | 64,384             | <sup>3</sup> 10,832  |
| Smelting <sup>e</sup>   | 100,000 | 100,000            | 100,000            | 100,000            | <sup>3</sup> 179,521 |
| Other ornamental  | 6,500   | 4,925              | <sup>e</sup> 5,000 | 6,578              | <sup>3</sup> 14,360  |
| Tourmaline  | 1,000   | 276                | 520                | 3,140              | <sup>3</sup> 4,076   |
| Salt, marine <sup>e</sup> metric tons                                 | 30,000  | 30,000             | 30,000             | 30,000             | 30,000               |
| <b>Stone:</b>   |         |                    |                    |                    |                      |
| Calcite, industrial <sup>e</sup> do.                                  | 2,000   | 2,000              | 2,000              | 2,000              | 2,000                |
| Dimension, marble, other <sup>e</sup> do.                             | 3,000   | 3,000              | 3,000              | 3,000              | 3,000                |
| Marble, cipoline do.  | 110     | 5                  | 4                  | 5                  | <sup>3</sup> 1       |

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>                     |                            | 1986         | 1987         | 1988         | 1989 <sup>p</sup> | 1990 <sup>e</sup> |
|--|----------------------------|--------------|--------------|--------------|-------------------|-------------------|
| <b>MINERAL FUELS AND RELATED MATERIALS</b> |                            |              |              |              |                   |                   |
| Petroleum refinery products:               |                            |              |              |              |                   |                   |
| Distillate fuel oil                        | thousand 42-gallon barrels | 216          | 560          | 664          | 540               | <sup>3</sup> 798  |
| Gasoline                                   | do.                        | 128          | 425          | 451          | 219               | <sup>3</sup> 405  |
| Kerosene and jet fuel                      | do.                        | 116          | 287          | 303          | 139               | <sup>3</sup> 253  |
| Residual fuel oil                          | do.                        | 986          | 813          | 979          | 329               | <sup>3</sup> 504  |
| Other                                      | do.                        | 19           | 48           | 96           | 14                | <sup>3</sup> 26   |
| <b>Total</b>                               | <b>do.</b>                 | <b>1,465</b> | <b>2,133</b> | <b>2,493</b> | <b>1,241</b>      | <b>1,986</b>      |

<sup>e</sup>Estimated. <sup>p</sup>Preliminary.<sup>1</sup>Table includes data available through Dec. 1991.<sup>2</sup>In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (clays, sand, gravel, and 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 1990**

(Thousand metric tons unless otherwise specified)

| Commodity | Major operating companies         | Location of main facilities    | Annual capacity |
|-----------|-----------------------------------|--------------------------------|-----------------|
| Chromite  | Kraomita Malagasy                 | Andriamena                     | 175.            |
| Graphite  | Etablissements Gallois            | Artsurakambo Mine, Brickaville | 4.8.            |
|           | Marovintsy Mine, Vatomandry       |                                | 3.6.            |
| Do.       | Societe Miniere de la Grande Ile  | Ambatomitamba Mine, Tamatave   | 6.              |
| Do.       | Etablissement Izouard             | Faliarno Mine, Moramanga       | 2.              |
| Mica      | Societe des Mines d'Ampandrandava | Ampandrandava Mine and         | .6 phlogopite.  |
|           |                                   | Sakamasy Mine                  | .6 phlogopite.  |

Graphite and mica production is owned and operated by foreign entities, but the Government asserts control of 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.

**COMMODITY REVIEW****Metals**

**Chromite.**—In 1990, production of chromite ore and concentrate in Madagascar showed a moderate increase. Madagascar's chromite ore is mined from a single operation in Andriamena. Initiated in 1969, chromite mining from the calc-ferromagnesian rocks of the Andriamena district has generally remained stable in recent years. The chromite industry is plagued by a lack of investment capital,

which is due in part to a global chrome and ferrochromium oversupply. The worldwide oversupply has caused a gradual decline in chromium prices since 1988. Antiquated mining equipment and the decline in price has had an adverse effect on chromite production in Madagascar.

**Titanium.**—After years of delay, QIT-Madagascar Minerals was cautiously optimistic on a 1992 date to commence mining TiO<sub>2</sub> beach sands in Madagascar. The Canadian firm QIT-Fer et Titane Inc., a subsidiary of RTZ's BP Minerals and OMNIS, had formed a joint-venture company, QIT-Madagascar Minerals, to exploit the ilmenite beach sands near Toalagnaro (formerly Fort Dauphin). The Madagascar scheme was owned 49% by QIT and 51% by OMNIS. An environmental impact study was conducted by OMNIS in 1990 which was partly financed by the World Bank. The study concluded that the mining operation would destroy 75% of coastal forest zone

or 3,000 ha. QIT has suggested that special conservation areas be set up to limit mining damage to the environment.

**Industrial Minerals**

Madagascar remained an important producer of high-quality flake graphite throughout the 1980's. Production tonnage was small to modest by world standards. In 1990, it was reported that the European Investment Bank, BEI, intended to finance studies for the graphite industry. The EC also expressed interest in studying Malagasy mineral resources to include industrial minerals.

**Mineral Fuels**

No exploratory drilling activity was reported in 1990. Domestic sources of hydrocarbons remained an elusive solution for Madagascar's increasing energy consumption. Madagascar was still in the midst



of a third round of petroleum exploration contract offers that commenced in 1988. To date, three companies have signed exploration contracts. Additionally, plans to exploit the heavy oil and bituminous sandstone on the island would cost an estimated \$980 million.

### Reserves

The Government stated that Madagascar has significant deposits of bastnasite, bauxite, chromite, ilmenite, and iron ore. Graphite deposits and pegmatite deposits and minerals associated with these deposits have been historically exploited. Hydrocarbons have been found in the form of natural gas, tar sands, heavy oil, and coal, but are not economic.

### INFRASTRUCTURE

Total electricity generated in Madagascar for 1990 was estimated at 510 MkWh. 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.

### OUTLOOK

The decade of the 1990's should be critical for Madagascar as it seeks to develop mineral resources in the context of environmental concerns. There are indications that previous environmental problems must be addressed before new lenders participate in new mining development projects.

Recent political upheaval along with poor transportation and electrical power infrastructure may continue to prevent major mineral development in the short term.

<sup>1</sup>Where necessary, values have been converted from Madagascar francs (FMG) to U.S. dollars at the rate of FMG1,494.1=US\$1.00.

### OTHER SOURCES OF INFORMATION

#### Agencies

Direction des Mines et de l'Energie  
Ministere de l'Industrie et du Commerce  
Ambohiday, 101 Antananarivo, Madagascar  
Office Militaire National pour les Industries  
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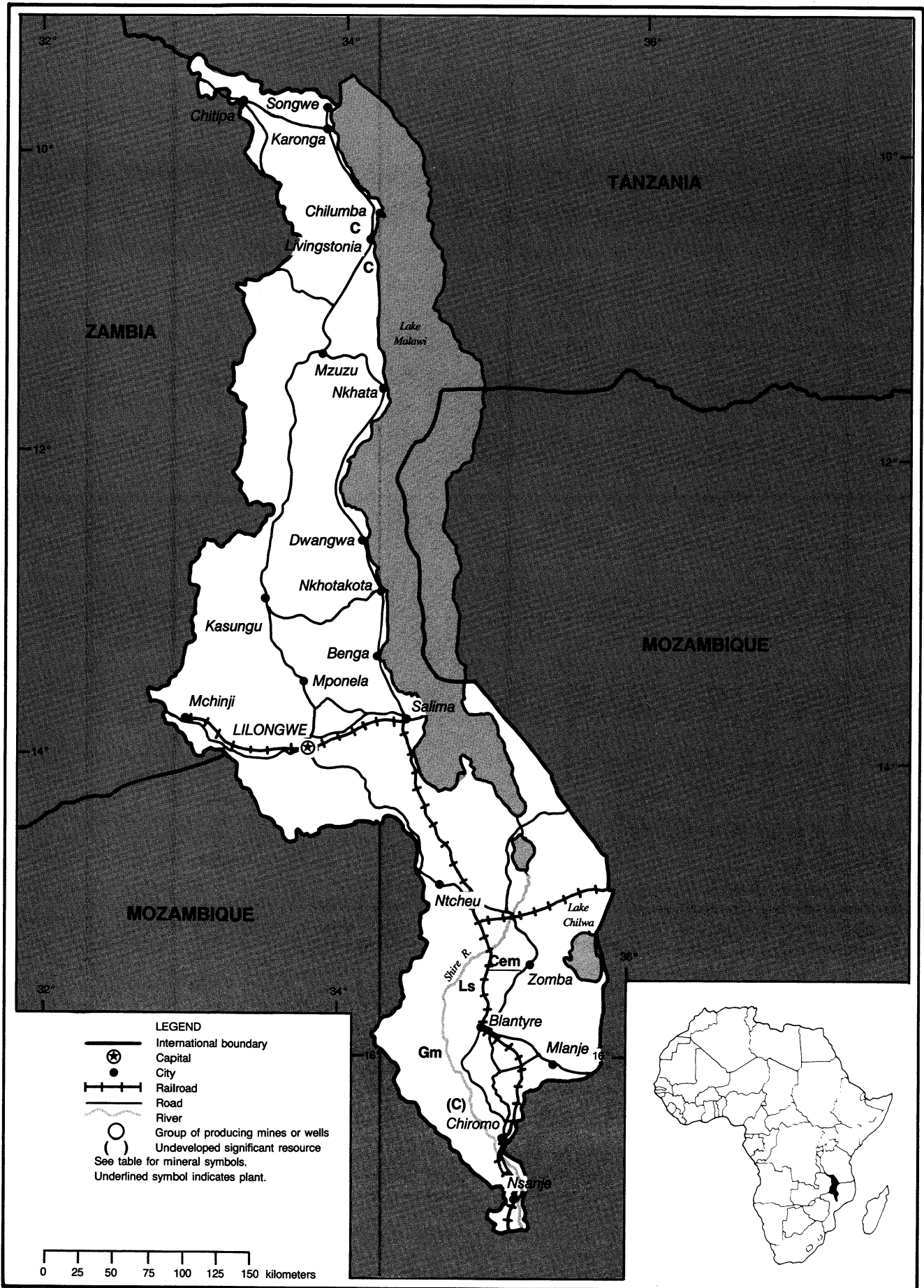
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# MALAWI

AREA 119,000 km<sup>2</sup>

POPULATION 9.3 million



# THE MINERAL INDUSTRY OF MALAWI

By Audie L. King

**M**alawi's mineral industry accounted for less than 0.6% of Malawi's GDP in 1990. Although a wide variety of mineral deposits have been discovered in Malawi, only limestone and coal for cement and lime production, crushed stone, and minor quantities of gem stones are being mined at the present time.

Agriculture dominated Malawi's economy. It accounted for 43% of the nation's GDP, 90% of exports, and employed 85% of the population. Tobacco was the most important export product and accounted for 50% of Malawi's total export revenue.

Malawi's economy grew by 4.8% in real terms in 1990. This was the third consecutive year of economic growth following several years of poor performance. The reversal in Malawi's economic fortunes came despite a drought in the early part of 1990 that adversely affected the nation's agricultural output. The strong economic performance can be attributed to recent adjustments made to the Government's policies on trade and industrial development, higher international prices for its principal exports of tobacco and sugar, and the increased availability of foreign exchange.

## GOVERNMENT POLICIES AND PROGRAMS

Malawi's Department of Mines opened up a mineralogy laboratory in 1990. It supports the Government and parastatal institutions as well as small-scale miners in the area of mineral processing. The laboratory's applied mineralogy unit will also conduct its own research in the area of utilization of raw materials. Malawi's Geological Survey Department (GSD) expanded its mineral exploration program while it continued its geologic mapping program.

Malawi's economic growth accelerated significantly since the Government's introduction of strict financial discipline in 1988. Business confidence and investment

had increased since International Monetary Fund austerity measures, aimed to reduce domestic demand and lower inflation, took effect. Harsh measures were necessary to deal with increasingly adverse external developments that were out of Malawi's control. Malawi's economy expanded by 5% per year throughout the 1970's before declining sharply in the early 1980's. The decline was a result of the civil war in Mozambique that cut off Malawi's rail export routes through Nacala and Beira through which more than 90% of exports had been shipped. In 1990, rebel attacks closed down the highway through Tete in northwestern Mozambique that linked Malawi to Zimbabwe and the south. The closure added 800 km to the trucking route and at least doubled transportation costs. Malawi's budget was further strained when almost 1 million Mozambican refugees entered Malawi. Regional security forces claimed that refugees continued to arrive at the rate of about 10,000 per month.

Besides monetary reforms, an important goal of Malawi's economic adjustment program was to increase foreign investment in the manufacturing and agricultural sectors. The Government offered attractive preproduction incentives on buildings, plants, and machinery. It also offered allowances on capital expenditure and tariff protection. Foreign companies could freely transfer profits, dividends, and interest out of the country, but repatriating capital was still subject to approval from the Exchange Control Authority. The Government was especially soliciting investments in glassware, food and rubber processing, and lime production. It, however, insists that private Malawian citizens or parastatal companies hold a sizable share in all new enterprises.

Malawi's 1990 budget announced substantial reductions in both personal and corporate income taxes. Corporate taxes went down 5% to 45% and personal taxes were reduced by 15%.

## PRODUCTION

Although Malawi plans to raise coal, limestone, cement, and lime output in the

future to meet the needs of its expanding economy, production remained almost level in 1990.

## TRADE

Malawi's exports consisted mostly of tobacco, tea, and other primary commodities. A very small quantity of gem stones was the country's only mineral export. Imports consisted mostly of fuel, fertilizer, chemicals, and machinery.

Malawi's total exports in 1990 were \$321.2 million, of which 10.7% went to the United States. Malawi's imports were \$343.1 million, of which 4.6% came from the United States. Other major trade partners included the Republic of South Africa, the United Kingdom, the Federal Republic of Germany, the Netherlands, and Japan.

## STRUCTURE OF THE MINERAL INDUSTRY

The Mining Investment and Development Corp. (Midcor) was formed in 1985 with a priority of developing coal mines. It operated the Kaziwiziwi Mine and the Mchenga Mine in the northern district of Livingstonia. The Portland Cement Co. had mined limestone at Changalumi, near Zomba, since 1960. The Gem Co. of Malawi produced ruby and sapphire from the Chimwadzulu Mine in Ntcheu. Lime was produced by small-scale private lime burners.

The Kaziwiziwi coal mine employed an average of 264 people, the Mchenga Mine employed 53 people, the Portland Cement Co. employed an average of 650 people, and the Gem Company of Malawi employed about 65 people in 1989, the latest year that such data were available.

## COMMODITY REVIEW

### Metals

**Copper.**—The Geological Survey Department, in conjunction with the United Nations Development Program (UNDP),

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

(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>                     | 1986    | 1987    | 1988    | 1989 <sup>P</sup>  | 1990 <sup>e</sup> |
|--|---------|---------|---------|--------------------|-------------------|
| Cement, hydraulic                          | 69,471  | 72,831  | 65,597  | 77,000             | 77,000            |
| Coal                                       | 10,708  | 18,256  | 39,376  | 41,700             | 42,000            |
| Stone: Limestone for cement                | 103,037 | 107,040 | 105,000 | 113,000            | 113,000           |
| Gem stones: Ruby and sapphire <sup>e</sup> | grams   | 1,000   | 1,000   | <sup>3</sup> 1,096 | 500               |
| Lime <sup>e</sup>                          | 2,735   | 3,160   | 3,000   | 3,460              | 3,500             |

<sup>e</sup>Estimated. <sup>P</sup>Preliminary. <sup>R</sup>Revised.

<sup>1</sup>Includes data available through July 23, 1991.

<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.

has been investigating geophysical anomalies located during a 1987 airborne survey performed by Paterson, Grant, and Watson of Toronto, Canada. Geochemical and ground geophysical surveys covered the copper-nickel-bearing areas near Kasungu.

**Rare-Earths.**—The GSD, with Japanese technical assistance, drilled the Tundulu Carbonatite complex, about 7 km northwest of Kasungu. The exploration indicated significant reserves of both rare earths and phosphate rock. An exploration project with Japan in 1988 also revealed substantial rare-earth resources in the Kangankunde Carbonatite, about 60 km south-southeast of Ncheua, and the Songwe Carbonatite, about 60 km north-northeast of Mlanje.

**Uranium.**—The GSD, in conjunction with the UNDP, investigated geophysical anomalies in the uranium-bearing areas of Thambani, about 75 km west of Blantyre.

Nuclear Electric (NE) of the United Kingdom continued a feasibility study at the Kayelekera uranium deposit in Karonga District under its recently renewed exploration license. An environmental impact study, conducted by both the GSD and the NE in the vicinity of the uranium deposit, continued.

#### Industrial Minerals

**Clay.**—The Industrial Minerals Applied Research Laboratory (IMARL) of the GSD conducted field and laboratory assessments on a clay deposit, with potential for use in ceramics, from the Senzani area, about 55 km south-southeast of Ntcheu. The deposit was determined to be large enough and of sufficient quality to be of economic interest.

**Gem Stones.**—The Gem Co. of Malawi, which suspended operations at its

Chimwadzulu Mine in Ntcheu Province in June 1989 owing to operational problems, reopened in 1990.

**Gypsum.**—Preliminary feasibility studies to assess the economic viability of the Mponela gypsum deposit were conducted. Previous trial mining and washing operations had been unsuccessful due to flooding.

**Lime.**—Malawi's Bureau of Mines, together with the Intermediate Technology Development Group, carried out trial runs on simple vertical kilns near Balaka, about 21 km east by southeast of Ntcheu. Preliminary results indicate that the finished product could be upgraded to a 69% available lime content. The kilns were designed to be low cost and thus be made available to small-scale producers. Midcor planned to produce lime from a proposed 2.75-km quarry at Malowa Hill, about 11 km northeast of Blantyre in the Bwanje Valley. Some equipment had already been ordered from a variety of local, South African, and Canadian sources, but financing still had not been finalized. It was expected that the Government would retain a 40% equity and that the rest of the financing would come from a venture partner or from loans. The project would require an investment of \$1.7 million over a 3 year period. Midcor estimates that the plant's potential market would be about 15,000 mt/a. Initial production would be 4,000 tons of lime and 2,000 tons of aggregate. Malawi had been importing lime from Zambia and the Republic of South Africa for use by the local water boards and in the sugar and construction industries.

**Vermiculite.**—French-funded exploration, that began in mid-1989, continued at the vermiculite deposits near Mpatamanga,

about 56 km west of Blantyre. More than a dozen sites were investigated, and at least four of the vermiculite-bearing deposits were found to contain ore of sufficient quality and quantity to be of commercial interest. The prospect of reopening of the Nacala railway was a favorable factor in determining the economic viability of these deposits.

#### Mineral Fuels

Although coal deposits had been known for many years in the northern part of the country, they were not mined until recently because it was determined to be more economical to import coal from Mozambique. Mining these northern deposits presented economic difficulties because they were not close to an efficient transport system linking them to the nation's industry in the southern part of the country. When the civil war in Mozambique made coal imports unreliable, Malawi was forced to develop its own resources. Malawi now operates two coal mines in the Livingstonia Coalfield, in the northern part of the country. The Kaziwizi Mine is at the end of its life and the Mchenga Mine is in the beginning of its development stage.

A French-funded exploration drilling program, which started in October 1989, continued at the Lengwe and Mwabvi Coalfields in southern Malawi, about 65 km southwest of Blantyre, Malawi's commercial center and site of most of the country's coal consuming industry. So far, results of the drilling program have been encouraging, especially at the Mwabvi Coalfield where thick seams of, albeit high ash, coal have been discovered. The coal belongs to the Permian-Triassic Karoo system and is similar to other deposits in southern Africa. The rank of coals in Malawi was found to

decrease from south to north, ranging from anthracite in the south to high-volatile bituminous coal in the north.

### Reserves

The limestone deposit at Chungalumi in southern Malawi was estimated to contain 100 Mmt of material that was suitable for cement production.

The Kaziwiziwi coal deposit in northern Malawi had minable reserves that were estimated to be 120,000 tons. At present production rates, this deposit will be exhausted in 4 or 5 years. The Ngana Coalfield, a larger deposit of poorer quality coal on the Tanzanian border near Karonga, is reported to contain between 1.7 and 14 Mmt of coal in a seam that is about 1 m thick. The reserve potential of the Lengwe and Mwabvi Coalfields in the lower Shire Valley northwest of Chiromo are being investigated.

Malawi also possessed significant deposits of other minerals that had not yet been exploited. An apatite deposit at Tundulu near the southern end of Lake Chilwa contained 1.25 Mmt of rock that averaged 15%  $P_2O_5$ . The Kangankunde Carbonatite complex, about 75 km north-northwest of Blantyre, was reported to contain 11 Mmt of material that ran 8.4%  $SrCO_3$  and 1.9% rare-earth oxides. A 28.8 Mmt bauxite deposit occurs on the Mlanje syenogranitic massif, 25 km northeast of Mlanje. The bauxite averaged 4 to 5 m in thickness and covered 5.2 km. China clay, corundum, dimension stone, graphite, silicon sand, uranium, and vermiculite deposits had also been investigated but not yet exploited. Exploration for chromite, copper, gold, gypsum, nickel, petroleum, rutile, and salt has been conducted in recent years.

### INFRASTRUCTURE

Malawi remained almost totally dependent on South African transport routes for its export trade. More than 95% by weight of all trade was shipped by road through Mozambique's Tete Province, southward across Zimbabwe to the railhead at Messina, Republic of South Africa, where goods were loaded onto railcars and shipped to the port at Durban. In late 1990, Mozambican rebels closed down the road through Tete Province, requiring goods to be shipped through Zambia. The 3,800-km Zambian route was

1,100 km longer than the route through Zimbabwe. Most of the remaining 5% of traded goods, including 48% of fuel imports, were shipped via a provisional route to Dar es Salaam, Tanzania. A permanent road link with Tanzania was being established with the help of foreign aid from many countries, including the United States. This northern route would remain an alternative to the traditional export routes through Beira and Nacala, Mozambique, that had been virtually closed since 1985. The importance of the northern route was expected to increase in 1991 when most of the facilities on the northern corridor were scheduled for completion. Infrastructural problems made Malawi's external transportation routes one of the most expensive in the world. In 1990 alone, it was estimated that Malawi lost from \$60 to \$100 million as a result of high transportation costs. Trade through Mozambique remained very small. Restoration of the important rail route from Malawi to Nacala was scheduled to begin in June 1991, and take about 2 years. The French consortium Bolie SAE/DEHE had the repair contract. Under an agreement with Mozambique, Malawi consented to provide military protection from the border to Malema, Mozambique. Once reopened Malawi's transportation costs could drop from about \$0.40 for every dollars worth of exported goods to an estimated \$0.16.

Domestic trucking capacity was insufficient to meet demands. Critical distribution needs such as the transport of crops and the timely distribution of fertilizer were not met. The domestic rail system also experienced difficulties caused by the shortage of spare parts and railroad cars.

Kier International, part of the United Kingdom's Beazer National Construction Co., continued repairs on an 80-km road linking Lilongwe and Salima. It was estimated that the project would take 30 months to complete.

There were 2,662 km of paved roads, 334 km of gravel roads, and 9,219 km of dirt roads in 1988, the last year that such data were available. There were major airports at Lilongwe, Chileka (near Blantyre), Mzuzu, and Karonga and smaller airports at many other cities throughout the country.

In 1987, the last year such information was available, the Government reported that an average of 296 people were employed in the mining sector. This was less than 1% of the total of nonagricultural workers, which according to Government figures, consisted

of 316,359 in the private sector and 91,034 in the Government sector.

According to the Chamber of Mines of South Africa, the number of Malawian workers employed in gold and coal mines in the Republic of South Africa had decreased from almost 18,000 in 1987 to only 70 in 1990.

### OUTLOOK

For the present, the health of Malawi's mineral industry, which was almost exclusively involved in supplying raw materials to the domestic construction industry, is dependent on the expansion of the country's economy. The long-term future of the mineral industry looks bright. A wide range of undeveloped mineral deposits have been discovered in recent years, and the Government seems willing to cooperate with foreign agencies that have been offering technical and financial support in the areas of exploration and mineral processing. Development of new mines and process plants will diversify and expand the overall economy, but the mining sector will probably not become a major contributor to the nation's GDP.

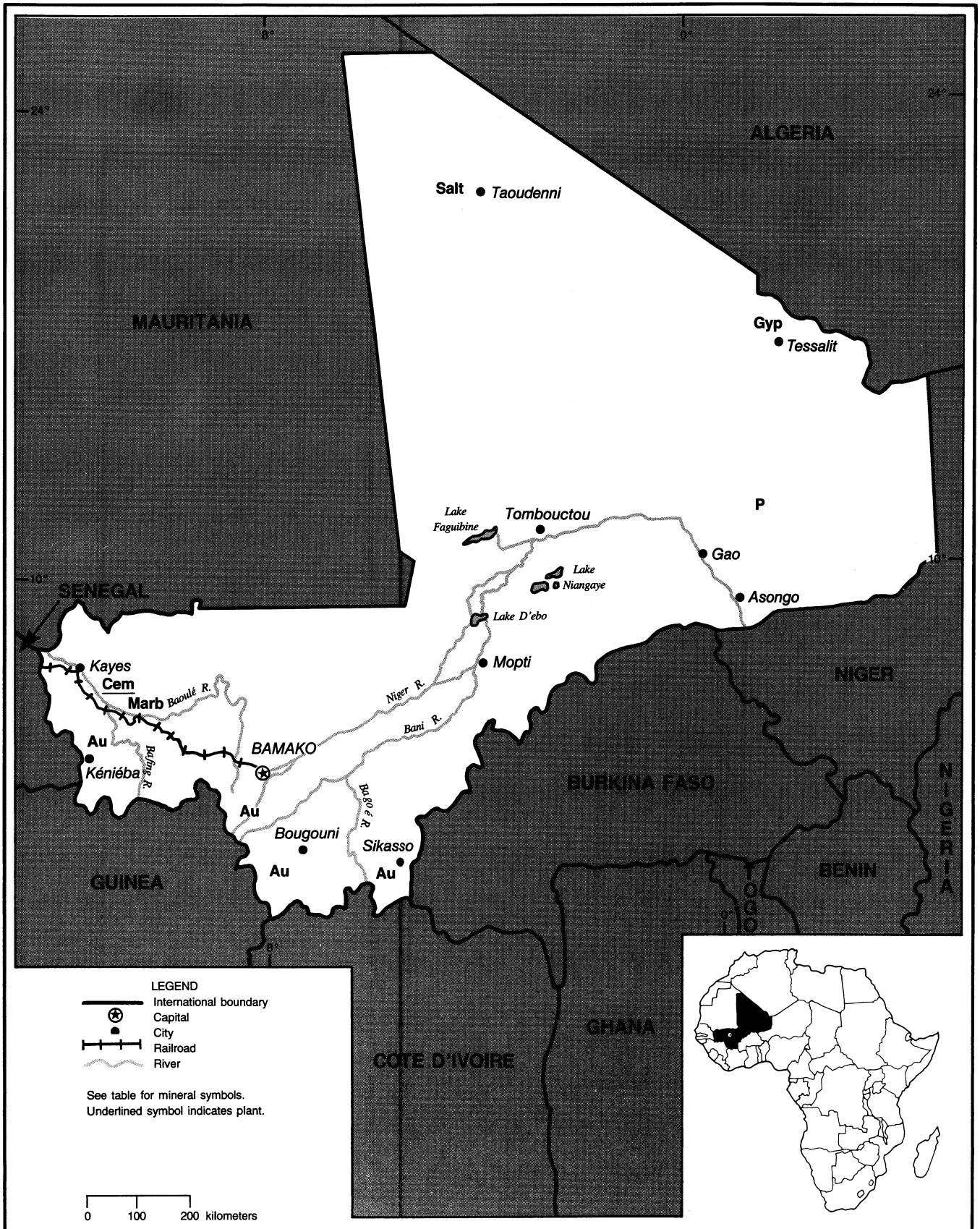
Malawi's economy will continue to be dependent on foreign aid and on the agricultural sector, which is vulnerable to fluctuations in world commodity prices, insect infestations, and adverse weather conditions. The country's resolve in improving its internal and external infrastructural problems will, in large measure, determine its future economic expansion. Easing of political tensions in Mozambique and the subsequent reopening of Malawi's traditional trade routes would be highly beneficial to the country's external finances. Until Mozambique solves its internal problems, the high cost of maintaining a rail link through Mozambique to Nacala will not substantially lower the cost of transportation of the country's exports and imports. Commerce along this route may also be perceived as an unacceptable risk. Thus, the timely completion of improvements to the Dar es Salaam transportation corridor is especially important because it is Malawi's only secure alternative to the costly South African port of Durban.

<sup>1</sup>Where necessary, values have been converted from Malawian kwacha (MK) to U.S. dollars at the rate of MK2.73=US\$1.00

# MALI

AREA 1,241,232 km<sup>2</sup>

POPULATION 8.1 million



# THE MINERAL INDUSTRY OF MALI

By Hendrik G. van Oss

**T**he mineral economy of Mali in 1990 was dominated by the production of gold, although small quantities of construction materials, gypsum, marble, phosphate, and salt were also produced. Mineral commodity revenues were equivalent to about 2.7% of the country's GDP, or about \$65 million;<sup>1</sup> gold made up about 97% of this. Despite its modest contribution to the GDP, mining was important to the country's foreign exchange earnings; gold accounted for about 20% of Mali's total exports and was the country's third most valuable export commodity, after cotton and livestock. Most of Mali's mineral deposits, of which there is a wide variety, are uneconomic because of a lack of infrastructure.

The geology of Mali is dominated by Precambrian rocks in the southwestern and central parts of the country, and Paleozoic to Cenozoic rocks over the remainder. By far the most important rocks economically are a number of north-to-northeast-trending belts of 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 Birimian rocks in these areas, in common with similar rocks elsewhere in West Africa, host gold deposits. Most of these are associated with shear-zone-related iron sulfide-rich rocks, including quartz veins. Near Kéniéba, the Precambrian terrane also hosts diamond-bearing kimberlites; these have proven not to be of economic grade. Iron ore deposits are also known in this area, as are large but low-grade bauxite deposits. South-southeast of Gao, a relatively small area of Birimian rocks contains a large but presently uneconomic manganese deposit.

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 exploited on a small scale. Paleozoic limestone deposits in western Mali are also exploited to a limited degree.

## GOVERNMENT POLICIES AND PROGRAMS

The mining sector, particularly gold, is viewed by the Government as having the greatest growth potential of any sector of the Malian economy, especially in terms of generating foreign exchange. The Government encourages foreign private investment in this sector and has sought to improve the availability and quality of information about the country's geology and mineral resources. For example, it has cooperated with the UN Development Program in a decade-long program of resource evaluation in Mali, including systematic regional geochemical sampling. The discovery and development of the Syama gold mine is a measure of the program's success.

The basic mining law of Mali in 1990 was the Mining Code, Ordinance No. 34/CMLN of September 3, 1970, as modified by Decree No. 112/PG of September 3, 1970, and by Order No. 65/MDITP, January 28, 1971. Later modifications include that of Article 48 of the Mining Code by law No. 81-80/An-RM of July 13, 1981, and of Article 8 of the Mining Code by Ordinance No. 90-07/P-RM of April 13, 1990. This last ordinance formalized the artisanal mining sector. In 1990, the Government began drafting a new mining code that, reportedly, contained elements of recently negotiated mining agreements.

Petroleum exploration and exploitation are 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.

Mining is regulated by the Direction Nationale de Géologie et des Mines, which is part of the Ministry of Industry, Hydraulics, and Energy.

## PRODUCTION

Production of most mineral commodities was relatively stable in 1990. However, gold and silver increased sharply with the opening of the Syama Mine. About 42% of the total gold output was from the new mine. Output from the Kalana gold mine, hitherto the largest single gold producer in the country, is believed to have remained essentially unchanged at about 400 to 450 kg. The remainder of the production, amounting to an estimated 2,600 kg, was from artisanal and a few small, semi-industrial operations.

## TRADE

Mali's mineral commodity trade consisted mainly of exports of gold, and imports of petroleum products, cement, and fertilizers. 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 was no significant mineral trade between the United States and Mali.

Mali's gold exports in 1990 were worth about \$63 million or about 21% of the country's total exports. Gold was the third largest export commodity behind cotton and livestock, exports of which were worth about \$125 million and about \$75 million, respectively, in 1989, the latest year for which data were available.

Mali was entirely dependent on imports for the country's petroleum products needs. In 1989, the latest year for which data were available, these imports amounted to about 1.2 Mbbbl, worth about \$65 million, or about 13% of total imports.

## STRUCTURE OF THE MINERAL INDUSTRY

Mali's formal mining sector was dominated by gold production from two gold mines. There was also gold production by semi-industrial operations and artisanal miners. Gypsum, marble, phosphate, and



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

(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>                     | 1986      | 1987             | 1988             | 1989 <sup>a</sup>  | 1990 <sup>c</sup>  |       |
|--|-----------|------------------|------------------|--------------------|--------------------|-------|
| Cement, hydraulic                          | 20,000    | 22,000           | 25,000           | 20,000             | 20,000             |       |
| Gold: Mine output, Au content <sup>3</sup> | kilograms | <sup>a</sup> 725 | <sup>a</sup> 950 | <sup>a</sup> 2,650 | <sup>a</sup> 3,000 | 5,200 |
| Phosphate rock <sup>c</sup>                | 3,452     | 8,092            | 10,000           | 10,000             | 10,000             |       |
| Salt <sup>c</sup>                          | 4,500     | 4,500            | 4,500            | <sup>a</sup> 5,000 | 5,000              |       |
| Stone: Marble                              | 750       | 200              | 155              | 155                | 160                |       |
| Gypsum <sup>c</sup>                        | 300       | 600              | 720              | 700                | 700                |       |
| Silver <sup>c,5</sup>                      | kilograms | 31               | 34               | 50                 | <sup>a</sup> 40    | 110   |

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

<sup>1</sup>Includes data available through Dec. 15, 1991.

<sup>2</sup>In addition to the commodities listed, Mali produced clay, 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 30% of the total output in 1986; 35% in 1987; 18% in 1988; 13% in 1989, and 8% in 1990. The Syama Mine began gold production in 1990 and accounted for about 42% of the total output for the year.

<sup>4</sup>Reported figure.

<sup>5</sup>Estimated output from Kalana Mine only (1986-89), and for the Kalana and Syama Mines in 1990.

TABLE 2  
MALI: STRUCTURE OF THE MINERAL INDUSTRY

(Metric tons unless otherwise specified)

| Commodity            | Major operating companies                                    | Location of main facilities                                     | Annual capacity     |
|----------------------|--|---|---------------------|
| Cement               | Société des Ciments du Mali                                  | Cement plant at Diamou, about 50 kilometers southeast of Kayes  | 50,000 <sup>c</sup> |
| Gold, fine kilograms | Société de Gestion et d'Exploitation des Mines d'O de Kalana | Kalana underground mine, 110 kilometers southwest of Bougouni   | 600                 |
| Do.                  | Société des Mines de Syama                                   | Open pit gold mine at Syama, 75 kilometers southwest of Sikasso | 2,240               |
| Gypsum               | Plâtre de Tessalit,  | Gypsum mine near Tessalit, 450 kilometers north of Gao          | 1,000 <sup>c</sup>  |
| Marble               | Marbre de Sélinkégni   | Marble quarry at Sélinkégni, 80 kilometers southeast of Kayes   | 200 <sup>c</sup>    |
| Phosphate            | Phosphates du Telemsi  | Tamaguilelt Mine, 205 kilometers north of Ansongo               | 25,000 <sup>c</sup> |
| Salt                 | Sel gemme de Taoudénit                                       | Taoudénit salt mine, near Taoudenni                             | 6,000 <sup>c</sup>  |

<sup>c</sup>Estimated.

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 industry employs approximately 1,100 persons, of whom about 500 are employed by the gold mines. The number of artisanal miners, many of whom

work only part-time, is not known, but is estimated to be in the range of 6,000 to 8,000 persons.

## COMMODITY REVIEW

### Metals

A mining agreement was signed in early 1989 between Mali and BHP-Utah Interna-

tional Inc. for the development of the Syama gold deposit. Mining started toward yearend at Syama after further construction work and ore reserve delineation. The deposit is about 75 km southwest of Sikasso. The first gold was poured in January 1990, and the mine was formally inaugurated on April 19. The Syama deposit has minable open pit reserves of oxide and sulfide ore, and deep sulfide reserves that would require under-

ground mining. The oxide reserves were sufficient for a 3-year operation, using a carbon-in-leach circuit to treat 2,000 mt/d. Planned gold output was about 2,200 kg/a, contained in doré; output for the first 12 months was about 2,400 kg.

A production decision for the sulfide reserves at Syama was expected early in 1991. Initial mining of the sulfide reserves would be by deepening the existing oxide ore pit, with the possibility of going underground at a later stage. Because of the need to roast the sulfide ore, a significant factor in the decision was expected to be the high cost of fuel in Mali.

### Reserves

Mali is a well-mineralized country. 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. There is, in addition, a modest amount of oxide ore in some small satellite deposits. Below the oxide ore, there are reserves of open pit minable mixed oxide-sulfide and sulfide ore of 2.5 Mmt grading 5.5 g/mt of gold. Indicated deep sulfide ore reserves, which would require underground mining, are 4.5 Mmt grading 7.2 g/mt of gold.

Published reserves at the Kalana Mine at yearend 1984, when mining commenced, were approximately 1 Mmt grading 36 g/mt of gold.<sup>2</sup> The ore consists of a number of largely subparallel quartz veins that have proven to have more variable grades than originally indicated. Gold output, totaling about 2,300 kg from the mine's startup at yearend 1984 through yearend 1990, has been much less than expected. Reserves are presently estimated by the company to be about 1.7 Mmt grading 15 g/mt of gold. The Kalana concession is believed to have potential for additional reserves. 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 COFRAMINES of France, 49%; was formed to exploit the property. The economic viability of the deposit had not been demonstrated as of yearend 1990.

Mali's phosphate resources are in the southeast part of the country and have been delineated only for the Tamaguilelt deposit, which is being mined. According to the Government, reserves of this deposit total about 10 Mmt grading 31.4%  $P_2O_5$ . The potential of this region for additional reserves is high; reportedly, the phosphate-bearing formation can be traced for more than 400 km along strike.

Mali has large deposits of limestone and dolomite, some of which are suitable for cement and others which are suitable for ornamental stone (marble). Most of the deposits are uneconomical because of a lack of transport infrastructure or local markets. The cement plant at Diamou exploits the Gangontéry I deposit. According to the Government, the deposit had reserves of about 7 Mmt of limestone at the time the cement plant started production in 1969. About 500,000 tons have been mined to date. There is an additional deposit nearby, reportedly of somewhat lower quality, that has proven plus probable reserves totaling almost 60 Mmt. The Sélinkégni marble deposit has approximately 10.5 Mmt of reserves suitable for marble aggregate and tile, or for lime manufacturing.

The In Kereit gypsum deposit near Tessalit is being exploited on a small scale. According to Société Nationale des Ressources Minières du Mali (SONAREM), the reserves of this deposit are approximately 370,000 tons. At Taoudéni, about 35 Mmt of gypsum have been delineated in evaporite beds. This area is also being exploited for salt, reserves of which are estimated to total 53 Mmt.

Mali has a number of iron ore deposits, most of which are in western Mali and most of which are low grade. The best known of these is the Balé deposit, 200 km west-northwest of Bamako, just north of the Guinea border. According to SONAREM, the Balé deposit has a resource of 146 Mmt grading 50% to 60% iron, within a larger inventory of lower grade material.

According to SONAREM, 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. Exploitation of this deposit will only be conceivable at such time as the Tambao deposit, 120 km to the southwest in Burkina Faso, becomes economic. However, development of Tambao faces major infrastructural problems.

Western Mali contains a number of low-to medium-grade bauxite deposits. Tonnes range from 10 to 580 Mmt, and grades typically are in the range of 20% to 48% alumina. None of these is currently economic, especially in light of higher grade deposits in Guinea.

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 had 15,700 km of highways in 1990, of which about 1,700 km were paved. The railroad and the major roads into Côte d'Ivoire are used to import mineral commodities, particularly fuels.

Mali's electrical generating capacity was 92 MW in 1989, the latest year for which data were available. 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. Mali's electricity production was 165 Mkw h in 1989. 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 had their own diesel generators; fuel for these was a major component of mining costs at both mines. Work was in progress to link the Kalana Mine to the Sélingué power grid.

## OUTLOOK

Mali's mineral industry will continue to be dominated by the production of gold, and the potential for discovery and development of additional gold deposits is high. 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 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 CFAF272.26=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.

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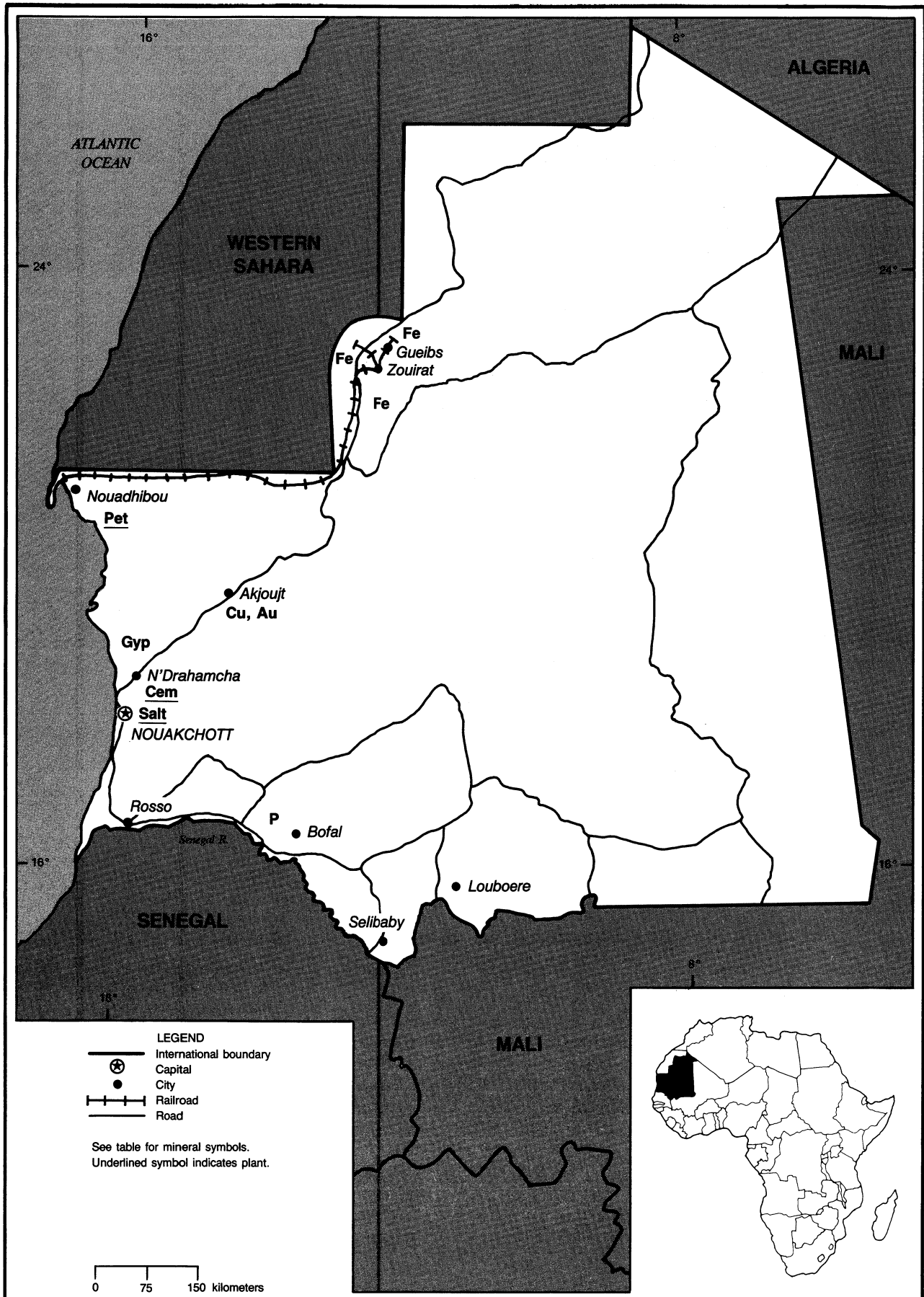
Kati, République du Mali



# MAURITANIA

AREA 1,030,700 km<sup>2</sup>

POPULATION 1.9 million



# THE MINERAL INDUSTRY OF MAURITANIA

By Bernadette Michalski

**I**ron ore production is the dominant mineral industry in Mauritania, competing with the fishing industry as the nation's leading source of income. Each industry accounts for more than one-third to just under one-half of the nation's foreign exchange earnings, with the lead position fluctuating from year to year with the variations in the world market price for iron ore. Cement, gypsum, and salt are also produced. Interest continued in the resumption of copper and gold mining near Akjoujt. This deposit was mined between 1970 and 1978, but reopening was postponed from a targeted 1989 to a 1991 startup date.

Mauritania's external debt service obligations substantially exceeded payment ability. Public and private investment programs focused on fisheries, iron ore mining, intensified hydrocarbon exploration, and infrastructure development.

## GOVERNMENT POLICIES AND PROGRAMS

The Government's new economic plan covering the period between 1989 and 1991 projected an annual growth rate of 3.5% by essentially continuing the economic reforms instituted in 1985. The real growth in GDP for 1990 was estimated at 4% by the World Bank.

## PRODUCTION

Iron ore continued to be Mauritania's principal mineral commodity, with 1990 output reported at 11.4 Mmt compared with 12.11 Mmt in the previous year. Iron ore production from the Guelb deposit was below expectations due to severe technical problems at the beneficiation plant.

Evaporated salt is derived from the coastal lagoons north of Nouakchott, principally for the fishery industry.

## TRADE

Mauritania's mineral export commodities are iron ore and small quantities of gypsum and plaster products. Iron ore ex-

ports in 1989 were reported at 11.14 Mmt and slightly higher in 1990 at 11.36 Mmt. The bulk of export shipments was to the steel mills of the EC. Leading importers were Belgium/Luxembourg, France, Italy, Spain, and the United Kingdom. Operations at the country's sole petroleum refinery recommenced in late 1987 using crude oil supplied by Algeria. Product imports in 1989 were 1.13 Mtbl and accounted for 43% of consumption in that year; the remainder was supplied from the refining of imported crude oil.

## COMMODITY REVIEW

### Metals

**Copper.**—Development of copper deposits at Guelb Moghreïn, 4 km west of Akjoujt, was scheduled to commence in late 1989. However, contract negotiations continued, and financing had not yet been secured. The deposits contain 100 Mmt of ore averaging 2.25% copper and 1.17 g/mt gold.

**Gold.**—Gold recovery operations from the Akjoujt copper mine were scheduled to commence in mid-1991 by Mines d'Or d'Akjoujt (MORAK). The principal shareholders in the venture are Société Arabe des Mines de L'Inchiri (SAMIN) at 45% equity and Minproc Holdings of Australia at 42.5% equity. Investment capital 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. Gold output is expected to exceed 1,000 kg/a.

**Iron ore.**—Iron ore mining operations were conducted by Comptoir Minier du Nord on behalf of Société Nationale Industrielle et Minière Société d'Economie Mixte (SNIM-SEM) in northwestern Mauritania. Mine development initially focused on the surface hematite deposits at Rouessa and the massive hematite deposits at Tazadit, both in the Kedia d'Idjill region. Since 1984, a growing share of Mauritanian output has been the low-grade magnetite ore from the El Rhein Mine in the desert plains known as the Guelbs. The ore

beneficiation plants designed and constructed to process the low-grade magnetite ores of the Guelbs employed a largely untested dry enrichment process involving magnetic separation. However, heavy dust buildup and the rapid abrasion on mechanical parts due to the quartzite present in the ore required major plant modifications. Only one of the two beneficiation plants operated in 1990. Planned output from the Guelbs deposits was revised downward from 6 Mmt/a of concentrates to 2 Mmt/a.

Additional hematite reserves were discovered in 1989 in the Kedia d'Idjill region at M'haoudat, 60 km from Zouirat. A feasibility study was completed in May 1990. While SNIM-SEM had announced that all financing had been secured for the \$140 million project, participation by the Kuwait Fund for Arab Development was unlikely considering Mauritania's support for Iraq during its invasion of Kuwait.

### Industrial Minerals

**Gypsum.**—Production was derived from the N'Drahamcha quarry, 50 km northeast of Nouakchott. The quarry was owned and operated by the Société Arabe des Industries Metallurgiques Maritano-Koweïtiennes (SAMIA). While capacity was reported at 120,000 mt/a, actual output was dictated by the local market, and demand was estimated at 20,000 tons. Most of the output was processed into plaster, and additional amounts were used in the production of concrete blocks.

**Phosphate.**—The resources identified at Bofal and Loubboira in southern Mauritania were estimated at 120 to 150 Mmt of phosphate rock averaging 20% P<sub>2</sub>O<sub>5</sub>. The remote deposit requires high infrastructure development costs; however, the Mauritanian Government announced plans to commence mining by mid-decade.

### 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.

TABLE 1

**MAURITANIA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>**

| Commodity <sup>2</sup>      |                            | 1986   | 1987   | 1988   | 1989 <sup>p</sup> | 1990 <sup>e</sup> |
|-----------------------------|----------------------------|--------|--------|--------|-------------------|-------------------|
| Cement <sup>3</sup>         | metric tons                | —      | 80,000 | 90,000 | 90,000            | 90,000            |
| Gypsum                      | do.                        | 18,060 | 19,402 | 6,000  | 6,400             | 8,000             |
| Iron and steel:             |                            |        |        |        |                   |                   |
| Iron ore:                   |                            |        |        |        |                   |                   |
| Gross weight                | thousand tons              | 8,929  | 9,000  | 10,004 | 12,110            | 11,420            |
| Iron content <sup>e</sup>   | do.                        | 5,840  | 5,850  | 6,500  | 7,150             | 7,000             |
| Metal: Semimanufactures     | metric tons                | 5,512  | 5,465  | NA     | NA                | NA                |
| Petroleum refinery products |                            |        |        |        |                   |                   |
|                             | thousand 42-gallon barrels | —      | 300    | 2,000  | 1,515             | 2,000             |
| Salt <sup>e</sup>           | metric tons                | 5,500  | 5,500  | 5,500  | 5,500             | 5,500             |

<sup>e</sup>Estimated. <sup>p</sup>Preliminary. <sup>r</sup>Revised. NA Not available.

<sup>1</sup>Table includes data available through Sept. 1, 1991.

<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.

TABLE 2

**MAURITANIA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990**

(Thousand metric tons unless otherwise specified)

| Major commodity           | Major operating companies                      | Location of main facilities  | Annual capacity |
|---------------------------|--|------------------------------|-----------------|
| Cement                    | Societe Ciment de Mauritanie                   | N'Drahamcha                  | 60              |
| Copper                    | Societe Arab Miniere d'Inchiri                 | 4 kilometers west of Ajkoudj | 65              |
| Gypsum                    | Societe Arabe des Industries Metallurgiques    | N'Drahamcha                  | 120             |
| Iron ore                  | Societe Nationale Industrielle et Miniere      | Kedia d'Idjill               | 9,000           |
| Do.                       | do.  | Guelbs                       | 4,000           |
| Petroleum products        |  |                              |                 |
| million 42-gallon barrels | Societe Mauritanienne d'Industrie de Raffinage | Nouadhibou                   | 7               |

**Refining.**—Mauritania's sole refinery was owned by the Société Mauritanienne d'Industrie de Raffinage (SOMIR) at Nouadhibou. The 20,000-bbl/d-capacity refinery, designed to process Algerian crude oil, was closed from 1983 to 1987 owing to financial and technical difficulties. After completion of a \$30 million renovation program funded by Algeria, the refinery reopened in September of 1987 under the technical management of Naftal, an Algerian oil corporation. The Nouadhibou refinery supplied most of the country's consumption requirements for refined products, about 8,000 bbl/d in 1990.

**RESERVES**

Information of reserves is limited to copper, gold, iron ore, and phosphate rock. 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-SEM.

**INFRASTRUCTURE**

Mauritania enjoyed a number of advantages over most iron ore exporters, including the close proximity of the Western European markets and a port that can accommodate ships of 120,000 to 150,000

dwt. Iron ore is carried 670 km to the port at Nouadhibou by unit trains of up to 220 cars, each car having a capacity of 80 tons, and hauled by up to five diesel electric locomotives. The railroad cars are discharged via a rotary dump unit into an underground receiving pit, from which ore is transferred to crushing and screening facilities and to the stockyard. Stored ore can be blended prior to ship loading. The shiploader was rated at 4,000 mt/h with a 22-m outreach. Water depth at the port is 17.5 m, and the maximum vessel size that can be accommodated for loading is 150,000 dwt.

TABLE 3

**MAURITANIA: RESERVES OF MAJOR MINERAL COMMODITIES FOR 1990**

(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 at 3 to 5 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% P2O5.   |

**OUTLOOK**

Existing and proposed mining operations suggest an improved outlook for the nation's economy. Fortunes are, however, largely dependent upon the successful development of the M'haoudat iron ore project and the resolution of the technical difficulties at the Guelbs beneficiation plants. The ultimate success of these projects is dependent upon

favorable world iron ore prices.

Development of the mineral industry is jeopardized by political instability as evident by the November 27, 1990, coup attempt. Border disputes have not been resolved; consequently, iron ore mining activities near the Western Sahara border could be interrupted, and border tensions with Senegal may delay phosphate rock deposit development.

Financial support under these conditions remains limited. In addition, Mauritania's support of Iraq during the Kuwait invasion placed financial aid from Saudi Arabia and Kuwait in jeopardy.

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<sup>1</sup>Where necessary, values have been converted from Mauritanian ouguiya (UM) to U.S. dollars at the rate of UM81.61=US\$1.00.

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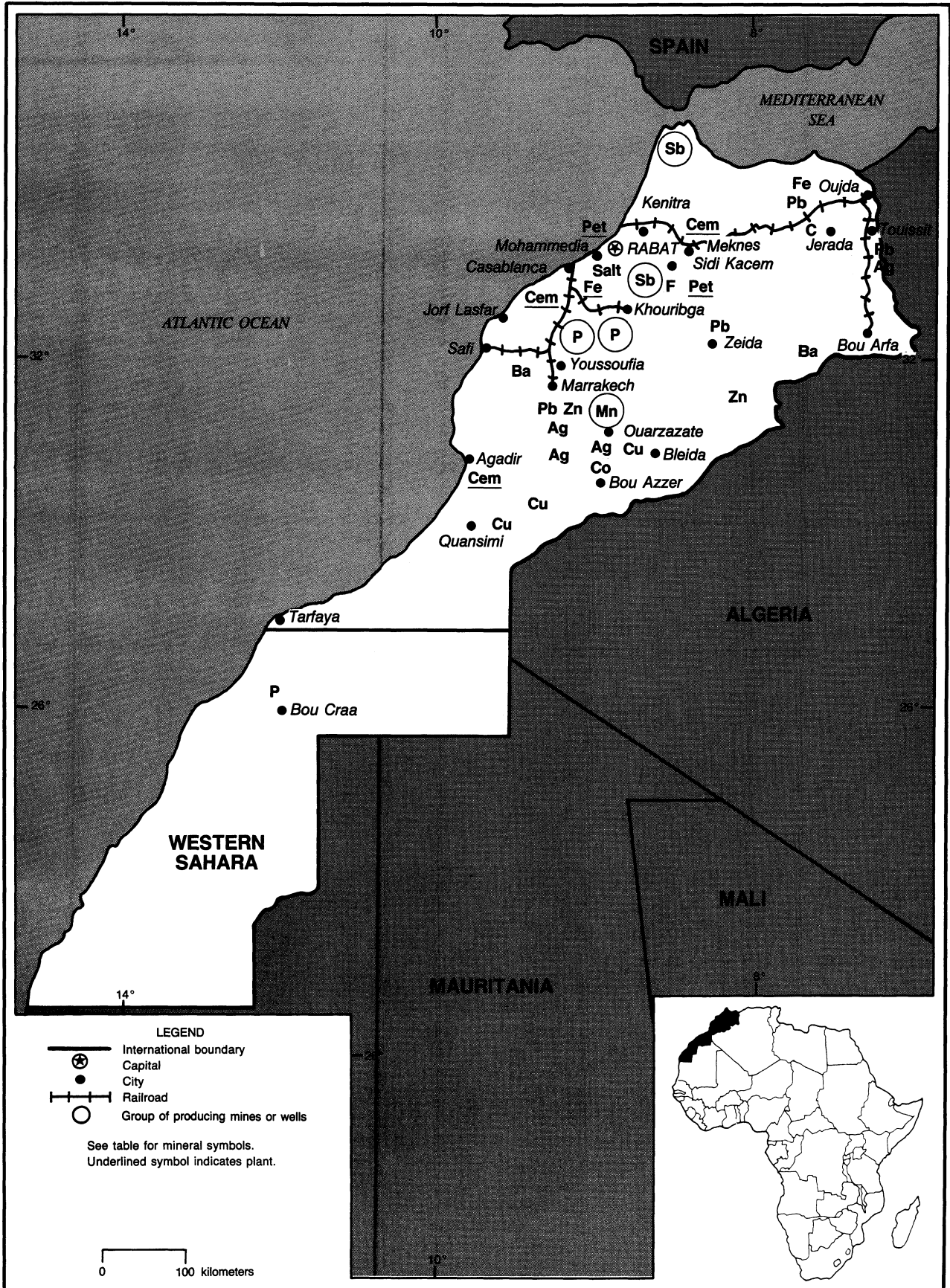
Société Nationale Industrielle et Minière  
Société d'Economie Mixte (SNIM-SEM)  
P.O. Box 42  
Nouadhibou, Mauritania  
Phone 2222-45-170  
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# MOROCCO AND WESTERN SAHARA

AREA 446,550 km<sup>2</sup>

POPULATION 25.6 million



# THE MINERAL INDUSTRY OF MOROCCO AND WESTERN SAHARA

By Thomas P. Dolley

**T**he mineral industry of the Kingdom of Morocco remained a major source of revenue despite the economic and political impact generated by Iraq's invasion of Kuwait. Remittances from wages earned by Moroccan workers abroad exceeded revenues generated from phosphate industry exports in 1990. These remittances were the most important source of foreign exchange earnings for Morocco in 1990, an extraordinary development for a nation where the mining and processing of phosphate rock and fertilizers is normally the major revenue-generating industry. Moroccan mineral production for 1990 had an estimated value of \$820 million<sup>1</sup> or about 4.5% of the GDP. Additionally, the mining sector contributes approximately 40% to 50% of Moroccan exports by value.

In 1990, Morocco felt the economic repercussions associated with Iraq's invasion of Kuwait. Particularly evident was the ever increasing hydrocarbon import bill. The major cost increase in the second half of the year was in the transportation sector following the Government's decision to raise retail fuel prices by approximately 15% in October 1990 as a result of the increased cost of crude oil imports. The increase in global oil prices added significantly to the 22% overall increase in the cost of Morocco's imports. However, economic performance in the second half of 1990 was better than expected notwithstanding the Persian Gulf scenario. Exports increased approximately 21% compared with those of the same period in 1989, owing to improved sales of phosphoric acid. The phosphoric acid sales dispute with India in 1989 was settled and sales resumed but at a decreased price. Initially anticipating poorer economic performance, the Government recorded a current account deficit of \$210 million in 1990. After declining economic performance in 1989, the current account deficit for 1990 was buoyed by increases in merchandise exports and revenue from tourism.

Approximately 5 million Moroccan workers had passed through Spain on their

way to employment in Europe in 1990. A 44% increase in workers' remittance inflows contributed significantly to improved balance of payments performance. Morocco's balance of payments improved owing to international lenders such as the Paris and London Club granting debt reschedulings along with increased financial assistance from several Arab Gulf countries. These actions also helped reduce the negative impact of higher prices for imported crude oil.

## GOVERNMENT POLICIES AND PROGRAMS

Current mining legislation in Morocco was based on Mining Code Bill No. 1-73-412 of August 13, 1973. In recent years, Morocco's parastatal Bureau de Recherches et de Participations Minières (BRPM) was particularly interested in attracting increased foreign investment in the mining industry. Therefore, 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 would be considered null and void. In general, the mining law revisions intended to expedite the bureaucratic process. Additionally, if a foreign company determines that a deposit under investigation is uneconomic, it may withdraw from Morocco under no penalty.

By yearend 1990, the Government announced to mining industry officials that mining industry legislation would be changed to reflect increased mine safety and rules for the use of explosives. Details of the legislative changes were not yet available; however, advisement on composition and implementation of the new laws was being sought through international agencies.

In late 1990, the Government submitted to the Parliament the new hydrocarbons code designed to make petroleum exploration more attractive to foreign operators. As of mid-1991 the new law had not been ratified by the Parliament, but the Gov-

ernment hoped that upon ratification the more liberal terms and conditions of the code would stimulate foreign operators to participate.

## PRODUCTION

Mineral production totals rebounded moderately from 1989 totals, but did not match production highs of the middle to late 1980's. This phenomenon was exemplified across the board in base metal and silver production along with other nonfuel and industrial mineral production. Barite, fluorspar, and iron ore mining are exceptions to this phenomenon based on fluctuating production figures for the past 2 to 3 years.

## TRADE

The cost of petroleum imports once again dealt a heavy blow to the Moroccan economy in 1990. Owing to Iraq's invasion of Kuwait, Morocco's oil import bill alone rose to almost \$1 billion. Iraq was Morocco's primary petroleum supplier until the international embargo on oil exports from Iraq. Thus, Morocco's total import bill increased dramatically, as it has since 1987 when import costs totaled \$2.7 billion and increased steadily to \$5.5 billion in 1989. Other petroleum suppliers that filled the gap left by Iraq were Cameroon, Egypt, Gabon, Libya, Saudi Arabia, the United Arab Emirates, and the U.S.S.R. as well as additional purchases on the spot market.

Morocco remained the world's leading exporter of phosphate rock; however, yearend 1990 evidenced declining phosphate rock exports for the country. Phosphate rock exports were down for the second year in a row, a reflection of shifting phosphate rock markets for Morocco. However, Europe remained a major market for Moroccan phosphate. Discussions between Swedish and Moroccan trade officials at yearend 1990 centered on proposals for

swapping Moroccan phosphate to Sweden with Swedish mining technology to Morocco.

## STRUCTURE OF THE MINERAL INDUSTRY

Mining activity in Morocco is controlled by the Government through public-sector companies and parastatals. BRPM is an autonomous public corporation involved directly or indirectly in the majority of Moroccan mining enterprises, excluding hydrocarbons and phosphates. Phosphate mining is managed and controlled by the parastatal Office Cherifien des Phosphates (OCP). Omnium Nord Africaine (ONA), involved in mining and infrastructure projects, remained Morocco's largest private company. ONA's profits for 1990 were \$69.6 million, an increase of almost 14% over 1989 earnings. Private, foreign companies are also active in the country.

Restructuring of the parastatal petroleum company Office National de Recherche & d'Exploitation Petroliere (Onarep) was announced at yearend 1990. The new goal of Onarep will be exploration for hydrocarbons through the encouragement of foreign participation. In the future, drilling and exploitation activities at Onarep will be more limited. Details of the changes were not yet made public.

## COMMODITY REVIEW

### Metals

Metal production in 1990, particularly lead, silver, and zinc, experienced resurgence due in part to the coming on-line of the Douar Hajar polymetallic mine owned by Compagnie Minière des Guemassa (CMG). Located approximately 30 km south of Marrakech, the mine produces lead, zinc, copper, silver, and sulfur. Base metal production at Douar Hajar is slated to increase to 2,000 tons per day by 1992, with further increases in the future.

El Heimer is located approximately 20 km southeast of Oujda in northeastern Morocco and is the site of the only operating lead smelter in North Africa. Another lead smelter located in Tunisia is closed. The smelter at El Heimer is operated by Société des Fonderies de Plomb de Zellidja (PZ), with PZ equity ownership of 20% by Compagnie Minière de Touissit (CMT), 26% BRPM, and 51% ONA. Production

capacity at the El Heimer smelter is 100,000 mt/a of Pb-Zn and associated metals of which 68,000 tons is 99.9% Pb. CMT provides approximately 60,000 mt/a of Pb concentrate to the smelter.

Roasted concentrates from CMT are smelted using imported coke, and separate recovery of zinc, copper, antimony, and silver is achieved. The smelting process begins with the Pb concentrate being initially roasted at a temperature of 980°C in order to volatilize the sulfur contained in the concentrate. The roasted concentrate is then placed in the smelter and heated to 1,200°C along with the addition of imported coking coal. Imported coke is supplied to the El Heimer smelter at a rate of 13,000 mt/a. The metals zinc, copper, antimony, and silver are recovered in secondary circuits, facilitated by overhead crane-driven crucibles. Finished products include approximately 9,300 mt/a of zinc, 3,000 mt/a of cupreous matte, 500 mt/a of antimony, and 40 mt/a of silver. Primary destinations for the lead and silver are in Europe.

### Industrial Minerals

**Phosphate Rock.**—Phosphate rock and downstream fertilizer production rebounded in 1990, but production was still far below the landmark production year of 1988. The phosphoric acid dispute with India in 1989 was resolved, but at a lowered profit margin for Morocco.

Phosphate rock is mined in several regions of Morocco; however, the most actively mined area is the Khouribga region. Khouribga represents the single largest producing phosphate mine in the world. In any given year, the two open pit mining operations at Khouribga account for approximately 50% of all phosphate rock mined in Morocco. An additional underground mine at Khouribga, plagued by low recovery and high cost, was to be closed down by yearend 1991.

Bone phosphate of lime (BPL) is defined as the amount of  $P_2O_5$  in phosphate rock multiplied by a factor of 2.184 to convert to the equivalent BPL. Khouribga phosphate ore frequently grades higher than 70% BPL, with 63% BPL being considered low-grade ore. Three beds of phosphate rock are mined at Khouribga. The grades are 63% BPL, 68% BPL, and 70% BPL. The lithology is Cretaceous to Tertiary in age containing both marine and terrestrial fossils. Overburden of approximately 40 m thickness must first be removed to expose the phosphate rock to be mined. Dragline

stripping and nitrate explosives are used to facilitate the overburden removal process. The phosphate ore is removed from the working face in the open pit by electric shovel and then placed in haulage dump trucks by front-end loaders. The ore is then trucked to a series of conveyor belt systems totaling 100 km in length throughout the mine area. The conveyor system then transports the ore to various washery or calcination plants. A significant portion of the 70% BPL rock is transported to the Port of Jorf Lasfar and loaded onto waiting ships for export. Not only a port and bulk phosphate loading quay, Jorf Lasfar represents one of the most totally automated and efficient phosphoric acid ( $H_3PO_4$ ) and fertilizer plants in the world. Globally, it is the largest plant of its kind and produces diammonium phosphate and triple superphosphate fertilizers. The plant was completely designed and built by OCP, with construction spanning 1982-86. The plant annually produces an average of 4.4 Mmt of  $H_3PO_4$  for export, and one-third of the total annual phosphate rock production in any given year arrives by train for processing. Further expansions of the facility are planned, including additions for recovery of uranium oxide ( $U_3O_8$ ) from phosphate ores; however, an overabundance of uranium oxide on the world market may preclude this development for some time.

**Salt.**—Société de Sel de Mohammedia (SSM), which is 100% owned by BRPM, manages the exploitation of salt at a mine approximately 10 km east of Mohammedia. This 16-year-old underground mine is one of the largest salt producers in Africa. It is the largest salt mine in Morocco and has a production capacity of 1 Mmt/a. Probable salt reserves are estimated at 600 Mmt. Officials at the mine stated that the salt deposit is Triassic in age, probably transgressively deposited in a shallow sea where blocked seawater could not return to the ocean. Tectonic activity later folded the salt and recrystallized it to a 98.9%-pure form. Clay was also remobilized in some places with the salt. The salt deposit reaches a thickness of 80 m in some places in the mine and rests on a basalt basement. However, mine planning only allows for removal of the bottom 7 m of salt, resulting in a stable roof for the mine. Entrance to the mine is by a shaft to a depth of 460 m. Room-and-pillar mining is the technique employed, with the salt being blasted by explosives and scooped to a conveyor belt system to primary and secondary crushers

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

(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>                         | 1986                | 1987    | 1988    | 1989 <sup>p</sup>   | 1990 <sup>e</sup>    |
|--|---------------------|---------|---------|---------------------|----------------------|
| <b>METALS</b>                                  |                     |         |         |                     |                      |
| Antimony concentrate:                          |                     |         |         |                     |                      |
| Gross Weight                                   | 1,468               | 1,058   | 555     | 316                 | <sup>3</sup> 426     |
| Sb content                                     | 617                 | 444     | 250     | 142                 | <sup>3</sup> 192     |
| Cobalt concentrate:                            |                     |         |         |                     |                      |
| Gross weight                                   | —                   | 2,113   | 2,384   | 1,144               | <sup>3</sup> 1,830   |
| Co content                                     | —                   | 224     | 253     | 121                 | <sup>3</sup> 194     |
| Copper:  |                     |         |         |                     |                      |
| Concentrates, gross weight                     | 58,707              | 46,251  | 41,001  | 44,033              | <sup>3</sup> 45,332  |
| Matte, gross weight                            | 1,349               | 2,441   | 2,981   | 2,126               | <sup>3</sup> 52,322  |
| Cu content, concentrates and matte             | 20,165              | 16,541  | 15,396  | 15,988              | 16,411               |
| Iron and steel:                                |                     |         |         |                     |                      |
| Iron ore:                                      |                     |         |         |                     |                      |
| Gross weight                                   | 195,600             | 210,200 | 114,209 | 175,600             | <sup>3</sup> 147,825 |
| Fe content                                     | 123,228             | 128,100 | 69,668  | 107,116             | 90,173               |
| Metal:   |                     |         |         |                     |                      |
| Pig iron <sup>e</sup>                          | 15,000              | 15,000  | 15,000  | 15,000              | 15,000               |
| Steel, crude <sup>e</sup>                      | 6,000               | 6,000   | 7,200   | 7,200               | 7,200                |
| Lead:  |                     |         |         |                     |                      |
| Concentrate:                                   |                     |         |         |                     |                      |
| Gross weight                                   | 104,398             | 105,090 | 100,221 | 93,513              | <sup>3</sup> 95,529  |
| Pb content                                     | 76,211              | 75,665  | 72,159  | 67,329              | <sup>3</sup> 68,781  |
| Cupreous matte, Pb content                     | 351                 | 635     | 775     | 553                 | <sup>3</sup> 604     |
| Metal:   |                     |         |         |                     |                      |
| Smelter, primary only                          | 60,000              | 62,500  | 68,410  | 63,676              | <sup>3</sup> 64,512  |
| Refined:                                       |                     |         |         |                     |                      |
| Primary  | <sup>e</sup> 60,000 | 62,497  | 68,410  | <sup>e</sup> 63,000 | 64,000               |
| Secondary <sup>e</sup>                         | 2,000               | 2,000   | 2,000   | 2,000               | 2,000                |
| Total <sup>e</sup>                             | 62,000              | 64,497  | 70,410  | 65,000              | 66,000               |
| Manganese ore, largely chemical-grade          | 40,334              | 42,500  | 30,100  | 32,000              | <sup>3</sup> 49,450  |
| Silver:  |                     |         |         |                     |                      |
| Ag content of concentrates and matte kilograms | 61,927              | 61,429  | 57,448  | 50,221              | <sup>3</sup> 53,708  |
| Ag content of mine and smelter bullion do.     | 163,355             | 108,302 | 168,767 | 186,390             | <sup>3</sup> 187,400 |
| Total do.                                      | 225,282             | 169,731 | 226,215 | 236,611             | 241,108              |
| Zinc concentrate:                              |                     |         |         |                     |                      |
| Gross weight                                   | 24,344              | 19,874  | 21,304  | 33,913              | <sup>3</sup> 36,860  |
| Zn content <sup>e</sup>                        | 13,100              | 10,300  | 10,865  | 18,652              | <sup>3</sup> 18,799  |
| <b>INDUSTRIAL MINERALS</b>                     |                     |         |         |                     |                      |
| Barite   | 189,881             | 143,503 | 321,562 | 370,000             | <sup>3</sup> 363,580 |
| Cement, hydraulic thousand tons                | <sup>e</sup> 3,700  | 3,800   | 4,220   | <sup>e</sup> 4,200  | 4,200                |
| Clays, crude:                                  |                     |         |         |                     |                      |
| Bentonite                                      | 3,834               | 2,948   | 3,445   | 3,970               | 4,000                |
| Fuller's earth (smectite)                      | 35,100              | 46,271  | 52,694  | 48,820              | <sup>3</sup> 45,230  |
| Montmorillonite (ghassoul)                     | 4,313               | 4,981   | 4,367   | 4,133               | <sup>3</sup> 4,427   |
| Feldspar <sup>e</sup>                          | 1,000               | 1,000   | 1,000   | 1,000               | 1,000                |
| Fluorspar, acid-grade                          | 83,000              | 78,000  | 100,500 | 105,000             | <sup>3</sup> 86,500  |
| Gypsum <sup>e</sup>                            | 450,000             | 450,000 | 450,000 | 450,000             | 450,000              |
| Mica   | <sup>e</sup> 1,500  | 1,500   | 1,500   | <sup>e</sup> 1,500  | 1,500                |

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>                                    | 1986             | 1987    | 1988                | 1989 <sup>p</sup>   | 1990 <sup>e</sup>    |
|---|------------------|---------|---------------------|---------------------|----------------------|
| <b>INDUSTRIAL MINERALS—Continued</b>                      |                  |         |                     |                     |                      |
| Phosphate rock (includes Western Sahara)<br>thousand tons | 21,178           | 21,300  | 25,015              | 18,067              | <sup>3</sup> 21,396  |
| Salt, rock  | 96,514           | 107,838 | 132,661             | 89,075              | <sup>3</sup> 124,909 |
| <b>MINERAL FUELS AND RELATED MATERIALS</b>                |                  |         |                     |                     |                      |
| Coal, anthracite<br>thousand tons                         | <sup>e</sup> 775 | 634     | 637                 | 504                 | <sup>3</sup> 526     |
| Gas, natural:   |                  |         |                     |                     |                      |
| Gross<br>million cubic meters                             | 91               | 74      | 83                  | 62                  | 62                   |
| Marketed <sup>e</sup><br>do.                              | 57               | 57      | 57                  | 57                  | 57                   |
| Petroleum:  |                  |         |                     |                     |                      |
| Crude<br>thousand 42-gallon barrels                       | 176              | 145     | 151                 | 102                 | 114                  |
| Refinery products: <sup>e</sup>                           |                  |         |                     |                     |                      |
| Distillate fuel oil<br>do.                                | 9,500            | 9,500   | <sup>3</sup> 14,454 | <sup>3</sup> 15,968 | 16,000               |
| Gasoline<br>do.   | 3,300            | 3,300   | <sup>3</sup> 2,769  | <sup>3</sup> 2,897  | 2,800                |
| Jet fuel<br>do.   | 1,500            | 1,500   | <sup>3</sup> 1,640  | <sup>3</sup> 1,684  | 1,680                |
| Kerosene<br>do.   | 750              | 750     | <sup>3</sup> 347    | <sup>3</sup> 386    | 380                  |
| Other<br>do.  | 2,100            | 2,100   | 2,100               | 2,100               | 2,100                |
| Refinery fuel and losses<br>do.                           | 1,500            | 1,500   | 1,500               | 1,500               | 1,500                |
| Residual fuel oil<br>do.                                  | 13,000           | 13,000  | 13,000              | 13,000              | 13,000               |
| Total<br>do.  | 31,650           | 31,650  | 35,810              | 37,535              | 37,460               |

<sup>e</sup>Estimated. <sup>p</sup>Preliminary.<sup>1</sup>Includes data available through May 8, 1991.<sup>2</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>3</sup>Reported figure.<sup>4</sup>Includes the following types of concentrates: Copper (42,137 tons at 35% Cu); gold-silver-copper (3,195 tons at 9.9% Cu, 105.3 grams per ton Au, 770 grams per ton Ag).<sup>5</sup>Cupreous matte containing 58% Cu, 26% Pb, 1,500 grams per ton Ag.<sup>6</sup>Contained in copper concentrates and matte identified in 3/ and 4/ above and in lead concentrates (95,529 tons at 500 grams per ton Ag).<sup>7</sup>Contained in a presumably mine-produced bullion: 149.4 tons at 98.9% Ag and lead smelter product 41.2 tons at 99.8% Ag.

TABLE 2

**MOROCCO: EXPORTS OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

| Commodity   | 1988   | 1989   | Destinations, 1989 |  |
|---|--------|--------|--------------------|--|
|   |        |        | United States      | Other (principal)                              |
| <b>METALS</b>   |        |        |                    |  |
| Aluminum: Metal including alloys:                                   |        |        |                    |  |
| Scrap   | 2,526  | 1,809  | —                  | France 960; Spain 252; Belgium-Luxembourg 208. |
| Unwrought   | 25     | —      | —                  | —  |
| Semimanufactures  | 157    | 155    | —                  | France 130; Tunisia 25.                        |
| Antimony: Ore and concentrate                                       | 465    | —      | —                  | —  |
| Chromium: Ore and concentrate                                       | 1,400  | 551    | —                  | All to Spain.                                  |
| Cobalt: Ore and concentrate   | 2,148  | —      | —                  | —  |
| Columbium and tantalum: Metal including alloys, all forms, tantalum |        |        |                    |  |
|   | —      | 1      | —                  | All to Libya.                                  |
| Copper:   |        |        |                    |  |
| Ore and concentrate   | 44,675 | 45,229 | —                  | Spain 35,769; West Germany 7,021.              |
| Oxides  | 1      | —      | —                  | —  |
| Matte and speiss including cement copper                            | 2,738  | 2,647  | —                  | Belgium-Luxembourg 1,971; West Germany 675.    |

See footnotes at end of table.

TABLE 2—Continued

MOROCCO: EXPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity   | 1988     | 1989     | Destinations, 1989 |  |
|---|----------|----------|--------------------|--|
|   |          |          | United States      | Other (principal)  |
| <b>METALS—Continued</b>   |          |          |                    |  |
| <b>Copper:—Continued</b>  |          |          |                    |  |
| Metal including alloys:   |          |          |                    |  |
| Scrap   | 3,312    | 5,323    | —                  | France 2,250; West Germany 1,014; United Kingdom 744.        |
| Unwrought   | —        | 32       | —                  | France 16; United Kingdom 15.                                |
| Semimanufactures  | 88       | 75       | —                  | Spain 73.  |
| <b>Iron and steel:</b>  |          |          |                    |  |
| Iron ore and concentrate including roasted pyrite                             | 84,484   | 86,909   | —                  | Tunisia 49,300; Albania 34,750.                              |
| Metal:  |          |          |                    |  |
| Scrap   | 91,430   | 96,144   | —                  | Spain 52,408; Italy 33,750; Netherlands 8,104.               |
| Pig iron, cast iron, related materials kilograms                              | 180      | —        |                    |  |
| Semimanufactures:   |          |          |                    |  |
| Bars, rods, angles, shapes, sections  | 31       | 1,176    | —                  | Libya 1,172.   |
| Universals, plates, sheets  | 16       | 400      | —                  | Libya 200; Tunisia 199.                                      |
| Wire  | 1        | 28       | —                  | Cameroon 19; Mali 5.   |
| Tubes, pipes, fittings  | 68       | 2,843    | ( <sup>2</sup> )   | Libya 2,023; Tunisia 785.                                    |
| Castings and forgings, rough  | —        | 20       | —                  | All to Switzerland.  |
| <b>Lead:</b>  |          |          |                    |  |
| Ore and concentrate   | 43,487   | 31,663   | —                  | Belgium-Luxembourg 12,109; Spain 10,246; West Germany 3,909. |
| Oxides  | 20       | 20       | —                  | All to Pakistan.   |
| Metal including alloys:   |          |          |                    |  |
| Scrap   | 653      | 72       | —                  | Belgium-Luxembourg 40; France 32.                            |
| Unwrought   | 62,528   | 62,004   | —                  | Italy 25,774; Iraq 16,997; Spain 6,405.                      |
| Semimanufactures  | 1        | 1        | —                  | Mainly to Libya.   |
| Magnesium: Metal including alloys, scrap                                      | 18       | —        |                    |  |
| Manganese: Ore and concentrate, metallurgical-grade                           | 47,371   | 45,873   | 35                 | France 16,921; United Kingdom 9,500; Spain 9,056.            |
| Nickel: Metal including alloys, semimanufactures                              | 3        | —        |                    |  |
| Silver: Metal including alloys, unwrought and partly wrought value, thousands | \$21,970 | \$21,890 | —                  | France \$12,558; Switzerland \$5,343.                        |
| <b>Zinc:</b>  |          |          |                    |  |
| Ore and concentrate   | 23,098   | 35,332   | —                  | Belgium-Luxembourg 19,132; Yugoslavia 6,650; Spain 4,500.    |
| Matte   | 281      | —        |                    |  |
| Ash and residue containing zinc   | 423      | —        |                    |  |
| Blue powder   | 53       | —        |                    |  |
| Metal including alloys, unwrought   | 20       | —        |                    |  |
| <b>Other:</b>   |          |          |                    |  |
| Ores and concentrates   | —        | 2,083    | —                  | China 2,000.   |
| Oxides and hydroxides   | 1        | 2        | —                  | All to France.   |
| <b>INDUSTRIAL MINERALS</b>  |          |          |                    |  |
| <b>Abrasives, n.e.s.:</b>   |          |          |                    |  |
| Natural: Corundum, emery, pumice, etc.  | 148      | —        |                    |  |
| Grinding and polishing wheels and stones                                      | 11       | 2        | 1                  | Mauritania 1.  |
| Asbestos, crude   | 429      | 400      | —                  | All to Tunisia.  |

See footnotes at end of table.

TABLE2—Continued

**MOROCCO: EXPORTS OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

| Commodity  | 1988                       | 1989             | Destinations, 1989 |  |  |
|--|----------------------------|------------------|--------------------|--|--|
|  |                            |                  | United States      | Other (principal)  |  |
| <b>INDUSTRIAL MINERALS—Continued</b>                         |                            |                  |                    |  |  |
| Barite and witherite   | 398,090                    | 358,909          | —                  | Norway 137,950; Venezuela 47,200; United Kingdom 45,900. |  |
| Boron materials: Oxides and acids                            | 2                          | —                |                    |  |  |
| Cement   | 4,100                      | 29,436           | —                  | Algeria 27,305; Spain 2,130.                             |  |
| Chalk  | 75                         | —                |                    |  |  |
| Clays, crude   | 78,902                     | 92,372           | —                  | Spain 46,200; United Kingdom 21,007; Italy 18,000.       |  |
| Feldspar, fluorspar, related materials                       | 89,694                     | 110,578          | 36,540             | Canada 29,700; Norway 21,476.                            |  |
| Fertilizer materials: Manufactured:                          |                            |                  |                    |  |  |
| Phosphatic   | thousand tons              | 1,478            | 1,618              | —  | Belgium-Luxembourg 379; France 266; Italy 117.     |
| Potassic   |                            | —                | 1                  | —  | All to Libya.                                      |
| Unspecified and mixed  |                            | 216,486          | 128,000            | —  | Hungary 30,000; Italy 29,396; Spain 23,000.        |
| Gypsum and plaster   |                            | 203,912          | 239,842            | —  | Cote d'Ivoire 61,300; Spain 45,641; Japan 35,200.  |
| Iodine, elemental  |                            | 2                | <sup>3</sup> 13    | —  | All to Libya.                                      |
| Mica: Crude including splittings and waste                   |                            | 1,862            | 1,121              | —  | All to France.                                     |
| Phosphates, crude  | thousand tons              | 14,260           | 12,426             | 683  | Spain 1,706; Belgium-Luxembourg 1,172; Mexico 926. |
| Pigments, mineral:   |                            |                  |                    |  |  |
| Natural, crude   |                            | 1                | —                  |  |  |
| Iron oxides and hydroxides, processed                        |                            | 18               | —                  |  |  |
| Precious and semiprecious stones other than diamond, natural | value                      | \$300            | —                  |  |  |
| Salt and brine   |                            | 17,050           | 5,682              | —  | Netherlands 5,680.                                 |
| Sodium compounds, n.e.s.: Soda ash, manufactured             |                            | 805              | 632                | —  | Cote d'Ivoire 500; Senegal 132.                    |
| Stone, sand and gravel:                                      |                            |                  |                    |  |  |
| Dimension stone:   |                            |                  |                    |  |  |
| Crude and partly worked                                      |                            | 7,422            | 779                | —  | Italy 551; Portugal 77; Belgium-Luxembourg 55.     |
| Worked   |                            | 432              | 525                | 65   | Singapore 178; Italy 80; Spain 48.                 |
| Gravel and crushed rock                                      |                            | 108,229          | 108,531            | —  | Spain 108,500.                                     |
| Quartz and quartzite   |                            | 1,253            | —                  |  |  |
| Sand other than metal-bearing                                |                            | 68,166           | 79,650             | —  | All to Spain.                                      |
| Sulfur: Sulfuric acid  |                            | 38               | 33                 | —  | Gabon 18; Mauritania 15.                           |
| Talc, steatite, pyrophyllite                                 | kilograms                  | 32               | —                  |  |  |
| Other: Crude   |                            | 2,004            | 35                 | —  | France 21; Saudi Arabia 14.                        |
| <b>MINERAL FUELS AND RELATED MATERIALS</b>                   |                            |                  |                    |  |  |
| Asphalt and bitumen, natural                                 | kilograms                  | 300              | —                  |  |  |
| Coal: Anthracite   |                            | 10,655           | 2,659              | —  | All to France.                                     |
| Peat including briquets and litter                           | value, thousands           | —                | \$1                | —  | All to Libya.                                      |
| Petroleum refinery products:                                 |                            |                  |                    |  |  |
| Gasoline   | thousand 42-gallon barrels | 2,662            | 3,146              | —  | Netherlands 2,442; France 352.                     |
| Mineral jelly and wax  | do.                        | ( <sup>2</sup> ) | —                  |  |  |
| Kerosene and jet fuel  | do.                        | 271              | 288                | —  | All for bunkers.                                   |
| Distillate fuel oil  | do.                        | 255              | 75                 | —  | Mainly for bunkers.                                |
| Lubricants   | do.                        | 342              | 250                | —  | Tunisia 151; Belgium-Luxembourg 64; Italy 23.      |
| Residual fuel oil  | do.                        | 5                | ( <sup>2</sup> )   | —  | Mainly to Tunisia.                                 |
| Bitumen and other residues                                   | do.                        | ( <sup>2</sup> ) | —                  |  |  |
| Bituminous mixtures  | do.                        | —                | ( <sup>2</sup> )   | —  | All to Tunisia.                                    |

<sup>1</sup>Table prepared by Virginia A. Woodson.<sup>2</sup>Less than 1/2 unit.<sup>3</sup>May include bromine and fluorine.

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

(Metric tons unless otherwise specified)

| Commodity   | 1988      | 1989   | Sources, 1989 |  |
|---|-----------|--------|---------------|--|
|   |           |        | United States | Other (principal)                                  |
| <b>METALS</b>   |           |        |               |  |
| <b>Alkali and alkaline-earth metals:</b>  |           |        |               |  |
| Alkali metals   | kilograms | 167    | —             |  |
| Alkaline-earth metals   | do.       | 1      | 4,000         | — Mainly from Spain.                               |
| <b>Aluminum:</b>  |           |        |               |  |
| Ore and concentrate   |           | 5,118  | 10,841        | 2 France 6,091; Guyana 2,300; French Guiana 2,000. |
| Oxides and hydroxides   |           | 3,029  | 2,608         | — France 2,325; West Germany 81.                   |
| <b>Metal including alloys:</b>  |           |        |               |  |
| Scrap   |           | 112    | —             |  |
| Unwrought   |           | 1,717  | 2,151         | — Netherlands 1,353; France 342; West Germany 237. |
| Semimanufactures  |           | 5,422  | 5,620         | (?) France 2,087; Spain 1,416; West Germany 689.   |
| <b>Arsenic:</b>   |           |        |               |  |
| Elemental including tellurium   |           | 5      | —             |  |
| Oxides and acids  |           | 9      | —             |  |
| <b>Beryllium: Metal including alloys, all forms</b>   |           |        |               |  |
|   | kilograms | 70     | —             |  |
| Cesium and rubidium   | do.       | 1      | —             |  |
| <b>Chromium:</b>  |           |        |               |  |
| Ore and concentrate   |           | 4      | 14            | — All from Belgium-Luxembourg.                     |
| Oxides and hydroxides   |           | 32     | 56            | 3 United Kingdom 40; West Germany 9.               |
| <b>Cobalt:</b>  |           |        |               |  |
| Ore and concentrate   | kilograms | 35     | —             |  |
| Oxides and hydroxides   |           | 1      | 1             | — Mainly from France.                              |
| <b>Columbium and tantalum: Metal including alloys, all forms, tantalum value, thousands</b> |           |        |               |  |
|   |           | \$1    | —             |  |
| <b>Copper:</b>  |           |        |               |  |
| Matte and speiss including cement copper  | do.       | —      | \$7           | — All from Hong Kong.                              |
| Oxides and hydroxides   |           | 16     | —             |  |
| Sulfate   |           | 25     | —             |  |
| <b>Metal including alloys:</b>  |           |        |               |  |
| Scrap   |           | 15     | 38            | — All from France.                                 |
| Unwrought   |           | 662    | 761           | — France 420; Italy 190; West Germany 150.         |
| Semimanufactures  |           | 11,549 | 14,753        | — France 7,620; Belgium-Luxembourg 3,369.          |
| <b>Germanium and zirconium: Oxides and hydroxides</b>                                       |           |        |               |  |
|   |           | 60     | —             |  |
| <b>Gold: Metal including alloys, unwrought and partly wrought</b>                           |           |        |               |  |
|   | grams     | 7      | —             |  |
| <b>Iron and steel:</b>  |           |        |               |  |
| <b>Iron ore and concentrate excluding roasted pyrite</b>                                    |           |        |               |  |
|   |           | 48     | —             |  |
| <b>Metal:</b>   |           |        |               |  |
| Scrap   |           | 37     | 82            | — France 42; Spain 39.                             |
| Pig iron, cast iron, related materials  |           | 3,500  | 1,665         | — Brazil 1,151; Canada 258.                        |
| <b>Ferroalloys:</b>   |           |        |               |  |
| Ferroaluminum and silicoaluminum  |           | 16     | —             |  |
| Ferrochromium   |           | 60     | —             |  |
| Ferromanganese  |           | 174    | 122           | — Belgium-Luxembourg 75; Spain 23.                 |
| Ferromolybdenum   |           | 3      | —             |  |
| Ferronickel   |           | 5      | —             |  |
| Ferrosilicomanganese  |           | 12     | —             |  |

See footnotes at end of table.



TABLE 3—Continued

MOROCCO: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity  | 1988    | 1989    | Sources, 1989    |   |
|--|---------|---------|------------------|---|
|  |         |         | United States    | Other (principal)                                     |
| METALS—Continued   |         |         |                  |   |
| Iron and steel:—Continued  |         |         |                  |   |
| Metals:—Continued  |         |         |                  |   |
| Ferroalloys:—Continued   |         |         |                  |   |
| Ferrosilicon   | 197     | 124     | —                | West Germany 57; Norway 40; France 14.                |
| Silicon metal  | 22      | —       | —                | —   |
| Unspecified  | 3       | 102     | —                | Belgium-Luxembourg 45; U.S.S.R. 25.                   |
| Steel, primary forms   | 425,056 | 499,980 | —                | Italy 140,505; Brazil 101,783; Spain 61,722.          |
| Semimanufactures:  |         |         |                  |   |
| Bars, rods, angles, shapes, sections   | 103,160 | 104,427 | ( <sup>3</sup> ) | Spain 21,431; Italy 18,373; France 16,842.            |
| Universals, plates, sheets   | 150,295 | 163,377 | 6,536            | France 39,727; West Germany 28,037; Spain 14,968.     |
| Hoop and strip   | 10,330  | 13,306  | —                | France 7,542; Spain 3,124.                            |
| Rails and accessories  | 14,591  | 14,401  | —                | Canada 9,829; France 4,175.                           |
| Wire   | 18,349  | 21,556  | ( <sup>3</sup> ) | France 11,588; Belgium-Luxembourg 3,023; Spain 2,773. |
| Tubes, pipes, fittings   | 17,125  | 18,214  | 5                | France 10,408; West Germany 2,231; Spain 1,718.       |
| Castings and forgings, rough   | 80      | 483     | 1                | France 428; West Germany 25.                          |
| Lead:  |         |         |                  |   |
| Ore and concentrate  | 6,773   | 36,052  | —                | Canada 31,146; Spain 3,026.                           |
| Oxides   | 445     | 522     | —                | Spain 291; West Germany 90; France 86.                |
| Metal including alloys:  |         |         |                  |   |
| Unwrought  | 282     | 206     | —                | France 113; Netherlands 75.                           |
| Semimanufactures   | 72      | 69      | —                | France 32; Netherlands 19; Portugal 11.               |
| Lithium: Oxides and hydroxides   | 20      | —       | —                | —   |
| Magnesium: Metal including alloys:   |         |         |                  |   |
| Semimanufactures   | 1       | —       | —                | —   |
| Manganese:   |         |         |                  |   |
| Ore and concentrate, metallurgical grade                                     | —       | 42      | —                | All from China.                                       |
| Oxides   | 615     | 721     | —                | Ireland 540; Belgium-Luxembourg 175.                  |
| Mercury value, thousands   | \$43    | \$10    | \$1              | France \$2; Netherlands \$2; Switzerland \$2.         |
| Molybdenum:  |         |         |                  |   |
| Oxides and hydroxides  | 6       | —       | —                | —   |
| Nickel:  |         |         |                  |   |
| Matte and speiss   | 7       | 8       | —                | United Kingdom 6; Canada 2.                           |
| Oxides and hydroxides kilograms  | 4       | —       | —                | —   |
| Metal including alloys:  |         |         |                  |   |
| Unwrought  | 16      | 19      | —                | France 17; Canada 2.                                  |
| Semimanufactures   | 288     | 316     | —                | West Germany 238; Italy 26.                           |
| Platinum-group metals: Metals including alloys, unwrought and partly wrought |         |         |                  |   |
| value, thousands   | \$4     | \$3     | —                | All from France.                                      |
| Rare-earth metals  | 2       | —       | —                | —   |
| Selenium, elemental  | 1       | —       | —                | —   |
| Silicon, high-purity   | 1       | —       | —                | —   |
| Silver: Metal including alloys, unwrought and partly wrought                 |         |         |                  |   |
| value, thousands   | \$150   | \$135   | —                | France \$50; West Germany \$32; Spain \$18.           |
| Tin: Metal including alloys:   |         |         |                  |   |
| Scrap kilograms  | 200     | 1,000   | —                | All from France.                                      |

See footnotes at end of table.

TABLE 3—Continued

MOROCCO: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity  | 1988             | 1989   | Sources, 1989 |  |                               |
|--|------------------|--------|---------------|--|-------------------------------|
|  |                  |        | United States | Other (principal)                                    |                               |
| <b>METALS—Continued</b>  |                  |        |               |  |                               |
| <b>Tin: Metal including alloys:—Continued</b>                                |                  |        |               |  |                               |
| Unwrought  | 122              | 138    | —             | Malaysia 53; Belgium-Luxembourg 20; Brazil 18.       |                               |
| Semimanufactures   | 10               | 11     | —             | Belgium-Luxembourg 3; West Germany 3; France 2.      |                               |
| <b>Titanium:</b>   |                  |        |               |  |                               |
| Ore and concentrate  | 168              | —      |               |  |                               |
| Oxides   | 2,118            | 2,418  | —             | France 1,409; Belgium-Luxembourg 860.                |                               |
| <b>Tungsten:</b>   |                  |        |               |  |                               |
| Ore and concentrate  | value, thousands | \$16   | \$10          | —  | West Germany \$6; France \$4. |
| Metal including alloys, all forms  | kilograms        | 1,144  | —             |  |                               |
| Vanadium: Oxides and hydroxides  | do.              | 20     | —             |  |                               |
| <b>Zinc:</b>   |                  |        |               |  |                               |
| Oxides   | 683              | 628    | —             | France 283; Portugal 218; West Germany 70.           |                               |
| Blue powder  | 97               | —      |               |  |                               |
| <b>Metal including alloys:</b>   |                  |        |               |  |                               |
| Unwrought  | 2,922            | 4,243  | —             | France 1,968; Algeria 1,390; Belgium-Luxembourg 599. |                               |
| Semimanufactures   | 301              | 388    | —             | Belgium-Luxembourg 228; Italy 96.                    |                               |
| <b>Other:</b>  |                  |        |               |  |                               |
| Ores and concentrates  | 22               | 323    | —             | Australia 267; France 55.                            |                               |
| Oxides and hydroxides  | 2                | 168    | 26            | France 81; Belgium-Luxembourg 32.                    |                               |
| Base metals including alloys, all forms                                      | 16               | —      |               |  |                               |
| <b>INDUSTRIAL MINERALS</b>   |                  |        |               |  |                               |
| <b>Abrasives, n.e.s.:</b>  |                  |        |               |  |                               |
| Natural: Corundum, emery, pumice, etc.                                       | 3,435            | 3,817  | —             | Turkey 3,235; Greece 275.                            |                               |
| <b>Artificial:</b>   |                  |        |               |  |                               |
| Corundum   | 380              | 506    | —             | France 372; Italy 80; Austria 36.                    |                               |
| Silicon carbide  | 220              | —      |               |  |                               |
| Dust and powder of precious and semi-precious stones excluding diamond grams | 300              | —      |               |  |                               |
| Grinding and polishing wheels and stones                                     | 379              | 466    | 1             | Italy 210; France 88; Denmark 73.                    |                               |
| Asbestos, crude  | 5,691            | 3,944  | —             | Canada 2,744; Mozambique 1,100.                      |                               |
| Barite and witherite   | 11               | —      |               |  |                               |
| <b>Boron materials:</b>  |                  |        |               |  |                               |
| Crude natural borates  | 1                | 1      | —             | All from France.                                     |                               |
| Elemental  | kilograms        | 58     | —             |  |                               |
| Oxides and acids   | 33               | 20     | —             | West Germany 5; Italy 5; Turkey 3.                   |                               |
| Bromine kilograms  | 230              | *1,000 | —             | Mainly from France.                                  |                               |
| Cement   | 43,660           | 58,741 | —             | Spain 24,416; France 23,154; Italy 5,987.            |                               |
| Chalk  | 697              | 551    | —             | Spain 387; France 119.                               |                               |
| Clays, crude   | 17,940           | 21,824 | 36            | France 13,192; United Kingdom 5,626; Spain 2,181.    |                               |
| Cryolite and chiolite  | —                | 10     | —             | All from Belgium-Luxembourg.                         |                               |
| <b>Diamond, natural:</b>   |                  |        |               |  |                               |
| Industrial stones  | carats           | 17,250 | —             |  |                               |
| Dust and powder  | do.              | 4,000  | —             |  |                               |
| Diatomite and other infusorial earth   | 341              | 416    | 206           | France 146; Spain 58.                                |                               |

See footnotes at end of table.

TABLE 3—Continued

MOROCCO: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity   | 1988    | 1989    | Sources, 1989    |   |
|---|---------|---------|------------------|---|
|   |         |         | United States    | Other (principal)                                     |
| <b>INDUSTRIAL MINERALS—Continued</b>  |         |         |                  |   |
| Feldspar, fluorspar, related materials  | 1,096   | 651     | —                | France 430; Spain 200.                                |
| <b>Fertilizer materials:</b>  |         |         |                  |   |
| Crude, n.e.s.   | 96      | 42      | —                | China 40.   |
| <b>Manufactured:</b>  |         |         |                  |   |
| Ammonia   | 312,878 | 467,478 | 26,028           | U.S.S.R. 303,651; Trinidad and Tobago 44,496.         |
| Nitrogenous   | 331,774 | 299,288 | —                | Romania 80,315; Belgium-Luxembourg 73,445; 60,697.    |
| Phosphatic  | —       | 19      | —                | All from Netherlands.                                 |
| Potassic  | 130,932 | 67,686  | 700              | Spain 22,395; East Germany 22,114; Netherlands 5,015  |
| Unspecified and mixed   | 1,565   | 2,384   | —                | Belgium-Luxembourg 986; France 533; West Germany 419. |
| Graphite, natural   | 20      | 36      | —                | France 30; Spain 6.                                   |
| Gypsum and plaster  | 8       | 238     | —                | France 220; Italy 8.                                  |
| Iodine kilograms  | 485     | —       | —                | —   |
| Lime  | 1,285   | 606     | —                | Spain 600; France 6.                                  |
| Magnesium compounds, unspecified  | 171     | 207     | —                | Spain 126; Austria 68; France 13.                     |
| <b>Mica:</b>  |         |         |                  |   |
| Crude including splittings and waste  | 6       | 10      | —                | All from Norway.                                      |
| Worked including agglomerated splittings  | 2       | 3       | —                | France 2; Spain 1.                                    |
| Nitrates, crude   | 10      | —       | —                | —   |
| Phosphates, crude   | —       | 4       | —                | All from Italy.                                       |
| Phosphorus, elemental   | 8       | —       | —                | —   |
| Pigments, mineral: Iron oxides and hydroxides, processed                        | 1,339   | 1,212   | —                | West Germany 544; Spain 244; United Kingdom 158.      |
| Precious and semiprecious stones other than diamond: Synthetic value, thousands | \$4     | \$8     | —                | All from France.                                      |
| Pyrite, unroasted   | 2       | —       | —                | —   |
| Quartz crystal, piezoelectric kilograms   | 2       | —       | —                | —   |
| Salt and brine  | 2,459   | 19      | —                | Denmark 6; France 6; West Germany 6.                  |
| Sodium compounds, n.e.s.: Soda ash, manufactured                                | 12,702  | 17,620  | ( <sup>2</sup> ) | Spain 12,020; United Kingdom 1,173.                   |
| <b>Stone, sand and gravel:</b>  |         |         |                  |   |
| <b>Dimension stone:</b>   |         |         |                  |   |
| Crude and partly worked   | 1,885   | 2,727   | —                | Italy 2,687.  |
| Worked  | 2,297   | 5,156   | —                | Italy 4,338; Spain 415.                               |
| Dolomite, chiefly refractory-grade  | 499     | 357     | —                | France 317; West Germany 20.                          |
| Gravel and crushed rock   | 1,170   | 656     | 1                | Belgium-Luxembourg 493; France 120.                   |
| Quartz and quartzite  | 569     | 670     | —                | Belgium-Luxembourg 593; Italy 39.                     |
| Sand other than metal-bearing   | 34,787  | 35,038  | —                | Belgium-Luxembourg 27,354; Portugal 3,600.            |
| <b>Sulfur:</b>  |         |         |                  |   |
| <b>Elemental:</b>   |         |         |                  |   |
| Crude including native and byproduct thousand tons                              | 2,925   | 1,095   | 26               | Canada 641; Poland 194.                               |
| Colloidal, precipitated, sublimed   | 4       | 5       | —                | France 4; Netherlands 1.                              |
| Dioxide   | 2       | —       | —                | —   |
| Sulfuric acid   | 1,789   | 11,713  | —                | Spain 22,655.   |
| Talc, steatite, soapstone, pyrophyllite   | 1,914   | 1,482   | —                | France 1,034; Belgium-Luxembourg 157.                 |

See footnotes at end of table.

TABLE 3—Continued

**MOROCCO: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

| Commodity                                     | 1988             | 1989             | Sources, 1989    |  |
|---|------------------|------------------|------------------|--|
|   |                  |                  | United States    | Other (principal)  |
| <b>INDUSTRIAL MINERALS—Continued</b>          |                  |                  |                  |  |
| Vermiculite, perlite, chlorite                | 140              | —                |                  |  |
| <b>Other:</b>                                 |                  |                  |                  |  |
| Crude   | 20,318           | 18,053           | —                | France 23,548; Netherlands 1,953.                        |
| Slag and dross, not metal-bearing             | 20               | —                |                  |  |
| <b>MINERAL FUELS AND RELATED MATERIALS</b>    |                  |                  |                  |  |
| Asphalt and bitumen, natural                  | 170              | 25               | 1                | Italy 21; France 2.                                      |
| Carbon black                                  | 5,702            | 5,200            | 3                | Spain 2,440; Portugal 856; Mexico 845.                   |
| Coal: Anthracite and bituminous thousand tons | 1,018            | 1,278            | 800              | United Kingdom 293; U.S.S.R. 142.                        |
| Coke and semicoke                             | 32,650           | 31,262           | —                | Italy 31,256.  |
| Peat including briquets and litter            | 5,229            | 7,436            | —                | West Germany 6,718; France 481.                          |
| <b>Petroleum:</b>                             |                  |                  |                  |  |
| Crude thousand 42-gallon barrels              | 36,009           | 42,113           | —                | Iraq 22,274; United Arab Emirates 7,483; U.S.S.R. 7,113. |
| <b>Refinery products:</b>                     |                  |                  |                  |  |
| Liquefied petroleum gas do.                   | 2,155            | 2,597            | —                | Algeria 1,656; France 464; Spain 379.                    |
| Gasoline do.                                  | 35               | 59               | —                | Portugal 31; Spain 20.                                   |
| Mineral jelly and wax do.                     | 52               | 80               | —                | Spain 34; France 20; West Germany 18.                    |
| Kerosene and jet fuel do.                     | 1                | 1                | —                | All from Netherlands.                                    |
| Distillate fuel oil do.                       | ( <sup>2</sup> ) | 39               | —                | West Germany 38.   |
| Lubricants do.                                | 42               | 51               | ( <sup>3</sup> ) | France 16; Spain 13; Belgium-Luxembourg 7.               |
| Bitumen and other residues do.                | ( <sup>3</sup> ) | ( <sup>3</sup> ) | —                | All from France.   |
| Bituminous mixtures do.                       | ( <sup>3</sup> ) | ( <sup>3</sup> ) | —                | Mainly from France.                                      |
| Petroleum coke do.                            | 11               | ( <sup>3</sup> ) | —                | All from France.   |

<sup>1</sup>Revised.<sup>1</sup>Table prepared by Virginia A. Woodson.<sup>2</sup>Unreported quantity valued at \$8,000.<sup>3</sup>Less than 1/2 unit.<sup>4</sup>May include iodine and fluorine.

TABLE 4

**MOROCCO: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990**

(Thousand metric tons unless otherwise specified)

| Major commodity | Major operating companies                                    | Location of main facilities | Annual capacity               |
|-----------------|--|-----------------------------|-------------------------------|
| Barite          | Compagnie Marocaine des Barites (COMABAR)                    | Near Marrakech              | 270 (concentrate).            |
| Cobalt          | Compagnie Tifnout Tiranimine (CTT)                           | Bou Azzer                   | 2 (concentrate)<br>150 (ore). |
| Copper          | Société Minière de Bou Saffer (SOMIFER)                      | Bleida                      | 50 (concentrate).             |
| Do.             | Société Minière Marocaine (SOMIMA)                           | Quansimi                    | NA.                           |
| Do.             | Société du Développement du Cuivre de l'Anti-Atlas (SODECAT) | Near Quansimi               | NA.                           |
| Fluorspar       | Société Anonyme d'Entreprises Minières (SAMINE)              | Near Khouribga              | 70 (concentrate).             |
| Lead            | Compagnie Minière d'Touissit (CMT)                           | Touissit                    | 73 (concentrate).             |
| Do.             | Société de Développement Industrie et Minière                | Zeida                       | 40 (concentrate).             |
| Manganese       | Société Anonyme Cherifienne d'Etudes Minières (SACEM)        | Near Quarzazate             | 130 (concentrate).            |
| Phosphate       | Office Cherifien des Phosphates (OCP)                        | Khouribga and Youssoufia    | 25,000 (concentrate).         |
| Silver          | Société Metallurgique d'Imiter (SMI)                         | Near Quarzazate             | 73 (ore).                     |

NA Not available.

within the mine. Additionally, an aspirator system is also located at the crushers to control dust for mine safety and health.

Crushed salt is transported by conveyor to the surface at the SSM operation at a rate of 220 mt/d. The salt is then trucked to the nearby Port of Mohammedia. Production of salt at SSM's operation at Mohammedia is market demand driven with the primary customers being the United Kingdom and Holland where the salt is used as a traction enhancer on roads.

### Mineral Fuels

The newly proposed hydrocarbons law attracted renewed exploration for petroleum in 1990. Azienda Generali Italiana Petroli S.p.A. (AGIP) was awarded a production sharing contract with Onarep covering exploration of three offshore tracts in the Atlantic Ocean southwest of Agadir. Additionally, the Netherlands' Royal Dutch/Shell Group and Texaco Inc. of the United States both signed exploration agreements. All of the latter exploration agreements cover offshore tracts, Texaco's being offshore of Casablanca. Central Morocco will be a target for seismic surveying and other geophysical exploration over an estimated 11 million acres that flank the Atlas Mountains by Maxus Energy Corp. of the United States. The 1-year contract includes options for further exploration upon termination of the study.

In 1990, BRPM and Onarep have shown increasing interest in the exploitation of oil shale deposits. Oil-bearing shale was first discovered in the Atlas Mountains of Morocco in 1964, and current development has proceeded to the pilot-plant stage. The current low cost per barrel of oil has prevented any large-scale development. Assuming the development of an oil shale mine and a surface retorting plant of 50,000-bbl/d capacity, the approximate cost would be about \$2 billion.

Total throughput petroleum refining capacity was approximately 55 Mbbbl/a from two refineries at Sidi Kacem and Mohammedia.

### Reserves

The Government's estimated reserve of phosphate rock was approximately 22 bil-

lion tons. Sufficient reserves existed to sustain base metal production.

## INFRASTRUCTURE

An agreement signed on November 10, 1987, between Charbonnages de Jerada and a Belgian company called for the construction of a powerplant that would run on bituminous shale. The proposed 15-MW fluid bed powerplant should be completed in the mid-1990's, and its output would supply the energy needs of the Jerada anthracite coal mine.

The International Atomic Energy Agency (IAEA), in cooperation with Morocco's National Nuclear Energy, Science and Technology Center (CNESTEN), has been formulating a strategy for civil nuclear energy development in the country. This strategy has led to what will be Morocco's first nuclear research reactor, a 1.5-MW triga Mark II reactor that is to be built at a site prepared by CNESTEN in the Maamoura forest between Rabat and Kenitra. In July 1990, a contract was signed between the Government and the United States' General Atomics to supply the reactor.

## OUTLOOK

Morocco continues to import an overwhelming percentage of its energy needs. Discovery of significant domestic sources of energy is critical to Morocco's future economic success. Until this occurs, the cost of energy importation will continue to worsen the trade deficit.

Because of dependence upon the development of rich phosphate rock resources, the Moroccan economy has shown itself to be sensitive to shifting global phosphate rock prices. Near-term solutions to this problem could be facilitated by an expansion into different markets areas for phosphate and associated downstream products. Additionally, privatization and the opening of nonessential sectors to private investment could be positive strategies toward the goal of a more decentralized economy.

## WESTERN SAHARA

Western Sahara has a total land area of 266,000 km<sup>2</sup>. It has been claimed and administered by Morocco since the mid-1970's. Debate over the sovereignty of the area continues, and the Moroccan Government has supported a planned UN referendum concerning the outlook for the Western Sahara. Economic activity, including all trade, is controlled by the Moroccan Government. The only significant mineral production from this region is from the phosphate mine at Bou Craa. Phosphate rock production from this mine has remained stable over the past several years, with 1990 production totaling approximately 1.5 Mmt. Production data from Bou Craa is included with Moroccan phosphate output. Royal Dutch/Shell Group's petroleum exploration tracts lie offshore of Tarfaya. The 8-year agreement could total an estimated \$72 million, and Shell plans to drill its first well in 1992 pending positive exploratory indications.

<sup>1</sup>Where necessary, values have been converted from Moroccan dirhams (DH) to U.S. dollars at a rate of DH8.27=US\$1.00.

## OTHER SOURCES OF INFORMATION

### Agencies

Bureau de Recherches et de Participations  
Minières  
5 Charia Moulay Hassan  
P.O. Box 99, Rabat, Morocco  
Ministere del-Energie et des Mines  
5 Rue de Rich, Tour Hassan  
Rabat, Morocco  
Office Cherifien de Phosphates  
Angle Route de 'El Jadidaet Bd de Grande  
Ceinture  
Casablanca, Morocco

### Publications

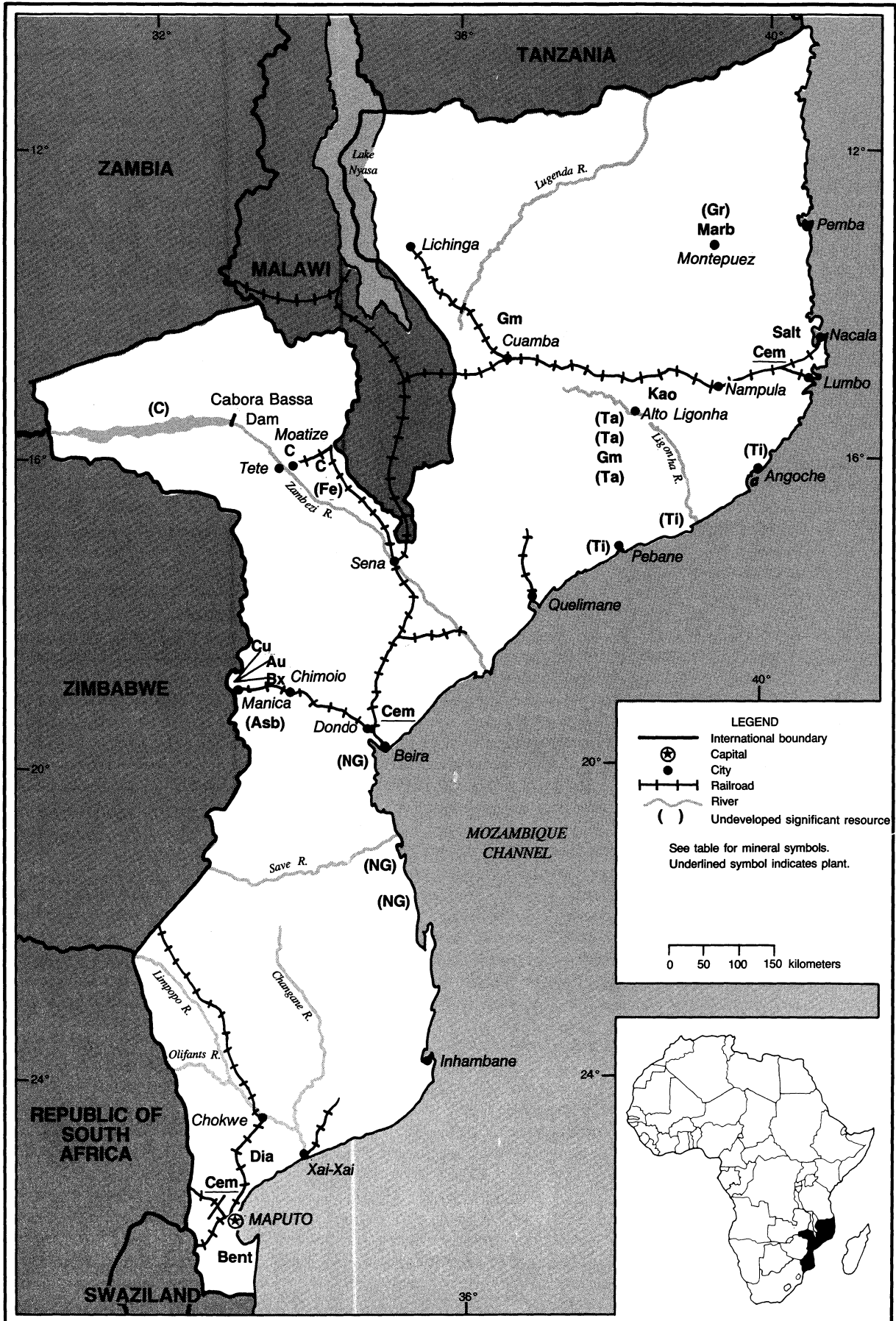
Statistique de Commerce Exterieur, Rabat,  
Morocco.  
Marches Tropicaux et Meditteraneens,  
Paris, France.



# MOZAMBIQUE

AREA 801,590 km<sup>2</sup>

POPULATION 14.6 million



# THE MINERAL INDUSTRY OF MOZAMBIQUE

By Hendrik G. van Oss

**S**ales of domestically produced mineral commodities were a relatively minor factor in Mozambique's agriculture-dominated economy. However, mineral commodities, particularly fuels, were a dominant component of the country's imports. Mozambique's ports and railways have traditionally been major components of the trade infrastructure of Southern Africa. Significant revenues are earned by Mozambique by the transshipment of goods, particularly mineral commodities, to and from the country's inland neighbors. As in years past, a large number of Mozambique nationals worked in mines in the Republic of South Africa, and their repatriated wages were an important source of income for a large segment of Mozambique's population. Virtually all facets of the Mozambique economy were aggravated by the ongoing insurgency, although negotiations during the year between the rival political groups brought about a partial cease fire toward yearend.

Mozambique's GDP was about \$1.5 billion<sup>1</sup> in 1990. Sales of domestically produced primary minerals were reported to have been worth \$2.7 million, of which about \$1.8 million was exports. These values, however, may not include sales of salt and do not include secondary mineral products such as cement. Taken together, total revenues from mineral commodity sales are estimated at \$8 to \$8.5 million, with exports worth about \$3.5 million, or almost 3% of total exports. Revenues from the transshipment of mineral commodities are estimated to have declined somewhat to about \$15 million owing to security and transport problems. Wages in the Mozambique mineral and mineral transshipment industry totaled about an estimated \$4 million. However, if the repatriated wages of Mozambique mineworkers in the Republic of South Africa are counted, total mining-related wages in Mozambique were approximately \$100 million. These wages support an estimated 300,000 persons. Imports of mineral commodities and electricity amounted to an estimated \$120 million, of which petroleum products accounted for almost 90%. Ow-

ing to price increases, petroleum product imports were \$25 million higher in 1990 than in 1989; the increase almost completely offset the rise in the country's overall exports.

There was a large increase in the number of applications for exploration and mining licenses by Mozambique nationals. This was partly due to a new constitution, approved at the beginning of the year, and to a perception of improved security. Most of these license applications, reportedly, were for gem stones.

The geology of Mozambique is complex, a manifestation of which is the diversity of the country's mineral deposits. The northeast one-third of Mozambique is predominantly made up of Precambrian granitic rocks. Within this terrane, especially near Alto Ligonha, are a large number of complex pegmatites. Some of these pegmatites have 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 host some locally important metamorphic deposits, notably of marble and garnet. 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.

Precambrian granitic rocks are also found in northwest Mozambique. However, except for some deposits of graphite near the Malawi border and some minor low-grade iron and copper-nickel deposits, this area has been relatively unimportant in terms of minerals. Immediately to the south of this terrane 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. Within the Karoo terrane, immediately north of Tete and

Moatize, is a large window of Precambrian gabbroic rocks, which host low-grade iron-titanium deposits.

Adjoining the Zimbabwe border in west-central Mozambique is a west-facing crescentic area of Precambrian granitic rocks, extending about 350 km south of Tete. This terrane, especially near Manica, contains a variety of metasedimentary inliers. A number of these 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 but high-grade 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.

Except for a narrow strip of Karoo volcanics along the Swaziland and the Republic of South Africa borders, the rest of Mozambique, amounting to about 50% 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

Despite the past and likely continued dominance of agriculture in the Mozambique economy, the Government is anxious to improve the country's industrial base. Mining is seen as having great potential for expansion. Some of the country's existing mines, such as for tantalum and gem stones, could be rehabilitated and expanded. A number of new deposits could be developed, most notably of heavy-mineral sands and coal. Further, 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.



Mozambique continued to significantly benefit from the wages earned by Mozambique workers abroad, particularly those working in mines in the Republic of South Africa and in various industries in Eastern Europe and the U.S.S.R. The Government's political policies have, in part, reflected the need to preserve these employment opportunities. Of grave concern has been the recent political changes in the U.S.S.R. and Eastern Europe. These changes have resulted in work contracts having been canceled and Mozambique nationals repatriated. About 20,000 were so repatriated in 1990. Estimates of the resulting wage losses range from \$20 to \$70 million per year. Of additional concern is the eventual return home of more than 1 million refugees. This has made even more vital the continuation of mining employment opportunities in the Republic of South Africa. However, retrenchments in the gold sector in that country and demands to increase the use of local labor threaten this effort.

In order to attract more foreign investment and international financial assistance, the Government has, in recent years, revised the country's mining and investment laws. In addition, the Government has improved the dissemination of new geologic information on the country. A great deal of geologic mapping has been done in recent years, commonly in cooperation with foreign geologic agencies. The completion in 1987 of a geologic map of the country at a scale of 1:1,000,000 was an outcome of this effort. In 1986, the Government released an information packet on the country's petroleum potential. In 1989, a new book was published on the country's industrial minerals.<sup>2</sup>

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, and accelerated depreciation of capital investments. Royalties range from 3% to 10% of gross revenues, depending on the mineral(s) produced. Petroleum and natural gas exploration and exploitation are governed by law No. 3/81 of October 3, 1981. Negotiations for hydrocarbon explo-

ration leases are handled by the parastatal Empresa Nacional de Hidrocarbonetos de Moçambique (ENH).

In an attempt to eliminate the illegal parallel trade in currency, the Government in 1990 established a licensed secondary market for foreign exchange.

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## PRODUCTION

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The production of mineral commodities was mixed in 1990, with output of most commodities continuing to be affected by equipment and power problems, as well as by civil strife. Coal mining continued to be on a caretaker basis only, with the salable material being derived from washed stocks. The railroad to the coal mines remained closed owing to security problems, and the modest shipments from the mine were by truck.

Production of tantalum minerals and of most gem stones was cut off in 1986 when civil disorder forced the cessation of mining in the Alto Ligonha area. The Government secured the area in 1988, and there has been minor production of gem stones from the region since that time. The two tantalum mines that had been in production in 1986 remained closed pending rehabilitation. The Government's efforts to find investors for these mines have so far been unfruitful. In late 1989, the Government signed an agreement with the U.S.S.R. to rehabilitate the Morrua tantalum mine, 65 km southwest of Alto Ligonha. Subsequent political and economic changes in the U.S.S.R. make fulfillment of this agreement unlikely.

The country's sole copper mine ceased mining in 1990. However, a small quantity of copper concentrates was produced from stockpiled ore. Marble production continued to be at a reduced rate owing to ongoing rehabilitation of the workings near Montepuez.

A positive development in Mozambique's mineral economy was the resumption, after many years, of gold mining.

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## TRADE

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Exports of mineral commodities were reported to have increased by 73% to about \$1.9 million in 1990. The increase was almost entirely due to the export of gold from the country's new gold mine. Exports of most other commodities declined owing to various production problems. The reported export data for minerals appear not to in-

clude exports of a few mineral commodities, such as salt, inclusion of which would raise the total value of mineral commodity exports to about \$3.5 million. By comparison, Mozambique's total exports amounted to \$126 million, a 25% increase.

Not included in the above is the value of mineral commodity transshipments to and from Mozambique's neighbors. These are estimated at \$15 million, including about \$10 million from pipeline transport fees for petroleum products shipped to Zimbabwe. The remainder was for copper shipments from Zambia and coal shipments from the Republic of South Africa and Swaziland.

Petroleum product imports increased about \$25 million to between about \$100 to \$105 million. This increase was due to higher prices rather than volume; the latter actually decreased substantially. The price increases were due to the Persian Gulf crisis and a change in the U.S.S.R.'s sales arrangements. At midyear 1990, the U.S.S.R. stated that deliveries of petroleum products to Mozambique would be for cash at world prices, not at discount through barter. The overall added fuel bill effectively offset Mozambique's increase in total exports.

Because of security problems with railroad shipments of limestone, Mozambique had to import most of its clinker requirements for the cement industry. Clinker imports were worth an estimated \$3.5 to \$4 million in 1990. Coal imports to fuel power stations in southern Mozambique were estimated at \$500,000.

Electricity imports in 1990 were all from the Republic of South Africa and amounted to 326.4 GW-h, worth about \$10 million.

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## STRUCTURE OF THE MINERAL INDUSTRY

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The mining industry of Mozambique is underdeveloped with, in general, commodities produced by single operations only. With the exception of the bauxite and gold mines and most of the salt operations, all mineral commodity production was controlled by the Government. The coal mines and cement mills were operating well below their design capacities, and both the copper and bentonite mines reported no mine output during 1990.

A number of foreign companies had active exploration programs in Mozambique during the year. Cluff Resources Ltd. of the United Kingdom was exploring a diatomite prospect near Maputo. Kenmare Resources Plc of Ireland was involved in a graphite

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

(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>                       | 1986               | 1987                | 1988                | 1989 <sup>p</sup>   | 1990 <sup>p</sup> |
|--|--------------------|---------------------|---------------------|---------------------|-------------------|
| Asbestos                                     | —                  | —                   | —                   | —                   | —                 |
| Bauxite                                      | 4,247              | <sup>1</sup> 5,114  | 6,548               | <sup>1</sup> 5,501  | 7,186             |
| Beryllium: Beryl concentrate kilograms       | <sup>1</sup> 1,425 | —                   | —                   | —                   | —                 |
| Bismuth: Bismuth minerals do.                | 80                 | —                   | —                   | —                   | —                 |
| Cement, hydraulic thousand tons              | 73                 | <sup>e</sup> 73     | 69                  | <sup>e</sup> 80     | <sup>e</sup> 80   |
| Clays:                                       |                    |                     |                     |                     |                   |
| Bentonite                                    | 1,112              | 936                 | 986                 | 126                 | —                 |
| Kaolin                                       | ( <sup>3</sup> )   | ( <sup>3</sup> )    | ( <sup>3</sup> )    | ( <sup>3</sup> )    | —                 |
| Coal, bituminous                             | 3,895              | 43,319              | 23,856              | 62,010              | 40,411            |
| Copper:                                      |                    |                     |                     |                     |                   |
| Ore, gross weight <sup>e</sup>               | 20,300             | 11,200              | 10,300              | 6,500               | <sup>4</sup> —    |
| Concentrate:                                 |                    |                     |                     |                     |                   |
| Gross weight                                 | 1,303              | 719                 | 660                 | 420                 | <sup>4</sup> 133  |
| Cu content <sup>e</sup>                      | 274                | 151                 | 139                 | 88                  | 28                |
| Feldspar                                     | ( <sup>3</sup> )   | —                   | —                   | —                   | —                 |
| Gem stone:                                   |                    |                     |                     |                     |                   |
| Cut stones, all types carats                 | 35,477             | <sup>1</sup> 36,341 | <sup>2</sup> 26,552 | <sup>1</sup> 19,766 | 13,385            |
| Aquamarine grams                             | 568                | —                   | —                   | —                   | <sup>5</sup> NA   |
| Beryl, morganite do.                         | 7,303              | —                   | —                   | 913                 | <sup>5</sup> NA   |
| Emerald do.                                  | <sup>e</sup> 5,000 | —                   | —                   | 36                  | <sup>5</sup> NA   |
| Garnet <sup>6</sup> kilograms                | <sup>8</sup> 73    | <sup>1e</sup> 1,201 | <sup>2</sup> 2,026  | 1,966               | 2,558             |
| Tourmaline grams                             | 4,231              | —                   | —                   | 966                 | <sup>5</sup> —    |
| Gold kilograms                               | —                  | —                   | —                   | —                   | 63                |
| Lime, hydraulic <sup>e</sup>                 | 10,000             | 5,000               | 5,000               | 5,000               | 5,000             |
| Marble cubic meters                          | 1,137              | 1,140               | 940                 | 687                 | 488               |
| Mica, waste <sup>e</sup>                     | ( <sup>3</sup> )   | —                   | —                   | —                   | —                 |
| Monazite concentrate kilograms               | 117                | —                   | —                   | —                   | —                 |
| Ornamental stones, rose quartz do.           | <sup>e</sup> 1,000 | —                   | —                   | —                   | —                 |
| Salt, marine <sup>e</sup>                    | 28,000             | 30,000              | 37,500              | 40,000              | 40,000            |
| Tantalum mineral concentrates, gross weight: |                    |                     |                     |                     |                   |
| Microlite kilograms                          | 2,649              | —                   | —                   | —                   | —                 |
| Tantalite do.                                | <sup>1</sup> 2,720 | —                   | —                   | —                   | —                 |

<sup>e</sup>Estimated. <sup>p</sup>Preliminary. <sup>1</sup>Revised. NA Not available.

<sup>1</sup>Data available through Dec. 20, 1991.

<sup>2</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>3</sup>Revised to zero.

<sup>4</sup>No mining occurred at the Mundonguara Mine, the country's sole copper producer, during 1990. Copper concentrate was produced from stockpiled ore.

<sup>5</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. Information is inadequate to make reliable estimates of output levels.

<sup>6</sup>Facet-grade. In addition, there was waste garnet production, in kilograms, as follows: 1986—6,870; 1987—12,039; 1988—15,834; 1989—8,211; and 1990—4,786.

exploration project in northern Mozambique. Two companies had titaniferous sand projects along the northeast coast. Lonrho Plc of the United Kingdom was exploring for lode gold in the Manica area. A Brazilian company conducted a prefeasibility study of coal reserves in the Moatize region, and the UN Development

Program was evaluating some of the bauxite deposits of the Manica area. Most of these efforts were in some form of partnership with the Government's Empresa Nacional de Minas. Owing to the prevalence of civil disorder, all exploration activity was conducted in the accompaniment of Government troops.

Current data are not available on the mining component of the Mozambique labor force. It is estimated that in 1990 only about 6,000 workers were employed in the mining or related value added industries. Of these workers, about one-third were employed in the cement industry and glass industries and related quarries. The coal

TABLE 2  
**MOZAMBIQUE: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990**

(Metric tons unless otherwise specified)

| Commodity           | Major operating companies                | Location of main facilities  | Annual capacity                                    |
|---------------------|--|--|--|
| Bauxite             | E.C. Meikle Plc of Zimbabwe              | Open pit mine just west of Manica  | °10,000 bauxite.                                   |
| Cement              | Cementos de Moçambique                   | Cement plant at Dondo  | °75,000 cement.                                    |
| Do.                 | do.                                      | Cement plant at Matola   | °100,000 cement.                                   |
| Do.                 | do.                                      | Cement plant at Nacala   | °50,000 cement.                                    |
| <b>Clays:</b>       |  |  |  |
| Bentonite           | Empresa Nacional de Minas                | Luzinda deposit, kilometers southeast of Maputo  | °6,000.35  |
| Kaolin              | do.                                      | Boa Esperanca Mine, Ribáuè District, 120 kilometers west of Nampula                                      | °300.  |
| Coal                | Empresa Nacional de Carvão de Moçambique | Underground mines near Moati   | 100,000 bituminous coal.                           |
| Copper <sup>1</sup> | Empresa Nacional de Minas                | Mundonguara Mine, 18 kilometers west of Manica   | °500 copper concentrates grading about 21% copper. |
| Gem stones          | Empresa Nacional de Minas                | Several small-scale lode and placer operations near Alto Ligonha (beryl, tourmaline) and Cuamba (garnet) | NA.  |
| <b>Gold</b>         |  |  |  |
| kilograms           | Aluviões da Manica Lda.                  | Placer operation near Manica   | °1,200 bullion.                                    |
| <b>Marble</b>       |  |  |  |
| cubic meters        | Empresa Nacional de Minas                | Quarry 5 kilometers north of Montepuez   | °2,500 blocks.                                     |
| <b>Salt</b>         |  |  |  |
|                     | Numerous operations                      | Small seawater evaporation operations near most coastal cities   | °40,000.   |

<sup>°</sup>Estimated. NA Not Available.

<sup>1</sup>Production of concentrate in 1990 was from stockpiled ore; there was no mining.

sector may employ about 1,500 workers, compared with 2,500 in the 1980's. It is estimated that about one-third of the country's railroad and port employees, or about 10,000 workers, were involved in the transportation of mineral commodities. None of these estimates includes security personnel; these can number several hundred for the larger operations.

It is estimated that wages in the domestic mining and related transportation sectors totaled about \$4 million in 1990. Of far greater importance was the employment of Mozambique miners in the Republic of South Africa. About 44,500 were so employed, with 43,000 in the gold mines.

## COMMODITY REVIEW

### Metals

**Copper.**—The Mundonguara Mine, the only copper producer in Mozambique, ceased mining in early 1990 after several years of declining output. Shipments of concentrates continued, but were derived from stockpiles. The mine's closure was due to a combination of severely declining reserves, myriad problems with equipment and power outages, and continued insecurity in the region. The mine's reopening was considered unlikely.

**Gold.**—In October, Lonrho began production at its placer gold mine on the Chua

River about 14 km northeast of Manica. The Chua is a tributary of the Revuè River, which was first exploited for placer gold in 1904. From 1923 to 1949, Lonrho subsidiary Revuè Dredging Co. extracted 6.5 tons of gold from gravels in the area. Fine gold output in 1990 was 62.824 kg, and output in 1991 was expected to be at a rate of about 35 kg/month. The company is also exploring for lode gold deposits in the area.

**Titanium.**—In November 1989, Kenmare Resources announced that it would proceed with development of its Congolone titaniferous sands deposit, about 190 km southwest of Nacala, near Angoche.

The approximately \$100 million project had been forecast to be in production in 1992, with an expected annual output of about 421,000 mt/a of ilmenite, 37,500 mt/a zircon, about 8,100 mt/a rutile, and about 1,000 mt/a monazite. However, the company's efforts to secure a joint-venture partner apparently fell through late in 1990, which put the project's financing in some doubt and made unlikely a startup as forecast.

Edlow Resources Ltd. of the United States continued its exploration work on the Pebane titaniferous sands concession, which covers about 200 km of coastline stretching northeast from a point about 75 km southwest of the town of Pebane. Drilling was completed in February, after which the samples were sent to an independent consulting group for analysis and a prefeasibility study. The latter, completed late in the year, was favorable and showed an indicated resource of about 250 Mmt grading 5% heavy minerals, dominantly ilmenite. At yearend, an operating partner for the project was being sought; the partner would be expected to do the ore reserve delineation drilling and to conduct a full feasibility study.

### Industrial Minerals

Kenmare Resources continued its exploration work, begun in 1989, on the Ancuabe graphite deposit, 120 km west of Pemba. The deposit is in Precambrian graphitic gneisses and overlying residuum and is believed to have the potential to support a production level of 20,000 mt/a of flake graphite. The company expected to do a feasibility study of the project late in 1991.

### Mineral Fuels

**Coal.**—Coal production from the mines at Moatize was well below capacity and fell significantly in 1990 owing to security problems as well as numerous power outages and equipment breakdowns. The mines' ability to ship coal, generally a blend from an estimated stockpile of about 200,000 tons, was hampered by the lack of raiing ability, the result of the continued security-related closure of the Sena railroad line. Consequently, the coal shipments, which largely went to Malawi, were by truck, reportedly at a transport cost approaching \$20 per ton.

In 1990, the Government signed an agreement with Brazil's Companhia Vale do Rio Doce (CVRD) to do a prefeasibility

study of the coal resources of the Moatize area. The objective was to establish long-term reserves adequate to support a coal output of 22 Mmt/a (9 Mmt/a salable), as well as to determine the required export railing and port infrastructure. Trans-Natal Corp. of the Republic of South Africa was contracted by CVRD to do the drilling and the metallurgical bulk sampling for the prefeasibility study. It was anticipated that the development of major new open pit coal mines at Moatize would require either a new railroad to the coast or a complete overhaul of the existing railroad, and the construction of an entirely new port facility somewhere near Beira. The prefeasibility study was expected to be completed by mid- to late-1991.

**Oil and Gas.**—No new petroleum exploration activity was reported for Mozambique during the year. ENH analyzed its drill and seismic data for the Pande gasfield, 150 km south of Beira; reserves thus confirmed were the basis of discussions with several foreign oil companies to develop the field. Reportedly, Phillips Petroleum was to evaluate the field in 1991, including options as to its use. The options commonly cited are the building of a gas pipeline from the field to the Republic of South Africa, and the development of a local ammonia plant. The Pande Field was discovered in 1961 and has not been put into production despite having significant resources. Further, the field has experienced many years of blowouts, early years of which involved flaring and, more recently, severe gas-water spouting. The latter involved two wells; these were finally capped in 1990.

### Reserves

Mozambique is a mineralogically diverse country; deposits that are or have been exploited include asbestos, various clays, coal, copper, fluor spar, gem stones, gold, graphite, marble, rare earths, and tantalum. Reserve data are unavailable for most of these commodities, although an upsurge in mineral exploration since 1986 will likely improve this picture.

Mozambique's coal reserves are mostly in the Tete area and are known to be large. 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.

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 ongoing 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. Although reserves for Edlow's Pebane concession had not been proved as of yearend 1990, prefeasibility work during the year indicated a potentially economic resource of about 250 Mmt grading 5% heavy minerals, dominantly ilmenite.

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>.

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. The country's best reserve potential would appear to be in its placer deposits and in ferruginous quartzite deposits such as those once exploited at the old Monarch Mine, close to the Zimbabwe border west of Manica. Lonrho's gold reserves at its Chua River placer deposit had not been announced at yearend 1990.

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, and these 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 has reportedly delineated resources of approximately 15 Mmt of ore grading about 2% to 5% carbon.

## INFRASTRUCTURE

Mozambique has 3,288 km of railroads, of which 3,140 km are 1.067-m gauge and the remainder 0.762-m narrow gauge. The bulk of the country's railroads are in six routes or "corridors." These routes are, from north to south, the Nacala Corridor, linking Nacala to Malawi (300 km); the Sena Corridor, linking Beira, via Dondo, to the coalfields at Moatize (513 km) and to Malawi (570 km); the Beira Corridor, linking Beira to Zimbabwe (315 km); the Limpopo Corridor, linking Maputo with Zimbabwe (534 km); the Ressano Garcia line, linking Maputo to the Republic of South Africa (88 km); and the Goba line, linking Maputo to Swaziland (68 km).

Rehabilitation work was ongoing during the year on the Beira, Limpopo, and Nacala corridors. The Beira Corridor was in use throughout the year; however, the freight handled along this corridor declined somewhat during the last quarter of the year owing to port congestion at Beira. Delays at Beira were due in part to the need for additional shunting locomotives (although 5 new locomotives for this purpose arrived midyear) and to rehabilitation of some of the ship berths. In addition, there were a number of derailments along the western

part of line late in the year. Rehabilitation work on the Limpopo Corridor was reported to have been only about 70% completed as of yearend, but nevertheless, some commercial freight was carried during the year.

Maputo-Matola and Beira are the country's main ore ports. Maputo-Matola saw an 8% decline in freight handled to 2.9 Mmt; the decline was attributed to port management problems and unacceptable levels of pilferage. The Government was reportedly considering privatizing the port to alleviate these problems. Beira handled about 2.7 Mmt during the year.

The rehabilitation of the Sena Corridor has assumed greater importance since the renewal of investment interest in Mozambique's coal resources. Production from the existing mines at Moatize has suffered from an inability to rail the output; truck transport has been much more expensive and has also been subject to attacks. Another factor lending urgency to the rehabilitation of the line was the presence of, reportedly, 20 locomotives at Moatize. Mozambique's entire rail system, and consequently much of its mining sector, suffers from a severe shortage of locomotives, and the Moatize locomotives, which have been regularly maintained, are a much needed resource. However, although the rehabilitation of the Sena line will be beneficial to the existing coal mines at Moatize, any significant expansion of production, such as to the 9 Mmt/a envisioned by the Government, will be beyond the line's capacity.

In 1990, Mozambique's installed electrical generating capacity was 2,323 MW, of which 2,040 MW was accounted for by the Cabora Bassa hydroelectric plant. As in 1989, sabotage of the main power line pylons prevented any export of Cabora Bassa electricity to the Republic of South Africa. Accordingly, power generation was limited to about 0.5% of capacity, for consumption by the cities of Tete, Quelimane, and Nampula. Reportedly, 94.4 GW-h was so supplied in 1990, a 14% increase. Mozambique's other hydroelectric plants, all comparatively small, generated a total of 153 GW h in 1990. Thermal plant output totalled about 168 GW h.

## OUTLOOK

Ultimately, any significant development of new industry in Mozambique will be dependent on the termination of the ongoing civil strife. In terms of mineral production, the near-term outlook is for Mozambique to become a significant producer of titanium minerals and a modest producer of gold. Gem stone production is also likely to increase significantly. In the intermediate term, it appears likely that coal production will return to levels approaching the installed capacity of the mines. Tantalum production may resume if interest can be generated in rehabilitating the existing workings. The most significant long-term mineral development should be the development of large open pit coal mines and the necessary transportation infrastructure for large-scale coal exports. The sources of funding for this project, particularly for the necessary railroad, are uncertain. The exploitation of Mozambique's natural gas resources likely has to await the development of a local market. The outlook for the discovery and development of petroleum reserves is only modestly encouraging.

<sup>1</sup>Where necessary, values have been converted from Mozambique meticals (M) to U.S. dollars at the rate of M929.09=US\$1.00.

<sup>2</sup>Cftek, V. Industrial Minerals of Mozambique, Geological Survey of Czechoslovakia, 1989, 326 p.

## OTHER SOURCES OF INFORMATION

Ministério dos Recursos Minerais  
Direcção Nacional de Minas  
C.P. 2904, Maputo, Mozambique  
Tel. 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

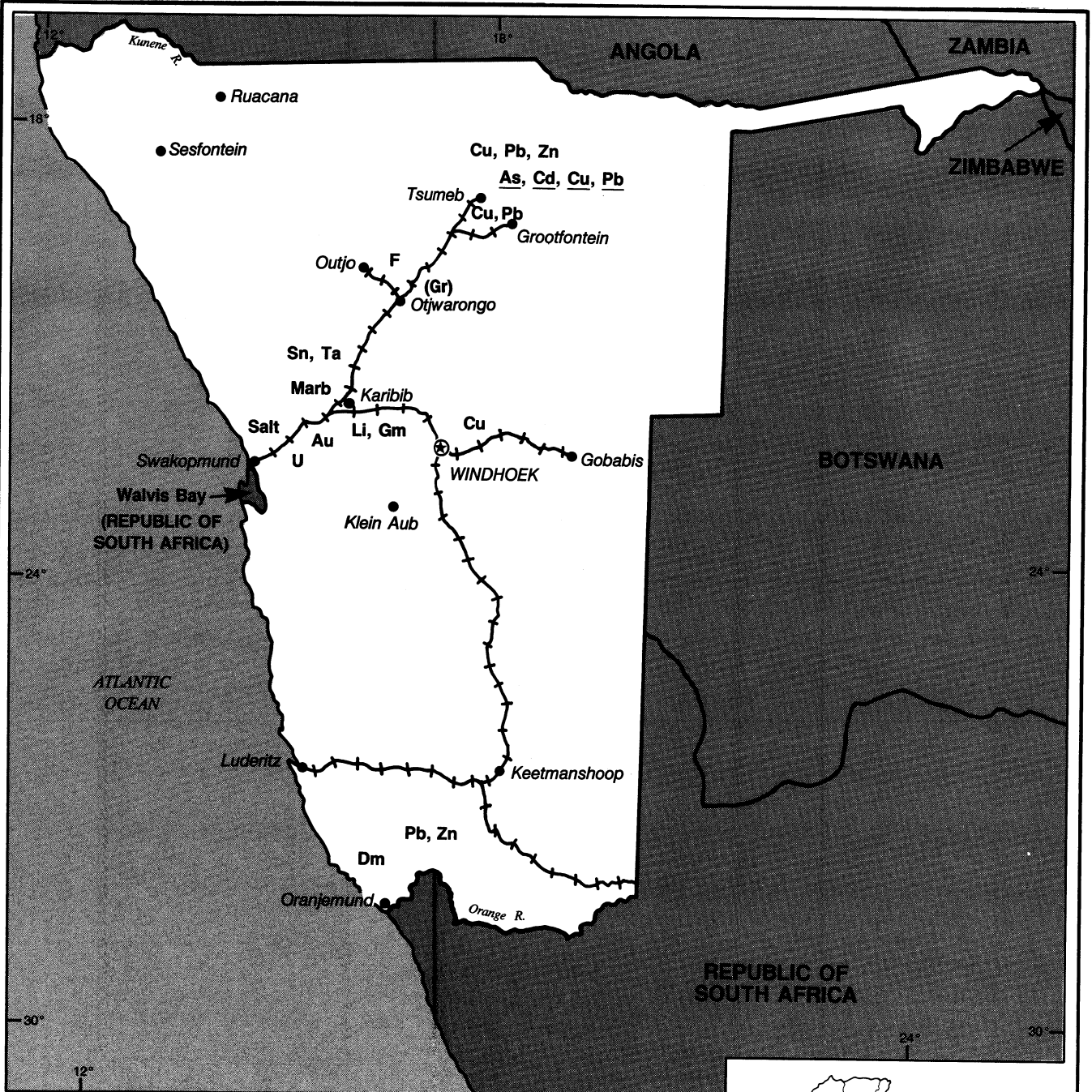
Maputo, Mozambique  
Empresa Nacional de Hidrocarbonetos de  
Moçambique  
C.P. 2904  
Maputo, Mozambique



# NAMIBIA

AREA 823,000 km<sup>2</sup>

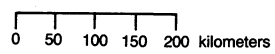
POPULATION 1.4 million



**LEGEND**

- International boundary
- Capital
- City
- Railroad
- River
- Undeveloped significant resource

See table for mineral symbols.  
Underlined symbol indicates plant.



# THE MINERAL INDUSTRY OF NAMIBIA

By George A. Morgan

**O**utput of minerals in 1990 was negatively affected by the closure of the Uis tin mine and by reduced output from the copper sector. The mining industry was estimated to account for about 28% of the GDP and 73% of foreign exchange earnings.

Prospecting was active, particularly in western Damaraland and in Kaokoland in northwest Namibia. Anglo American Corp., the Iron and Steel Corp. of South Africa, Rand Mines Ltd., and Rossing Uranium Ltd. all had active exploration programs underway in the region.

Exploration in Kaokoland centered on the Tsongoari-Otjipaka metasedimentary synclinal belt in the vicinity of Sesfontein. The mixed sulfide assemblages of copper-lead-zinc-silver and barite are considered to be exhalative stratabound submarine rock facies within iron formations. Tsongoari Exploration (Pty.) Ltd., affiliated with Rand Mines, was active at the Tsongoari prospect 45 km northwest of Sesfontein. Rhino Prospecting and Mining Co., in partnership with Tsongoari, held many of the mineral rights in the area.

## GOVERNMENT POLICIES AND PROGRAMS

New petroleum legislation was introduced in response to potential production of crude petroleum and natural gas both offshore and onshore. This legislation was titled the Petroleum Exploration and Production bill, and the Petroleum Taxation bill.

A Foreign Investment bill was also introduced to the National Assembly that addressed repatriation of profits, security of title and tenure, availability of foreign exchange, international arbitration, and fair compensation in case of expropriation.

The Government reserved the right to take an equity position in any mining venture. 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.

A cooperation agreement signed with China provided for economic and technical assistance from China for 5 years.

## PRODUCTION

Output of the minerals sector was negatively affected as changes in ownership and new market assessments led to the closure of the Uis tin mine, one of the largest hard-rock tin mines in the world. Gold Fields of Namibia's Tsumeb Mine, noted for its mineralogical diversity, was to be closed owing to exhaustion of reserves and increased operating costs. Exploration in the vicinity of Tsumeb continued in order to maintain a supply of copper to the Tsumeb smelter. Anglo American Corp.'s Navachab gold mine reached full production, and other companies were examining additional gold prospects in similar marble and limestone host rocks.

Discovery of a 20 Mmt reserve of lead-zinc-silver ore grading 10% lead and zinc was announced. Other discoveries in the north western part of the country in or near Kakoland included copper-lead-zinc, and gold. A world class graphite deposit was located near Otjiwarongo, and rare earths and titanium mineralization were found at Okorusu, about 10 km east of Outjo.

The Mineworkers Union of Namibia continued to press for increased membership at the country's major mines. Labor issues, particularly high wage demands, were a factor in Tsumeb's output level and economic viability, and may lead to increased mechanization.

## TRADE

Six companies provided the bulk of fuels and lubricants to Namibia through imports, there being no domestic refinery.

About 1.5 ML of high quality diesel was imported from Angola and stored at Luderitz in new tanks. About 28,000 tons of mixed product was imported from Bahrain and landed at Walvis Bay. All liquefied petroleum gas and bitumen were imported from the Republic of South Africa by railroad or truck transport. No bulk handling facilities exist at Walvis Bay or Luderitz. Prices of gas, diesel, and paraffin were Government controlled.

## STRUCTURE OF THE MINERAL INDUSTRY

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.

About 880 prospecting license holders were registered with the Department of Mines. Of this number, about 150 were active in exploration or mining.

The Association of Prospectors and Miners of Namibia, formed as a federation in 1986, had 44 paid up members, and was also a member of the Chamber of Mines. Its primary function was to represent individual prospectors and small exploration and mining companies before the Ministry of Mines and Energy.

## COMMODITY REVIEW

### Metals

**Copper.**—Gold Fields of Namibia announced that its Tsumeb Mine would be closed by midyear 1993 owing to exhaustion of ore reserves. In addition to commercial sales of blister copper, Tsumeb was noted for its mineralogical diversity, having provided innumerable specimens of unique or rare minerals to the world's museums. The smelter at Tsumeb was expected to continue operation using concentrates from the recommissioned Otjihase Mine. Additional reserves were about 22 km northwest of Tsumeb at the Tschudi Mine. Tschudi has about 10 Mmt of ore, and could produce 50,000 mt/month of concentrate.



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

(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>   | 1986    | 1987                | 1988               | 1989 <sup>p</sup>   | 1990 <sup>r</sup> |
|--|---------|---------------------|--------------------|---------------------|-------------------|
| <b>METALS</b>  |         |                     |                    |                     |                   |
| Antimony, Sb content of sodium antimonate                                | —       | 24                  | 73                 | 34                  | 47                |
| Arsenic, white   | 2,208   | 1,864               | 2,983              | 2,399               | 2,000             |
| Cadmium metal, refined   | 61      | 51                  | 106                | 88                  | 75                |
| Columbium and tantalum: Tantalite concentrate,<br>gross weight kilograms | 8,186   | 13,809              | 6,905              | 5,730               | 2,000             |
| <b>Copper:</b>   |         |                     |                    |                     |                   |
| Mine output, Cu content of concentrate                                   | 49,591  | 37,557              | 40,892             | 26,929              | 26,000            |
| Metal, blister   | 45,688  | 35,488              | 39,970             | 37,978              | 37,500            |
| Gold, Au content of smelter products kilograms                           | 184     | 172                 | 195                | 336                 | 2,000             |
| <b>Lead:</b>   |         |                     |                    |                     |                   |
| Mine output, Pb content of concentrate                                   | 37,494  | 32,997              | 37,200             | 23,710              | 25,000            |
| Metal, refined   | 40,047  | 40,634              | 44,447             | 44,183              | 40,000            |
| Silver, mine output, Ag content of concentrate<br>kilograms              | 107,525 | 103,264             | 116,520            | 108,247             | 107,000           |
| Tin, mine output, Sn content of concentrate                              | 880     | 1,097               | 1,182              | 1,120               | 800               |
| Uranium, U308 content of concentrate                                     | 3,990   | 4,175               | 4,100              | 3,700               | 3,700             |
| Zinc, mine output, Zn content of concentrate                             | 35,371  | 39,650              | 36,694             | 41,675              | 35,000            |
| <b>INDUSTRIAL MINERALS</b>   |         |                     |                    |                     |                   |
| <b>Diamond:</b>  |         |                     |                    |                     |                   |
| Gem <sup>e</sup> thousand carats   | 970     | 970                 | 890                | 910                 | 960               |
| Industrial <sup>e</sup> do.  | 40      | 50                  | 48                 | 17                  | 40                |
| Total do.  | 1,010   | 1,020               | 938                | 927                 | 1,000             |
| Fluorspar, chemical grade  | —       | —                   | <sup>e</sup> 1,500 | <sup>e</sup> 15,000 | 30,000            |
| Granite  | 71      | 730                 | 2,783              | 6,496               | 10,000            |
| Limestone and marble   | 33,829  | <sup>e</sup> 32,000 | 7,695              | 11,663              | 10,000            |
| <b>Lithium minerals:</b>   |         |                     |                    |                     |                   |
| Amblygonite  | 52      | 106                 | 147                | 131                 | 100               |
| Lepidolite   | 52      | 61                  | 18                 | 41                  | 50                |
| Petalite   | 751     | 749                 | 1,477              | 1,226               | 1,000             |
| Total  | 855     | 916                 | 1,642              | 1,398               | 1,150             |
| Mica   | —       | —                   | —                  | —                   | —                 |
| Quartz   | 851     | 2,173               | 48                 | 7                   | 10                |
| Salt   | 134,644 | 125,031             | 125,387            | 142,102             | 130,000           |
| <b>Semiprecious stones:</b>  |         |                     |                    |                     |                   |
| Agate  | 87      | 100                 | 99                 | 93                  | 100               |
| Amethyst   | 37      | 189                 | 115                | 149                 | 150               |
| Beryl  | 4       | 1                   | 1                  | —                   | 1                 |
| Chrysocolla kilograms  | 1,000   | 8,250               | 8,200              | 8,000               | 8,000             |
| Diopside do.   | 520     | 60                  | 60                 | 190                 | 200               |
| Rose quartz  | 172     | 365                 | 896                | 602                 | 300               |
| Sodalite   | NA      | —                   | 100                | 50                  | 50                |
| Tourmaline kilograms   | 2,878   | 1,709               | 223                | 973                 | 1,000             |
| <b>Silica:</b>   |         |                     |                    |                     |                   |
| High-purity  | 1,041   | 2,190               | 2,100              | <sup>e</sup> 2,200  | 2,200             |
| For flux   | 5,918   | <sup>e</sup> 6,000  | <sup>e</sup> 6,000 | <sup>e</sup> 6,200  | 6,200             |

<sup>e</sup>Estimated. <sup>p</sup>Preliminary. NA Not available.

<sup>1</sup>Table includes data available through Sept. 30, 1991.

<sup>2</sup>Data are compiled from the annual reports of the Chamber of Mines of Namibia, the Ministry of Mines and Energy, and from operating company annual reports as follows: Tsumeb Corp. Ltd. (TCL), South African Iron and Steel Corp. Ltd., Gold Fields Namibia Ltd., DeBeers Consolidated Mines Ltd., and others as available.

TABLE 2

## NAMIBIA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

(Metric tons unless otherwise specified)

| Major commodity        | Major operating companies              | Location of main facilities               | Annual capacity                                     |
|------------------------|--|---|---|
| Copper                 | Tsumeb Corp. Ltd.                      | Tsumeb                                    | 15,500 Cu in concentrate.<br>58,000 blister copper. |
| Do.                    | do.                                    | Kombat, 50 kilometers south of Tsumeb     | 12,000 Cu in concentrate.                           |
| Do.                    | do.                                    | Otjihase, near Tsumeb                     | 16,500 Cu in concentrate.                           |
| Diamond million carats | Consolidated Diamond Mines (Pty.) Ltd. | Oranjemund                                | 1.  |
| Fluorspar              | Okorusu Fluorspar (Pty.) Ltd.          | Okorusu                                   | 40,000 98% calcium fluoride.                        |
| Gold                   | Navachab Gold Mine Co.                 | Navachab                                  | 1.5 Au.   |
| Marble cubic meters    | Karibib Marble                         | Karibib                                   | 2,500 marble; 600 granite.                          |
| Lithium                | SWA Lithium Mines (Pty.) Ltd.          | Near Karibib                              | 1,500 concentrate.                                  |
| Salt                   | Salt Company (Pty.) Ltd.               | Swakopmund                                | 150,000.  |
| Tin                    | Imcor Tin (Pty.) Ltd. Corp.            | Uis, 100 kilometers north of Karibib      | 1,200 Sn in concentrate.                            |
| Uranium                | Rossing Uranium Corp.                  | Rossing, 30 kilometers east of Swakopmund | 4,800 uranium oxide.                                |

Construction of a copper refinery remained a possibility because of good infrastructure, the availability of additional copper, both as imported blister and from Namibian mines, and relatively abundant, low-cost electric energy.

The Kombat Mine, flooded in late 1989 when the West Fault water-bearing fissure was breached during a blasting operation, neared full production capacity as pumps, hoists, and electric equipment were recommissioned. Difficult stragraply and inadequate local drilling equipment prevented local resolution of the problem. Nearly 580 tons of oil well drilling equipment, along with personnel, were brought 1,400 km from Potchefstroom in the Republic of South Africa via railroad to locate and plug the water fissure. A 312-millimeter main hole was drilled 530 m in 21 days to intersect the 5-m-wide development drift near the water fissure. Secondary holes were drilled off the main hole. Portland cement railed from Cape Town was used with local dolomite aggregate and fine sand to produce concrete for plugging the development drift. Over 800 m<sup>3</sup> of concrete was poured to seal off the rupture.

**Gold.**—The Navachab Mine reached nearly full capacity after 1 year of operation, producing about 2 mt/a of gold. The low-grade, open pit mine had reserves of about 9.5 Mmt averaging 2.6 g/mt, with a cutoff grade of 1.2 g/mt. Monthly output from the pit is about 500,000 tons at a stripping ratio of 5.5:1 for waste rock and ore. Mill design capacity was 62,000 mt/month. However, at yearend 1990 this had been expanded to 78,000 mt/month through management and control techniques. The low-grade and erratic nature of the gold, found as free gold in quartz veins and skarns within marble, required a computerized method to survey, sample, assay, and make ore block determinations to minimize low recovery.

**Tin.**—The Uis Mine, discovered in 1909 and operated by the Iron and Steel Corp. of South Africa since 1958, was closed because of lack of viability. Mining and milling costs have exceeded sale prices for some time, and the operator had a \$4.6 million loss in the 1990 financial year, with a \$6.6 million loss projected for the 1991 financial year.<sup>1</sup> Considered to be one of the largest hard-rock mining operations in the

world, only a small staff was being retained for care and maintenance. Purchase of tributor's output of tin and columbite-tantalite would continue, estimated at several hundred tons annually.

**Uranium.**—Rossing Uranium Ltd. was to reduce output sharply through 1993 owing to termination of sales contracts. The company was unable to establish new sales contracts prior to the country's April, 1990 independence because it was subject to trade sanctions. Open pit mining operations will be scaled back to 5 d/week from 7 d/week. Overall about 400 jobs would be eliminated out of a labor force of 2,400. Direct and indirect tax loss to the Government may be about \$24 million. A major contract with Total Compagnie Miniere of France was to take effect in 1995. Electricite de France would be the consumer of the 4,700 tons of uranium, to be supplied over a 7-year period. Output was forecast to be about 3,175 tons in 1991, and 2,950 tons in 1992 and 1993.

#### Industrial Minerals

**Diamond.**—The reduction in output from older coastal deposits owing to

depletion of reserves was made up by the commencement of new operations on the Orange River. Output by Consolidated Diamond Mines Ltd. was shipped to Windhoek for sorting and valuation. It was then shipped to London for final valuation and sale through the Central Selling Organization. Construction of cutting and polishing facility in Namibia was considered impractical owing to the costs involved.

**Fluorspar.**—Mill processing of fluorspar at the Okorusu Mine was hampered early in 1990 because of high phosphorous content and inadequate equipment. However, primary crusher capacity increased in April. By August product compliance with respect to phosphorous level was achieved for sales in Europe. At yearend the mine was expected to produce about 50,000 mt/a of fluorspar grading 97% CaF<sub>2</sub>.

**Granite.**—A granite deposit consisting of about 3.6 million m<sup>3</sup> of black, green, grey, and red stone was located on the Dymoeb Farm, about 10 km north of Klein Aub in Rehoboth district. The owner of the deposit sought equity or joint-venture participation to produce about 560 m<sup>3</sup>/month. Capital costs were estimated at \$1.5 million, and cost of production was estimated at \$139 per m<sup>3</sup>. Electricity was available nearby, and gravel and paved roads connected to Walvis Bay, about 600 km distant.

#### Mineral Fuels

There was no domestic output of crude petroleum or natural gas. The Oriental Petroleum Investment Corp. began a seismic and airborne magnetic survey of the Etosha

Basin northwest of Tsumeb. One well was to be drilled in 1991.

Assessment of the natural gas potential of the offshore Kudu Field was incomplete owing to the lack of sufficient test data. In order to extend the base of data available to international petroleum companies, Exploration Consultants Ltd. was conducting seismic tests for the Government, and planned 4,000 km of seismic work north of Walvis Bay in 1991. The company worked as advisor to the Government on Namibia's oil and gas potential. The greatest offshore potential was believed to be between Walvis Bay and the Orange River.

#### Reserves

Reserve data reported by operating companies in Namibia indicated reserves of about 1 billion carats, 270,000 tons of contained copper, 100,000 tons of contained uranium, 20 tons of gold, and 70 Mmt of ore grading .135% tin.

#### INFRASTRUCTURE

Walvis Bay, part of the Republic of South Africa, had the ability to accept 28,000 mt/d of refined petroleum products, although private oil firms at the Port had considerably larger handling capacity. Luderitz can handle 1,500 mt/d of product. Over 330 retail outlets handling petroleum products were in Namibia.

Electric power is primarily from the Ruacana hydroelectric plant using water diverted from the Kunene River in northern Namibia and southern Angola. Possible expansion of this potential has led to a feasibility

study for the Epupa project, downstream from Ruacana. A dam and hydroelectric plant at Epupa could provide 500 MW of electricity. Water cost were \$0.23 to \$0.77 per m<sup>3</sup> at yearend 1990. Electric power costs about \$0.029 per kW h.

#### OUTLOOK

New mining and investment legislation under consideration by the Government is expected to provide incentive and guarantees to foreign participation in the Namibian mining sector. The health of the industry will remain important to the country's overall economy as mineral exports are the main source of foreign exchange earnings. The loss of export sales of uranium, although expected to be short-lived, will have a negative impact on the sector's overall export earnings.

<sup>1</sup>Where necessary, values have been converted from rand (R) to U.S. dollars at the rate of R2.62=US\$1.00 for 1989 and R2.59=US\$1.00 for 1990.

#### OTHER SOURCES OF INFORMATION

##### Agencies

Association of Prospectors and Miners of Namibia  
P.O. Box 5059  
Windhoek 9000, Namibia  
Telephone 061 34798

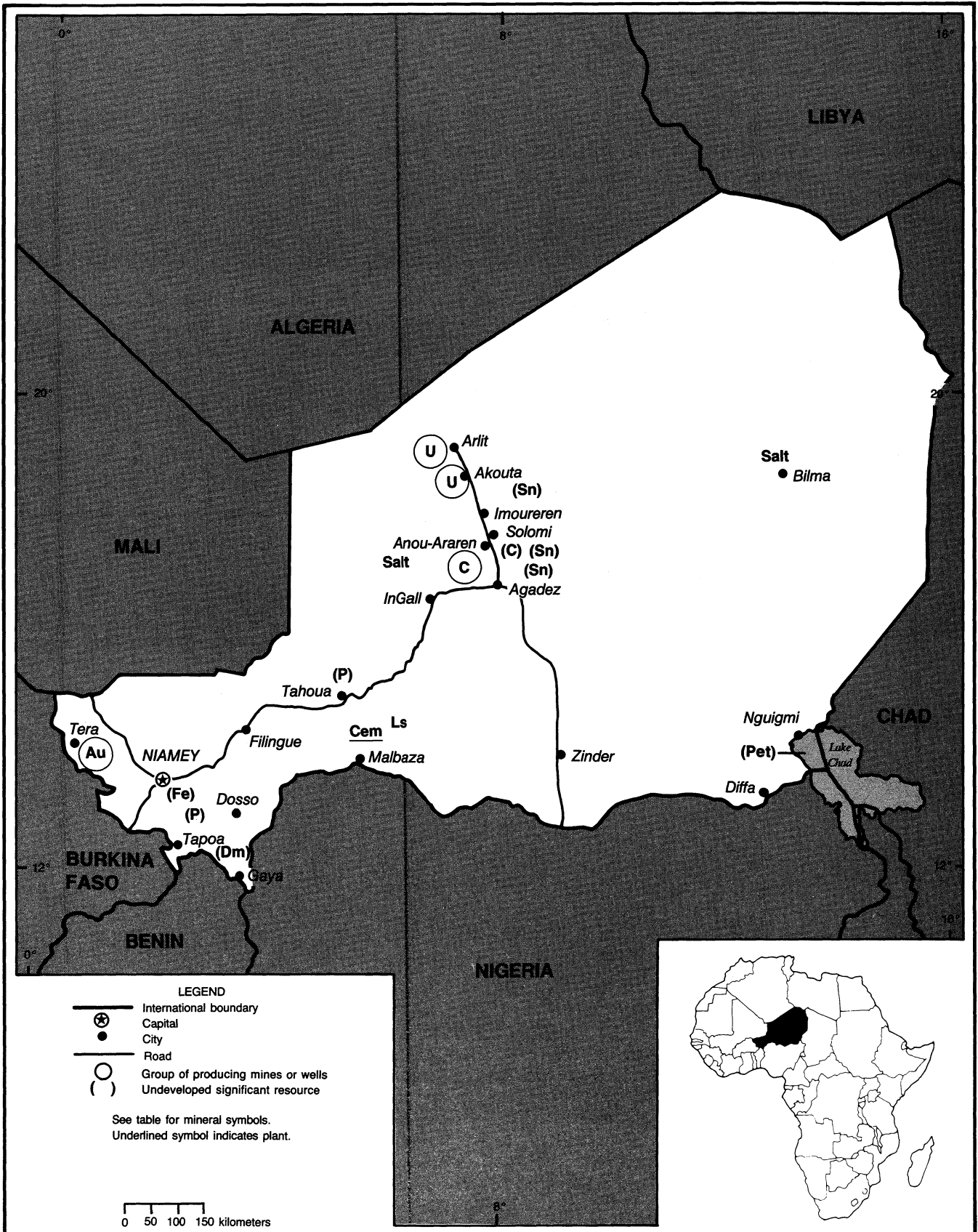
Geological Survey  
P.O. Box 2168  
Windhoek 9000, Namibia  
Telephone 061 37240; Fax 061 228324



# NIGER

AREA 1,267,000 km<sup>2</sup>

POPULATION 7.9 million



# THE MINERAL INDUSTRY OF NIGER

By David Izon

**N**iger remained the world's seventh largest producer and fourth largest exporter of uranium in 1990. Leading the economy was uranium production, exports of which were the dominant foreign exchange earner. Niger had the fifth largest uranium reserves in the world. The minerals sector accounted for about 7% of the GDP in 1990. Uranium accounted for 75% of total export proceeds and about 13% of Government revenue. Although the annual export volume of uranium remained constant, the export contract price and demand for uranium declined steadily.

The Government announced plans to restructure the uranium sector to make it more competitive. The two main buyers of Niger's uranium, France's Compagnie General des Matieres Nucleaires (COGEMA) and Japan's Overseas Uranium Resource Development (OURD), announced plans to halt subsidies to the country's uranium producers. A strike in May 1990 by the Union of Mine Workers caused France's Caisse Centrale de Cooperation Economique to call for a meeting of the principal donor countries, the local operators, the World Bank, and the Government. A restructuring plan was to be devised for the industry to prevent the failure of the two operating companies, the Société des Mines de l'Air (SOMAIR) and Compagnie Minière d'Akouta (COMINAK).

The Government was also seeking to attract foreign and domestic private investment in all aspects of the country's economy with its liberal investment policies.

## GOVERNMENT POLICIES AND PROGRAMS

Niger continued with the structural adjustment program of its economy in 1990. Major objectives of the program were to stimulate growth in the mineral sector, curtail civil service size, and increase public and foreign investment in infrastructure and the minerals sector. Emphasis was on the development of other minerals such as coal, gold, and oil. Other policy objectives were directed toward diversifying the participation in exploration for and production of miner-

als. Foreign investment was encouraged, with incentives in the form of tax breaks and the waiving of custom duties for imported materials. The European Development Fund, administered through the Ministère des Mines et de l'Énergie, established a \$12.4 million program for the reassessment of gold and coal resources in the country. The initial objectives were to conduct aerial surveys, collect and revise existing geologic data, and perform strategic prospecting. Also, plans include site evaluation and development of pilot projects. A feasibility study and construction of a coal washing plant at the Aaren Solomi coalfields is planned for 1992. An ongoing restructuring program for the uranium sector to reduce production costs to competitive levels relative to long-term contract prices continued.

In 1990, France and the United States forgave certain debts owed by the country, and Niger benefited from a new debt reduction fund to buy back all of its outstanding commercial bank debts. The buy-back program allowed the country's debt service to be cut in half to \$30 million per year and leaves the country's outstanding foreign debts owed only to Governments and multilateral organizations.

## PRODUCTION

Niger's mining industry was dominated by uranium production, with relatively

smaller amounts of cement, clays, coal, gold, salt, and tin. Hindered by the uranium mines' high production costs, the Government had little success selling its uranium to new customers. Coal was produced in Anou-Araren, about 80 km northwest of Agadez. Phosphate deposits at Tapoa in southwest Niger, estimated to contain about 400 to 500 Mmt, were not exploited.

## TRADE

Niger's major imports from the United States were food items, machinery, and spare parts valued at \$10 million in 1989, the latest year for which data were available. Exports to the United States in 1989 amounted to about \$2 million. Total imports amounted to about \$450 million in 1989, creating a negative trade balance of about \$83 million. Principal export products for 1989 were uranium, agricultural products, and tin. In 1989, the value of uranium exports amounted to about \$235 million. Areas of particular interest to the U.S. industries included oil exploration, industrial equipment, and other manufactured goods. Niger's main trading partners were France and Nigeria. More than 80% of the country's recorded exports were to France, and 35% of imports was obtained from France, the largest purchaser of Niger's uranium. Niger imported vehicles, machinery, and elec-

TABLE 1

### NIGER: PRODUCTION OF MINERAL COMMODITIES

(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>                          | 1986    | 1987    | 1988                 | 1989 <sup>c</sup>   | 1990 <sup>c</sup> |
|---|---------|---------|----------------------|---------------------|-------------------|
| Cement, hydraulic <sup>c</sup>                  | 38,000  | 40,000  | <sup>3</sup> 26,400  | <sup>3</sup> 27,000 | 27,000            |
| Coal  | 123,644 | 164,313 | <sup>e</sup> 160,000 | 171,434             | 170,000           |
| Gypsum <sup>c</sup>                             | 3,000   | 3,000   | 3,000                | 3,000               | 3,000             |
| Molybdenum concentrate, Mo content <sup>c</sup> | 20      | 8       | 15                   | 13                  | 10                |
| Salt <sup>c</sup>                               | 3,000   | 3,000   | 3,000                | 3,000               | 3,000             |
| Tin, mine output, Sn content                    | 80      | 94      | 119                  | 71                  | 70                |
| Uranium, content of concentrate                 | 3,662   | 3,493   | 3,482                | 3,013               | 3,000             |

<sup>c</sup>Estimated.

<sup>1</sup>Includes data available through Dec. 18, 1991.

<sup>2</sup>In addition to the commodities listed, Niger also produced clay and sand and gravel for local construction purposes; however, available information is inadequate to make reliable estimates of output levels.

<sup>3</sup>Reported figure.

tronic equipment from France and imported petroleum products and other consumer goods from Nigeria. Other important trading partners were the Federal Republic of Germany, Italy, and Japan.

## STRUCTURE OF THE MINERAL INDUSTRY

The Government participated in equity sharing arrangements with several companies through its ministry of mines, Office National des Ressources Minières (ONAREM). Production of uranium concentrates were by two companies, SOMAIR and COMINAK. An unknown amount of gold is produced by artisanal miners.

## COMMODITY REVIEW

### Metals

**Gold.**—Niger has considerable gold potential, but the Government declined to lease mining concessions until a full assessment of the extent of the resources are determined. In 1990, gold mining was done by small-scale artisanal miners in the Koma Bangou goldfield, 120 km northwest of Niamey. However, other deposits were known to exist along the Niger-Burkina Faso border.

**Tin.**—Small quantities of tin ore were mined from El Mecki, Tarouadji, Timie, Agahak, and Cuissat in the Air Mountains by private individual operators. Production was at its lowest in 1990, below a planned level of 250 mt/a owing to lower demand.

**Uranium.**—Uranium concentrate is produced mainly from two concessions, one near the town of Arlit, 250 km northwest of Agadez, and the other at Akouta. The operators, SOMAIR and COMINAK, were joint ventures between the Government and several French, German, Japanese, and Spanish firms. SOMAIR operated three open pit mines near Arlit that produced uranium silicate while COMINAK operated a single underground mine at Akouta. The managements of both companies were controlled by France's COGEMA, although the Nigerien Government held the largest equity shares in both firms. Niger's total production for 1990

TABLE 2

## NIGER: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

(Metric tons unless otherwise specified)

| Major commodity | Major operating companies                   | Location of main facilities | Annual capacity |
|-----------------|---|-----------------------------|-----------------|
| Cement          | Societe Nigerienne De Cimenterie            | Malbaza                     | 37,000.         |
| Coal            | Societe Nigerienne De Charbon d'Anou Araren | Anou-Araren                 | 150,000.        |
| Tin             | Societe Miniere du Niger                    | El Meki                     | 100.            |
| Uranium         | Societe Des Mines De L'Air                  | Arlit and Taza              | 3500 combined.  |
|                 |   | Akouta                      | 2,000.          |

was 3,000 tons (metal). Production had been on a decline since 1986 stemming from low world demand for uranium and subsequent decline in prices. The international spot price of  $U_3O_8$  in early 1991 was \$9.20 but contracted buying prices for Niger's  $U_3O_8$  remained at \$28 per pound.

### Reserves

According to the International Atomic Energy Agency (IAEA), uranium (metal) reserves in the Arlit-Akouta region in 1990 were estimated to be approximately 210,000 tons. Substantial but undeveloped resources were also reported to exist in other parts of the country. Total reserves also estimated by the IAEA are about 360,000 tons. Coal resources are estimated at 6 Mmt. There were no official reserve figures in 1990 for other minerals produced in the country.

## INFRASTRUCTURE

There was 39,970 km of roads in 1990. The total distance of paved roads were 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 3,330 km to 3,470 km. There were no existing railways, but plans were under discussion to extend the Cotonou-Parakou line in the Republic of Benin to Niger. The inland waterway of the Niger River was navigable 300 km from Niamey to Gaya on the Benin border from mid-December to March. The bulk of foreign trade was shipped through Cotonou in Benin via the organization Commune

Benin-Niger des Chemins de Fer et des Transports. Other transport routes were through Burkina Faso, Nigeria, and Togo because Niger is landlocked. Ocean terminals in Benin and Togo were about 1,000 km from Niger.

## OUTLOOK

Uranium will remain the mainstay of the economy for the immediate future. However, the longrun goals are aimed at diversifying the economy by gradual development of other minerals such as gold, iron ore, and petroleum. The short-term economic future of Niger is not very promising, but current efforts by the Government to reschedule debts coupled with investments by prominent oil companies could yield a welcome addition to the economy. Both Elf Aquitaine Oil Co. of France and Exxon Oil Co. have already established deposits of commercial quantity in the explored region. Prospects for commercial development of gold also appear good. The Government's economic recovery program, if continued, should improve the country's industrial growth. Foreign participation in the mineral industry is expected to continue.

<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 CFA310=US\$1.00 in 1990.

## OTHER SOURCES OF INFORMATION

Office Nationale des Recherches Minières  
B.P. 734  
Niamey, Niger

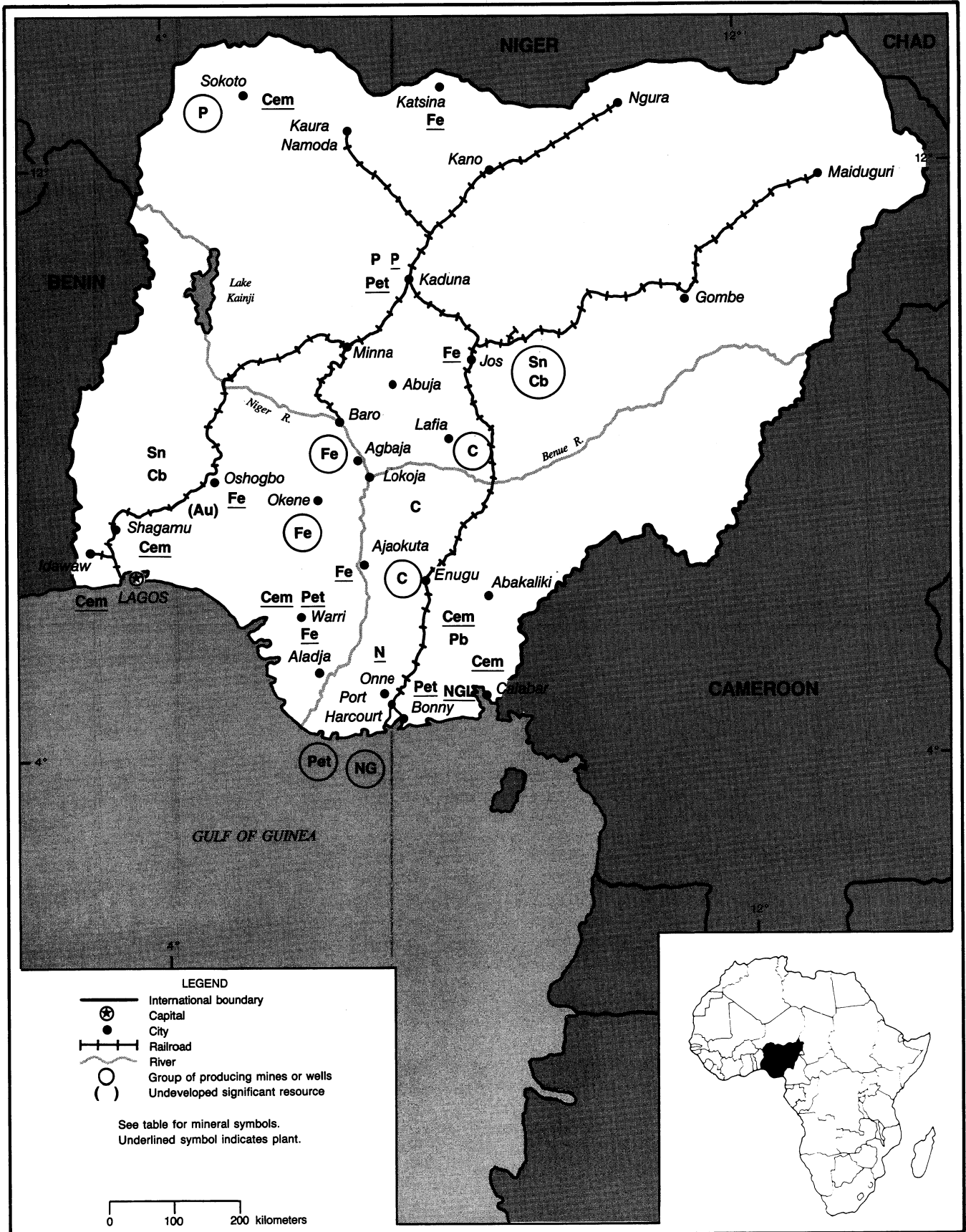




# NIGERIA

AREA 923,770 km<sup>2</sup>

POPULATION 118.8 million



# THE MINERAL INDUSTRY OF NIGERIA

By David Izon

In 1990, Nigeria was Africa's largest crude oil producer and was the 10th largest in the world. Nigeria accounted for 2.7% of world production and 8% of OPEC's total production. The hydrocarbon sector remained the mainstay of the economy, accounting for about 30% of GDP of \$26.6 billion.<sup>1</sup> The oil sector accounted for 82% of total Government revenues in 1990 and about 97% of the country's total export earnings. The value of exports from the oil sector amounted to about \$13.2 billion in 1990. The country has considerable mineral wealth and potential for diversified development of the mineral industry. Vast reserves of natural gas exist and barely have been exploited. However, efforts to increase reserves to about 20 billion barrels by 1995 was emphasized with the country giving concessions to several companies for prospecting. Some of such efforts have started to pay off, with British Petroleum Co. (BP) of the United Kingdom, Conoco Oil Co. of the United States, and Den Norske Stats Oljeselskap (Statoil) of Norway acquiring concessions in addition to the existing companies in the country.

Nigeria was the second largest supplier of oil to the United States, accounting for 14% of U.S. total imports. The Government announced plans to give high priority to natural gas-based projects in an effort to diversify the country's hydrocarbon exports and ensure production by the mid-1990's. The Government announced its intention to establish several export processing zones that were meant to encourage export-oriented investment.

## GOVERNMENT POLICIES AND PROGRAMS

The thrust of Nigeria's economic policies and programs in 1990 continues to be summarized in the Structural Adjustment Program (SAP) that was started in 1986 by the Government. As an integral part of SAP, the Government instituted policies to remove past legal barriers erected to limit foreign direct investment. A move was made to privatize or commercialize most

of the nation's Government-owned corporations. To this end, average tariffs were lowered, businesses were permitted to remit 100% of their net profits, and expatriates were allowed to remit 75% of their salaries.

Because oil served as the main revenue source for the country, it was evident that the national policy was closely related to programs associated with fuel minerals. The Government's main policy was to maximize returns from petroleum exports by limiting domestic consumption. To this end, a policy was adopted to look for ways to substitute natural gas for other fuels for industrial and residential use, thereby freeing more crude oil for export. Under a plan to increase production capacity, the Government guaranteed minimum profit margins of \$2 per barrel for oil companies and offered tax incentives to companies undertaking exploration and development. Contracts were signed to build new petrochemical plants and refurbish the existing refineries to accommodate the Nigerian LNG project. The Government's plans to acquire equity in overseas refineries have been temporarily suspended. A pipeline system connecting the Kaduna, Warri, and Port Harcourt refineries was underway, which will help to alleviate problems of product shortages created by an inadequate distribution system. The Government had made plans to construct natural gas pipelines to neighboring countries to facilitate transportation. The Government embarked on an incentive program that stressed the other factors of the economy such as agriculture and exploitation of other mineral resources. A significant foreign exchange policy was adopted to move the exchange and interest rates closer to market value.

## PRODUCTION

The mineral industry experienced some growth in 1990, resulting mainly from the increased output of crude petroleum and natural gas. OPEC was able to increase its total production ceiling to 19.5 Mbbbl/d, allowing member countries to produce above their allotted quotas. Crude oil production in 1990 averaged 1.8 Mbbbl/d. Re-

portedly, output of most other minerals declined in 1990 except coal and clay minerals.

## TRADE

Nigeria recorded a trade surplus of \$1.5 billion in 1990 compared with \$158 million in 1989. Value of total exports amounted to about \$13 billion, of which petroleum accounted for about 95%. Mineral exports other than oil accounted for 4.9% of total exports. The United States remained Nigeria's fifth largest export market after the United Kingdom, France, the Federal Republic of Germany, and Italy. Reports indicate that about \$6.9 billion was spent on imports in 1990, representing an increase of 25% over that of 1989. U.S. imports from Nigeria amounted to about \$5.9 billion in 1990, of which 98% was crude petroleum. The U.S. trade deficit with Nigeria in 1990 was more than \$5 billion. The United States was Nigeria's fifth most important supplier of industrial inputs and capital equipment. Nigeria was exploring ways of exporting its natural gas to the neighboring West African countries and elsewhere. In early 1991, sales agreements were signed with Gaz de France of France, Enel gas Co. of Italy, Enagas Co. of Spain, and Distrigas Corp. of the United States.

## STRUCTURE OF THE MINERAL INDUSTRY

The Nigerian mineral industry in 1990 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., 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.,

TABLE 1  
Nigeria: Production of mineral commodities<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity  | 1986               | 1987               | 1988               | 1989 <sup>p</sup>   | 1990 <sup>p</sup>   |
|--|--------------------|--------------------|--------------------|---------------------|---------------------|
| <b>METALS</b>                                      |                    |                    |                    |                     |                     |
| Columbium and tantalum concentrates, gross weight: |                    |                    |                    |                     |                     |
| Columbite  | 13                 | 48                 | 50                 | 46                  | 44                  |
| Tantalite  | —                  | —                  | —                  | —                   | <sup>2</sup> —      |
| Iron and Steel:                                    |                    |                    |                    |                     |                     |
| Iron ore, gross weight                             | —                  | 240                | 304                | <sup>e</sup> 300    | 374                 |
| Steel, crude                                       | 200                | 184                | 192                | <sup>e</sup> 200    | 133                 |
| Lead:  |                    |                    |                    |                     |                     |
| Mine output, Pb content <sup>e</sup>               | 100                | 86                 | 85                 | <sup>2</sup> —      | 106                 |
| Metal, refined secondary                           | 1,000              | 300                | 500                | <sup>e</sup> 500    | <sup>e</sup> 1000   |
| Tin:   |                    |                    |                    |                     |                     |
| Mine output, cassiterite concentrate:Gross weight  | 630                | 844                | 432                | 350                 | 227                 |
| Sn content   | 460                | 603                | 300                | <sup>e</sup> 254    | <sup>e</sup> 165    |
| Metal, smelter                                     | 91                 | 560                | 566                | 258                 | 310                 |
| Zinc ore and concentrate, Zn content               | ( <sup>3</sup> )   | ( <sup>3</sup> )   | ( <sup>3</sup> )   | <sup>2</sup> —      | <sup>2</sup> —      |
| <b>INDUSTRIAL MINERALS</b>                         |                    |                    |                    |                     |                     |
| Cement, hydraulic                                  | 3,860              | <sup>e</sup> 5,382 | <sup>e</sup> 3,500 | 3,500               | <sup>e</sup> 3,500  |
| Clays:   |                    |                    |                    |                     |                     |
| Kaolin   | 169                | 177                | 105                | 500                 | 1,356               |
| Unspecified  | 15,000             | 15,000             | 15,000             | 13,341              | 60,113              |
| Feldspar   | <sup>e</sup> 3,500 | 485                | 190                | 945                 | 714                 |
| Nitrogen:  |                    |                    |                    |                     |                     |
| N content of ammonia                               | —                  | 225                | <sup>e</sup> 300   | 364                 | <sup>e</sup> 360    |
| N content of urea                                  | —                  | 200                | <sup>e</sup> 260   | 522                 | <sup>e</sup> 550    |
| Stone:   |                    |                    |                    |                     |                     |
| Limestone  | 1,850              | 2,627              | 1,712              | 1,315               | 1,136               |
| Marble   | 1,482              | 6,900              | 5,445              | 1,377               | 1,605               |
| Shale  | 104                | 88                 | 86                 | 38                  | 67                  |
| <b>MINERAL FUELS AND RELATED MATERIALS</b>         |                    |                    |                    |                     |                     |
| Coal do.   | 144                | 110                | 150                | <sup>e</sup> 28     | 78                  |
| Gas, natural:                                      |                    |                    |                    |                     |                     |
| Gross  | 18,179             | 18,687             | 20,740             | 24,831              | <sup>e</sup> 26,500 |
| Marketed   | 3,285              | 2,852              | 3,193              | 3,833               | <sup>e</sup> 4,050  |
| Petroleum:   |                    |                    |                    |                     |                     |
| Crude  | 534,165            | 486,869            | 569,400            | 626,489             | 669,393             |
| Refinery products:                                 |                    |                    |                    |                     |                     |
| Gasoline   | 18,600             | 19,000             | 21,000             | 23,337              | 30,706              |
| Jet fuel   | 400                | 490                | 500                | <sup>e</sup> 510    | <sup>e</sup> 700    |
| Kerosene   | 8,700              | 9,000              | 10,600             | 11,873              | 14,521              |
| Distillate fuel oil                                | 12,400             | 12,500             | 15,000             | 17,591              | 17,366              |
| Residual fuel oil                                  | 15,330             | 14,000             | 13,600             | 19,254              | 23,935              |
| Unspecified  | 4,700              | 5,000              | 5,000              | 2,274               | 3,806               |
| Total  | 60,130             | 59,990             | 65,700             | <sup>e</sup> 74,839 | <sup>e</sup> 91,034 |

<sup>e</sup>Estimated. <sup>p</sup>Preliminary.

<sup>1</sup>Includes data available through Nov. 15, 1991.

<sup>2</sup>Reported figure.

<sup>3</sup>Less than 1/2 unit.

and the Nigerian Steel Development Authority. All important minerals such as coal, columbite and tin were mined by Government-owned companies or agencies.

## COMMODITY REVIEW

### Metals

Reports indicate that gold and lead occurrences were known in the country that had been extensively explored by the Nigerian Mining Corp. The lead-zinc-copper veins occurred within a mineralized zone stretching from near Abakaliki in the southeast to Gombe in the northeast. Deposits of galena and sphalerite were found in the Cretaceous sediments along the Benue Rift structure, with accessory barite and fluor spar. The Abakaliki lead-zinc ore deposits were currently being exploited.

**Iron and Steel.**—Iron ore deposits discovered recently in other parts of Nigeria were of the hematite-magnetite, hematite-goethite and siderite-goethite types. These deposits are mineralogically and geologically similar to that of Agbaja and Itakpe grading 37% to 47%. Deposits of commercial significance were at Ajabanoko, Chokochoko, and Agbade-Okudu grading 30% to 47% Fe in addition to those at Agbaja and Itakpe. Nigeria is in the process of developing a steel industry with two major projects and several steel mills in different parts of the country. In 1990, the National Iron Ore Mining Co. (NIOMC) produced about 374,000 tons of iron ore from the east and west open pit mines at Itakpe near Okene, with most of the output being stockpiled for the Ajaokuta steel complex to be commissioned in October 1992. Some of the problems facing the steel industry in Nigeria are dependency on imported inputs as feed materials, inadequate transportation system, and lack of capital for proper funding of the projects. The ores that occur mainly around Okene and Agbaja near Lokoja are of a low-grade and require beneficiation before being usable in the steel industry. The Itakpe beneficiation plant was being established primarily to supply iron ore for the Ajaokuta and Delta Steel plants. The Government expects to complete the Itakpe project by October 1991 in order to reduce the importation of iron ore. As the Ajaokuta and the Itakpe projects were still under construction, the higher grade ore required for direct feed into the furnace was imported mainly from Brazil for use at Delta's direct reduction plant at Aladja. The

TABLE 2  
NIGERIA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990  
(Million metric tons unless otherwise specified)

| Major commodity                     | Major operating companies          | Location of main facilities | Annual capacity                                   |
|-------------------------------------|------------------------------------|-----------------------------|---|
| Coal<br>thousand metric tons        | Nigerian Coal Corp.                | Enugu                       | 144.  |
| Iron ore                            | National Iron Ore Mining Co.       | Itakpe, near Okene          | 325.  |
| Do.                                 |                                    |                             |   |
| Iron and steel                      | Ajaokuta Steel Co. Ltd             | Ajaokuta City               | 1.2.<br>.54<br>(rolled steel).                    |
| Do.                                 | Delta Steel Co. Ltd                | Aladja                      | 1.00<br>(liquid steel).<br>.32<br>(rolled steel). |
| Do.                                 | Jos Steel Rolling Co. Ltd          | Jos                         | .21.  |
| Do.                                 | Katsina Steel Rolling Co. Ltd      | Katsina                     | .21.  |
| Do.                                 | Oshogbo Steel Rolling Co. Ltd      | Oshogbo                     | .21.  |
| Nitrogen:<br>thousand metric tons   | National Fertilizer Co. of Nigeria | Onne                        | 548<br>N content of<br>ammonia.                   |
| Do.                                 | do.                                | do.<br>N content of urea.   | 360   |
| Petroleum, crude<br>million barrels | Nigerian National Petroleum Corp.  | Lagos                       | 695.  |
| Petroleum refinery products         | Kaduna refinery                    | Kaduna                      | 40.   |
| Do.                                 | Warri refinery                     | Warri                       | 46.   |
| Do.                                 | New Port Harcourt refinery         | Port Harcourt               | 55.   |
| Do.                                 | Old Port Harcourt refinery         | do.                         | 22.   |
| Tin<br>thousand metric tons         | Makeri Smelting Co. Ltd            | Jos                         | 1.  |

civil unrest in Liberia had interrupted imports from that country in 1990. It is estimated that the beneficiation plant would upgrade the Itakpe iron ore to 64% and 68% Fe for Ajaokuta and Aladja, respectively. The Itakpe plant is expected to supply 2.155 Mmt/a of concentrates grading 64% Fe to Ajaokuta and 555,000 mt/a of super concentrates grading 68% Fe to Aladja. The 63-km Itakpe-Ajaokuta railroad project designed to transport iron ore from Itakpe to Ajaokuta was commissioned in October 1990. Work on a 365-km railroad project linking Ajaokuta and the Delta Steel Complex at Aladja near Warri was started in late 1990. Other secondary and service roads to the steel mills were at advanced stages of construction.

Production of raw material requirements for the steel industry in the country, such as coke from coal, is feasible. The Nigerian National Metallurgical Development Center determined that 41% of the country's coal reserves could be converted to coke. Funding so far by the Government had enabled the NIOMC to produce and stockpile substantial quantities of iron ore and

encouraged continued development of the project.

In early 1991, the Government was able to reach agreement with the U.S.S.R. to reschedule \$842 million of the existing debt owed to the U.S.S.R., thereby enabling continuation of the Ajaokuta project.

**Tin.**—Tin production in the country was at its lowest since the early 1970's, from 10,000 mt/a to 227 mt/a in 1990. An additional estimated 400 mt/a may have been lost in 1990 through smuggling to neighboring countries. There were plans underway to renovate the tin mine in Jos in early 1991. Major reasons for the weak domestic tin industry are that the cassiterite is found at a depth of about 70 m, which is too expensive to extract by open pit methods and too shallow for underground mining due to ground water conditions. The reduction in production was also due to a fall in world tin prices; smuggling, which is estimated to be 70% of production; frequent flooding of the mines; and the high cost of production due to lack of spare parts and high inflation. In 1990, Nigerian tin was mined

commercially from alluvial deposits by two major companies, Consolidated Tin Mines Ltd. and Nigerian Tin and Allied Minerals Products Ltd. Cassiterite was mined in association with columbite, tantalite, and tungsten minerals.

### Industrial Minerals

The National Fertilizer Co. of Nigeria (NAFCON) was the only plant producing ammonia and urea. The existing facility at Onne, near Port Harcourt, maintained its output of about 1,000 mt/d of ammonia, which was 97% of capacity. The complex also produced 1,500 mt/d of urea, as well as various nitrogen-phosphorous-potash (NPK) fertilizers. The plant was a joint-venture operation between the NNPC and M. W. Kellogg Co. of the United States, which owns 35% of NAFCON. Natural gas for NAFCON was supplied from the Alakiri Field via a 14-km pipeline system.

### Mineral Fuels

**Coal.**—Coal contributed very little to the country's energy consumption. The Enugu coal field was the primary producing field in the country. Production was maintained at about 144,000 mt/a, mainly for use by the National Electric Power Authority, the Nkalagu cement factory, and the Nigerian Railway Corp. The Enugu-type coals were of low grade and show very little coking properties for use at Ajaokuta. The Lafia type coals are of a medium rank having good coking properties but high ash and sulfur contents. The indicated reserve value of the Lafia coal is 22 Mmt. Production of coal was solely by the Nigerian Coal Corp. (NCC) and its subsidiary, the Eagle Mining Co.

**Natural Gas.**—Nigeria produced about 26.5 billion m<sup>3</sup> of natural gas in 1990, of which 24% was utilized. Most of the gas was produced as associated gas from oilfields, and about 73% of the gas produced in 1990 was flared. NNPC markets the gas used in the country through its subsidiary, the Nigerian Gas Co. In January of 1990, the Utorogu gas plant was commissioned with an installed capacity of 7.65 Mm<sup>3</sup>/d. Gulf Oil Co. of Nigeria had proposed to gather all the associated gas from three of its fields as feed to a processing plant for production and export of liquefied natural gas at Bonny near Port Harcourt. The gas that remained after stripping was expected to be sold locally. The plant was to begin

operation by 1995, with an initial capacity of 4.25 Mm<sup>3</sup>/d. Construction was scheduled to begin in 1991, with export of LNG scheduled for 1995.

**Petroleum.**—The production of crude oil rose in 1990 to about 669 Mbbl. During the first half of the year, the production rate increased from 1.82 Mbbl/d in January to 1.9 Mbbl/d in September. In July, the rate decreased slightly to about 1.67 Mbbl/d. Exports fluctuated from about 70% of production in February to about 90% in August, but averaged 83% of production for the rest of 1990. The balance was disposed of mainly in deliveries to local and offshore refineries for manufacture of petroleum products.

**Exploration and Development.**—Eleven companies explore for, develop, and produce crude oil in Nigeria. Eight of the 11 companies have joint ventures with NNPC, which has a 60% share in all of them. Shell Oil Co. was the largest producer of crude oil in the country, accounting for 50% of total production in 1990.

Shell Petroleum Development Co. planned to increase its \$700 million investment to \$1.2 billion by 1992 and aimed at increasing its productive capacity to 1.3 Mbbl/d in Nigeria. Mobil's Iyak Field, developed in 1989, reached a peak capacity of 52,000 bbl/d in 1990. The company expects reserves to total about 150 Mbbl by 1993.

**Refining and Marketing.**—Nigeria has four refineries, with a combined design capacity of 445,000 bbl/d. The combined output for 1990 was 62% of capacity due to various technical problems at the refineries. There are two refineries in Port Harcourt, the old one and a new one built near it. The new Port Harcourt refinery, commissioned in March 1989 and designed to meet rapidly rising domestic demand for petroleum products, operated at 75% of capacity in 1990. Most products were for domestic use except the heavier products, which were exported. The supply of crude oil to the domestic refineries increased by 6% over that for 1989.

**Petrochemicals.**—A new development project for the Nigerian petrochemical industry was designed to be implemented in three phases. Plants constructed under phase I of the project were reported to have operated at 20% of optimum capacity in 1990.

Phases I and II were designed to manufacture nitrogen and plastic products, respectively. Phase III is designed to produce advanced petrochemicals of simple aromatic-xylene type. Construction on phase III will not start until phase II is completed. The engineering, procurement, and construction contracts for phase II were awarded to a consortium composed of Japanese, French, and Italian companies in May of 1990. The estimated costs of the projects were about \$1.2 billion. Export marketing agreements were signed with Dupont Oil Co. of Canada and Tochiati International of Italy. Contractors for the construction were Chiyoda and Kobe of Japan, Tecnimont of Italy, and Spie Batignolles of France.

### Reserves

Nigeria was estimated to have oil reserves of approximately 16 billion barrels, which could be increased to 20 billion by 1995. Known natural gas reserves were about 2.6 trillion m<sup>3</sup> ranking Nigeria fifth in the world in natural gas resources. Almost 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% Fe. Reserve figures for columbite, feldspar, lead, phosphate, tin, zinc, and other minerals were unavailable.

## 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 Kafanchan. There are also five branch lines with railheads at Nguru, Kaura-Namoda, Jos, Idogo, 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, 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 proposed new capital of the country.

## OUTLOOK

Petroleum and natural gas will remain the mainstays of the economy for the foreseeable future. However, the key to new industrial development in Nigeria will continue to be based on the successful completion and operation of the iron and steel complexes. The iron and steel complex at Ajaokuta that was expected to be commissioned by the end of fiscal 1991 was postponed to October 1992. With the development of the steel industry, heavy

equipment and metal-working industries are expected to grow, providing jobs for the extensive labor force yet untapped. Exploitation of recent coal discoveries and joint-venture agreements with foreign countries are designed to improve the coking properties, and increased production of coal will reduce importation of coal and coke. Revenues thus saved will be used to fund other capital ventures. Some of the raw materials will continue to be imported because domestic supplies will likely remain insufficient. The mineral industry as a whole should continue to enjoy considerable growth because of increasing activity in the mineral fuels sector. The output of crude petroleum is expected to be raised to 2 Mbbl/d by 1995. Because of its abundance, natural gas is being promoted as an energy source and as a chemical and petrochemical feedstock. The rescheduling in 1990 of Nigeria's foreign debt of \$32 billion will enable the country to continue to undertake major fiscal projects aimed at promoting rapid industrial growth. Assuming no major declines in world oil prices, Nigeria's goals

of achieving industrial stability in the near future may be feasible. Natural gas is expected to displace a small percentage of oil products from the local market and emerge into a substantial export business at the completion of the LNG program. When outlined plans for a pipeline system to neighboring countries are completed, gas could play a significant role in slowing the deforestation of West Africa. The Government's fiscal and financial incentive programs to encourage local and foreign investment in new developments in the mineral industry is expected to continue through the mid-1990's.

<sup>1</sup>Where necessary, values have been converted from Nigerian naira (N) to U.S. dollars at N10.65=US\$1.00 in 1990.

## OTHER SOURCES OF INFORMATION

Federal Ministry of Mines and Power

Six Storey Building,

Lagos, Nigeria

Nigerian National Petroleum Corporation

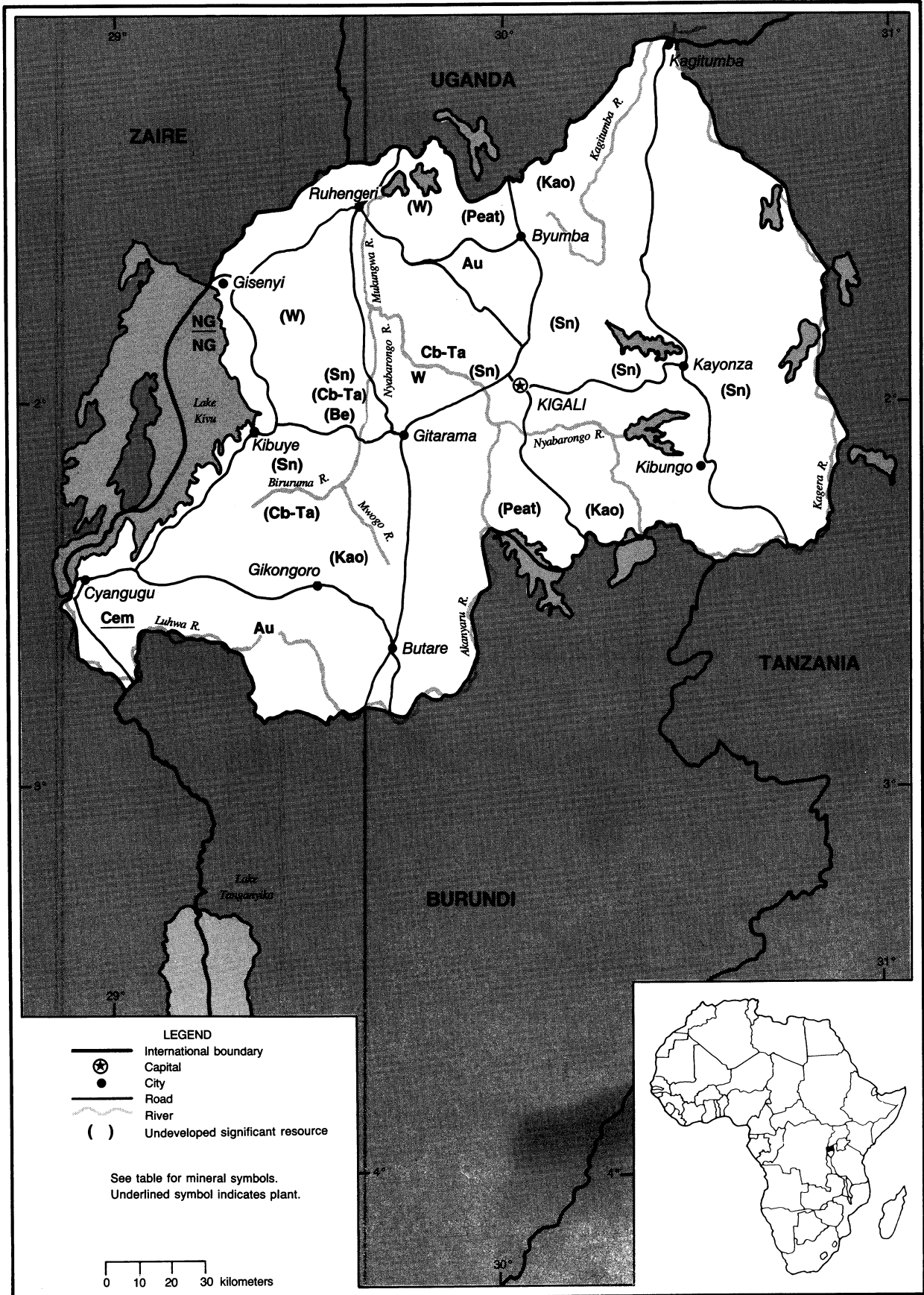
NNPC Building Falomo

Lagos, Nigeria

# RWANDA

AREA 26,340 km<sup>2</sup>

POPULATION 7.6 million



# THE MINERAL INDUSTRY OF RWANDA

By Lloyd E. Antonides

No major change in the status of Rwanda's mineral industry for 1990 was reported. Thus, it appeared to be recovering slightly from the mid-1980's slump. While minerals again made only a very small contribution to the economy, the Government continued promotional efforts toward more significant development of the rather attractive production potential for a variety of minerals. But possibilities of near-term investment in expansion of mineral production became less likely after October when Rwandan exiles from past tribal conflicts invaded from Uganda. Hostilities continued into 1991 in the north and east.

Data on the GDP contribution from minerals in recent years was not yet available by mid-1991, but probably was somewhat less than the 2% recorded in the early 1980's. Latest data indicated that, in that period minerals provided up to 15% of annual export earnings. Data for 1989 showed exported mineral products, excluding gold that was reported produced, were more than 6% of the total value of exports—\$6.6 million out of \$101.8 million.<sup>1</sup> The GDP for 1990 was \$2.04 billion according to International Monetary Fund data, and remained one of the world's lowest per capita. In current Rwanda francs, this showed a decrease of about 2.5% for the second year in a row but well within the range of fluctuations reported over the past 5 years. However, the economy was considered to be in a declining trend.

As always, the economy was heavily dependent on agriculture. Including processing, it comprised about 40% of GDP. Foreign aid also was a major factor in the economy, as it had been for at least the past decade, as export earnings dropped and Government budget deficits rose. Although most of the agricultural activity was subsistence farming, coffee and tea exports provided more than 90% of export earnings. Thus, the continued drop in coffee prices—1990's was less than one-half that of 1985-86—caused difficulties in the economy. In spite of the Government's attempt at maintaining prudent economic management based on long-standing conservative fiscal and monetary policies, the consumer price

index for 1990 rose more than 4% above that of 1989—still modest but the highest in the 5 years since 1985's 1.1% deflation.

The population in the Maryland-size, rugged highland country was very dense and the annual growth rate was more than 3.5%. An overwhelming majority of the officially French-speaking, mostly Christian population lived on farms. More than 90% of the active labor force had agriculture-related occupations. Literacy was almost 50%. A rather stable, though military-dominated, political environment existed for nearly two decades until the October invasion by exiles, most of whom had been living in Uganda for many years.

The Government long maintained a liberal approach to trade and investment, and legislation encouraged foreign investment. A new investment code went into effect in 1987 that simplified procedures and offered more incentives. Import controls were still restrictive, but tax and trade reforms were part of structural adjustment talks with the World Bank/IMF that continued through 1990 into 1991. Since the mining difficulties in 1985, the Government regularly budgeted for studies on how best to restructure and revive the minerals industry, especially the tin sector. *Regie d'Exploitation et de Development des Mines (REDEMI)*, an organization created in 1988—but reportedly only 51% owned—by the Government for the purpose of reopening 20 old tin and tungsten mines, was having some success based on latest country production statistics. A year or so earlier, another presumably Government-associated agency, *Cooperative de Promotion de l'Industrie Miniere Artisanale (COPIMAR)*, was established to train artisans in mining-related activities, reportedly with European Development Fund backing. Also, the UN and individual countries had several projects to aid mineral development over the past decade.

Mineral production statistics that became available in 1990 showed a somewhat better picture of mine output in the previous few years than had earlier been the case. Apparently, 1990 witnessed continued mine production by cooperatives and individual artisans. This included ores and concen-

trates of gold, tin, tungsten, and columbium-tantalum from a few of the many recorded deposits of a large variety of minerals. Production of natural methane gas—for use as fuel in a brewery—as well as limestone and cement also was maintained. Minor production of gem stones was reported as well, and undoubtedly, some construction materials were produced.

Mineral trade data available for Rwanda showed that historically, Europe—particularly Belgium—was the destination of almost all mineral commodities produced in Rwanda. In 1988-89, this included all the gold, cassiterite, wolfram, and colombo-tantalite. Import data for 1988-89 indicated two mineral commodities, petroleum products and steel, were among the five imports having highest value. Salt imports were of low value. Overall coffee and tea had the highest export value and most went to Western Europe, a little to the United States. The United States took most of the pyrethrum extract, an insecticide ingredient. Of total imports, Belgium-Luxembourg was the major source, followed closely by Kenya and Japan, then the Federal Republic of Germany and France. The United States was a minor supplier. Rwanda is an associated state of the EC and a member of some organizations promoting regional economic planning and coordination.

The structure of the mineral industry was simple. The Government was a major participant in mineral ventures in Rwanda in the recent past and apparently expected to have to continue to play such a role by forming REDEMI and COPIMAR. Most actual production continued to be by individual artisans or small cooperatives.

Commodity-specific information was very meager during the year. Gold production continued to be the most significant activity. Gem stones, particularly sapphire and tourmaline, were reported to be in new but still limited production. Natural gas, methane, from Lake Kivu, was being considered as feedstock for nitrogen in a fertilizer venture being evaluated by a U.S. company.

Output of beryl apparently remained suspended since 1985, as did tin metal from a smelter started up just north of Kigali in



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

(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>  | 1986    | 1987   | 1988    | 1989 <sup>p</sup> | 1990 <sup>e</sup> |
|---|---------|--------|---------|-------------------|-------------------|
| Cement  | '52,577 | 69,364 | '58,073 | '67,706           | 60,000            |
| Columbite-tantalite, ore and concentrate, gross weight <sup>3</sup> | —       | —      | '1      | '64               | 50                |
| Gold, mine output, Au content <sup>4</sup> kilograms                | 6       | 9      | '15     | '732              | 700               |
| Natural gas, gross thousand cubic meters                            | '900    | 955    | 903     | '900              | 900               |
| Tin: Mine output, Sn content <sup>e 5</sup>                         | 29      | —      | —       | '762              | 750               |
| Tungsten, mine output, W content <sup>e 6</sup>                     | 13      | '11    | '3      | '105              | 100               |

<sup>e</sup>Estimated. <sup>p</sup>Preliminary. <sup>r</sup>Revised.

<sup>1</sup>Includes data available through July 1, 1991.

<sup>2</sup>In addition to commodities listed, some gem stones (sapphire and tourmaline), limestone for cement, and possibly some for agricultural use, and presumably some other construction materials (clays for brick and tile, sand and gravel, stone, et al.) are produced, but information is inadequate to make reliable estimates of output. Beryllium (Beryl concentrate, estimated 10% BeO) production last reported in 1985 at 27 mt/a. Tin metal production (smelter output) last reported in 1985 at 800 mt/a when the smelter reported shut down.

<sup>3</sup>Estimated 22% Ta plus 30% Cb (reported in 1985 at 27% Ta<sub>2</sub>O<sub>5</sub>).

<sup>4</sup>Where estimated, reported gross weight output estimated to contain 92% Au.

<sup>5</sup>Reported gross weight output estimated to contain 70% Sn.

<sup>6</sup>Reported gross weight output estimated to contain 54% W (68% WO<sub>3</sub>).

1981. The latter operation was owned by the country's sole formal mining entity at the time, a company 49%-owned by the Government. It failed owing mostly to the collapse of the tin market price; but management problems of the other partner, a Belgian company, were also a factor. A low tin price kept the plant idle through 1990. Low market prices apparently also contributed to continued reluctance of investors to pursue oil possibilities suspected since at least the mid-1980's along the geological rift in western Rwanda. Peat was another unexploited source of energy, considered as fuel for the cement plant. Lithium minerals, produced for a few years in the 1970's, were also said to have some potential for revived output.

Mineral reserves data were not available, although a large number of deposits were referenced as to general size and recorded by the French Bureau de Recherches Geologiques et Minieres (BRGM) on a map published in 1982 for the Government of Rwanda.

Transportation in Rwanda was dependent on the extensive road network. The inter-

nal system of paved roads was excellent, and new road construction and improvement projects were continually under way. But long and difficult external connections to Indian Ocean ports 1,500 km east of Kigali in Mombassa (Kenya) and Dar es Salaam (Tanzania) were a constraint on trade—typical c.i.f delivered costs of imports being 30% higher than f.o.b. on vessel in port prices. Rwanda has no railways, but international funding of road improvements in Tanzania to a similarly funded new road-rail terminal at Isaka on the railroad to Dar es Salaam was expected to result in much lower costs and transit time. Lake Kivu provided some low-cost transportation to a limited area, and the international airport at Kigali was an important factor in the transportation picture.

Ample hydro electric power and the availability of methane and peat for fuel were advantageous to further industrial and mine development. However, the electrical distribution system was still rather limited.

Communication links with the rest of the world were among the best in Africa, and the internal telephone system is reliable.

The outlook for mineral production was a gradual and small growth in the near term. Major increases would require a substantial change in market prices for Rwanda's minerals as well as resolution of political problems.

<sup>1</sup>Where necessary, values have been converted from Rwanda francs (RF) to U.S. dollar at the rate of RF82.60=US\$1.00 for 1990 values and RF79.98=US\$1.00 for 1989 values.

## OTHER SOURCES OF INFORMATION

### Agency

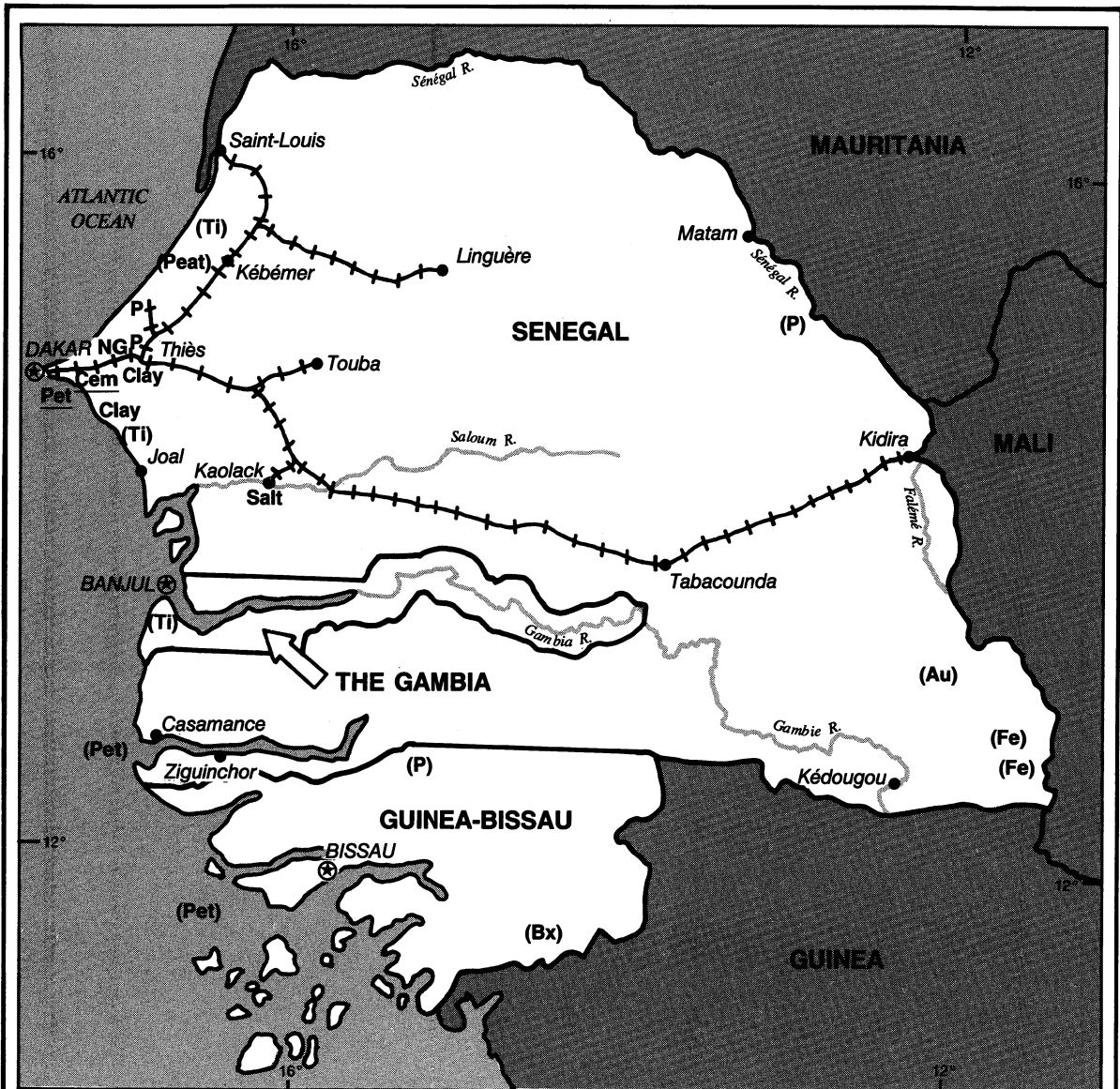
Ministry of Industry and Handicrafts  
Republic of Rwanda  
P.O. Box 73, Kigali, Rwanda  
Phone: 011-250-75417

### Publication

Map of Mineral Deposits of Rwanda  
Ministry of Natural Resources, Republic of Rwanda, 1982.

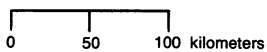


# SENEGAL, GUINEA-BISSAU, THE GAMBIA



- 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 7.7 million

**THE GAMBIA**  
 AREA 11,300 km<sup>2</sup>  
 POPULATION 848,000

**GUINEA-BISSAU**  
 AREA 36,120 km<sup>2</sup>  
 POPULATION 1.0 million



# THE MINERAL INDUSTRY OF SENEGAL, THE GAMBIA, AND GUINEA-BISSAU

By Hendrik G. van Oss and David Izon

## SENEGAL

The production of mineral commodities was an important component of the overall Senegalese economy in 1990 and was the dominant factor in the country's industrial sector. Total mineral commodity sales accounted for an estimated 11% of the country's GDP of \$5.84 billion,<sup>1</sup> counting mineral fuels, or 5% of GDP, excluding mineral fuels. Primary mineral production, largely of calcium and calcined aluminum phosphates, accounted for 22% of total mineral sales. Nonfuel secondary mineral commodity production was mainly cement, phosphoric acid, and manufactured fertilizers; these accounted for 23% of mineral sales. Refined petroleum product sales accounted for the rest. Exports of mineral commodities accounted for about one-quarter of total exports and were mainly phosphates and fertilizers. Almost 20% of Senegal's total imports were of mineral commodities, largely crude oil and petroleum products, and sulfur and ammonia for the fertilizer industry.

Most of Senegal is made up of Mesozoic and Tertiary sedimentary rocks of the Senegal Basin. Lower Tertiary rocks host the country's phosphate and clay deposits. Salt beds in Jurassic rocks offshore have yielded salt diapirs, some of which 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. These are, presumably, derived from Precambrian granites outside of Senegal and deposited in Senegal by longshore currents. Lower Proterozoic rocks are found in southeast Senegal, mostly volcano-sedimentary rocks of the Birimian Series and granites. The Precambrian rocks host a number of gold deposits, generally associated with quartz veins and/or iron sulfides, and commonly within northeast-trending shear zones.

Large deposits of iron ore are also found in this terrane, as are scattered occurrences of base metals, tantalum, and columbium mineralization.

Exploration was ongoing during the year for additional phosphate reserves, crude oil and natural gas, titaniferous sand deposits, and gold.

### Government Policies and Programs

The Government is a major participant in Senegal's mining sector and strongly supports the further development of the mineral industry. A high priority of the Government is the development of non-phosphate mineral commodities for which reserves are fairly well known, notably titaniferous sands, iron ore, gold, peat, and oil. With respect to the last, bidding was opened in May 1990 for an offshore block adjoining Guinea-Bissau waters.

In an effort to encourage mineral exploration in Senegal, the Government has in recent years drafted legislation governing new ventures in this sector. In 1986, a new petroleum code was adopted, thus abrogating 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, in time for the signing of a major agreement with an international company for the exploration and potential development of Senegal's resources of titaniferous sands. The Government has adopted a privatization program that, initially, will include selling the parastatal cement company.

### Production

The output of mineral commodities was mixed in 1990. Production of calcium phosphate, the backbone of the mining sector,

declined slightly for the second year in a row. As in 1989, the decline reflected a decrease in output from Compagnie Sénégalaise des Phosphates de Taïba (CSPT). CSPT was the larger of the country's two phosphate producers, and the decline was due to a loss of sales to the EC. The decrease in demand on the European market was almost completely offset, however, by very strong demand for calcium phosphate by the local fertilizer company Industries Chimiques du Sénégal (ICS); sales to ICS by CSPT increased 21%. Phosphoric acid production by ICS increased 26% to 228,082 tons, and manufactured fertilizer output increased overall 48% to 173,323 tons. Crude aluminum phosphate production by Société Sénégalaise des Phosphates de Thiès (SSPT) was again reported to be nil. However, this merely reflected the fact that all of the mine output was calcined. In previous years, quantities of crude aluminum phosphate were sold to Europe, but, beginning in 1989, there was a lack of demand there for the raw product. There continued, however, relatively strong demand for calcined aluminum phosphate, which is commonly reported as clinker.

Cement production showed a large increase, apparently driven by strong local sales, which increased 22% to 462,324 tons, worth about \$61 million. The increase in local sales was despite a reported decrease in the number of construction starts and may reflect indirect export demand, as opposed to direct exports by the producing company.

Natural gas production data for 1990 were not available. Toward yearend 1988, the country's sole producer reportedly had an output of about 14,000 m<sup>3</sup>/d. Efforts during 1989 to increase this output apparently were unsuccessful. Output likely declined that year and in 1990, based on the decline in reported crude petroleum output, much of it condensate, from the same wells.

### Trade

Exports from Senegal totaled approximately \$840 – 850 million in 1990, of which an estimated \$200 – 230 million

TABLE 1

SENEGAL: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

| Commodity <sup>2</sup>                      |                            | 1986                | 1987                 | 1988               | 1989 <sup>p</sup>    | 1990 <sup>p</sup>   |
|---|----------------------------|---------------------|----------------------|--------------------|----------------------|---------------------|
| Cement, hydraulic                           | metric tons                | 359,446             | 372,071              | 390,956            | 379,793              | 469,537             |
| Clays: Fuller's earth (attapulgitite)       | do.                        | <sup>3</sup> 81,857 | <sup>3</sup> 111,048 | 118,725            | 98,882               | 114,610             |
| Petroleum:                                  |                            |                     |                      |                    |                      |                     |
| Crude                                       | thousand 42-gallon barrels | —                   | <sup>e</sup> 11      | 20                 | 13                   | 8                   |
| Refinery products:                          |                            |                     |                      |                    |                      |                     |
| Gasoline                                    | do.                        | 550                 | 800                  | 951                | <sup>4</sup> 2,261   | <sup>4</sup> 2,520  |
| Kerosene and jet fuel                       | do.                        | 400                 | 576                  | 799                | 652                  | 682                 |
| Distillate fuel oil                         | do.                        | 650                 | 1,270                | 1,564              | <sup>e</sup> 2,000   | 2,057               |
| Residual fuel oil                           | do.                        | 750                 | 1,395                | 1,815              | 1,493                | <sup>e</sup> 1,500  |
| Other                                       | do.                        | 20                  | 43                   | <sup>e</sup> 44    | <sup>e</sup> 57      | <sup>e</sup> 32     |
| Refinery fuel and losses                    | do.                        | 230                 | 213                  | 227                | <sup>e</sup> 185     | 209                 |
| Total                                       | do.                        | 2,660               | 4,297                | <sup>e</sup> 5,400 | <sup>e</sup> 6,648   | <sup>e</sup> 7,000  |
| Phosphate rock and related products:        |                            |                     |                      |                    |                      |                     |
| Crude:                                      |                            |                     |                      |                    |                      |                     |
| Aluminum phosphate                          | thousand metric tons       | 131                 | 191                  | 119                | <sup>e</sup> 5115    | <sup>e</sup> 5105   |
| Calcium phosphate                           | do.                        | 1,850               | 1,874                | 2,326              | 2,273                | 2,147               |
| Manufactured:                               |                            |                     |                      |                    |                      |                     |
| Aluminum phosphate, dehydrated <sup>6</sup> | do.                        | 60                  | 89                   | 61                 | 100                  | 91                  |
| Other <sup>7</sup>                          | do.                        | 5                   | 4                    | 2                  | 2                    | 1                   |
| Salt  | metric tons                | 114,151             | 75,442               | 75,000             | <sup>r</sup> e97,000 | <sup>e</sup> 92,000 |

<sup>e</sup>Estimated. <sup>p</sup>Preliminary. <sup>r</sup>Revised.

<sup>1</sup>Includes data available through Jan. 24, 1992.

<sup>2</sup>In addition to the commodities listed, Senegal produced clay, sand and gravel, and stone for local construction purposes, limestone for cement, and natural gas for electricity generation. Information is inadequate to make reliable estimates of output levels, although, at yearend 1988, gas production was reportedly at a rate of 500,000 cubic feet per day.

<sup>3</sup>Attapulgitite production for 1986-87 is for Société Sénégalaise des Phosphates de Thiès (SSPT) only. Data are unavailable for the production from Compagnie des Produits Chimiques et Matériaux for this period, although it was likely to have been about 10,000 metric tons per year.

<sup>4</sup>Includes gasohol, reported as 66% of total production in 1989 and 68% in 1990.

<sup>5</sup>Output was reported by SSPT as nil. Estimate based on required usable crude output for reported clinker (dehydrated aluminum phosphate) production.

<sup>6</sup>Derived from crude product output, including any stockpiled from previous year.

<sup>7</sup>SSPT products marketed under the trade names "Balifos" and "Phospal."

was accounted for by mineral commodities. As in the past, the dominant mineral commodity exports from Senegal were of phosphate rock and derived manufactured fertilizers and phosphoric acid. Exports of calcium phosphate rock declined almost 9% in tonnage, but increased in value 5.5% to \$70.6 million. Aluminum phosphate rock exports were reported as nil, because the entire production was calcined. Exports of the calcined product, called clinker, declined 11% in tonnage but increased almost 17% in value to \$4.5 million. Phosphoric acid exports increased 28% in tonnage and were \$60.2 million. Manufactured fertilizer exports were worth \$25.3 million.

For cement, reported exports were those of the producer only and amounted to \$1.2 million, compared with local sales worth \$61 million. The local sales represents an increase of 30% from sales in 1989. However, because the construction industry in Senegal declined in 1990, it is assumed that the healthy local sales were partly for resale as exports. It is estimated that such sales may have been worth as much as \$30 mil-

lion. Refined petroleum products exports were about \$25 million. Salt exports increased 96% to \$8.8 million, and attapulgitite exports increased 33% to \$5.6 million.

Europe has been a traditional major customer for Senegalese calcium phosphates. Concerns in the EC over the high cadmium content of the Senegalese material has led to a dramatic decline in sales to the EC in recent years. In 1990, such sales fell by almost 29%. This decline has been mitigated, however, by sales to Asia, particularly the Philippines and India and, new for 1990, to Iran. About 65% of calcium phosphate exports in 1990 were to these three countries. Exports of calcined aluminum phosphate continued to be all to Europe. As in past years, phosphoric acid exports were almost all to India. About one-half of manufactured fertilizer exports were to Europe; the rest were to various West African countries. West African countries were also the main customers for Senegalese refined petroleum products exports and salt. Attapulgitite exports were almost all to the EC.

Senegal's imports in 1990 totaled about \$1.05 billion. Of this amount, mineral commodity imports are estimated to have accounted for about 20%. Of this trade, crude oil and petroleum product imports in 1990 are estimated to have been worth about \$190 million. Imported mineral inputs for the fertilizer industry were worth an estimated \$20 million, of which sulfur imports accounted for about 90%. Petroleum products were imported from a variety of sources, including \$5.1 million from the United States. Crude oil imports were all from Nigeria and Gabon. In 1990, Senegal's imports of sulfur from the United States, the only significant nonfuel mineral trade between the two countries, declined 86% to only \$1.1 million. The remainder of Senegal's sulfur imports, amounting to 187,000 tons, were from Canada, Saudi Arabia, and France.

### Structure of the Mineral Industry

In 1990, the mining industry of Senegal was dominated by the production of phos-

phates and derived phosphoric acid and manufactured fertilizers. Sulfur and ammonia for the latter were imported. The Government owned 50% of both phosphate mining companies and part of the fertilizer factory. Apart from construction materials, primary mineral production was dominated by the production of attapulgitite, salt, and small quantities of hydrocarbons. The Government owned shares in most of the producers of these commodities. Limestone for cement clinker was mined by the cement company, which was 100% Government-owned.

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 a significant proportion of Dakar's port workers owed their livelihood to the transportation of mineral commodities.

## Commodity Review

**Metals.—Iron Ore.**—Past feasibility studies of the Falémé iron deposits in southeast Senegal have enumerated three hematite and two magnetite deposits of potential economic interest. The largest of the hematite deposits, Koudékourou, is 70 km east-southeast of Kédougou, and was the main impetus for the formation of the Société des Mines de Fer du Sénégal Oriental (MIFERSO) in 1975. As formed, MIFERSO was a joint venture of the Governments of Senegal and France, and German and Japanese companies. The French and German interests drilled the deposits and conducted a feasibility study during the late 1970's and early 1980's. Although the reserves demonstrated by these efforts were of interest, the needed ore transportation was felt by the foreign partners to be too costly to justify development of the deposit. Accordingly, only

the Government of Senegal continued to finance the venture after about 1985, and reportedly, now owns almost all of the company. An audit of the past work on the Falémé Project was commissioned in 1989, and the Government released the results in October 1990. The audit essentially confirmed the previously determined reserves of about 300 Mmt grading 60% iron, the need to build approximately 300 km of new heavy-duty railroad to connect the deposit with the existing railroad at Tambacounda, and the need to construct an iron ore-shipping port 30 km east of Dakar at Bargny. However, although the audit confirmed the existing feasibility study's cost estimates, it questioned some of the infrastructural criteria upon which they were based. It was felt that significant cost savings could be realized by simplifying the port and raiing facilities; potentially, costs for the project could be reduced below \$700 million. A new full feasibility study was recommended

TABLE 2

### SENEGAL: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

(Metric tons unless otherwise specified)

| Commodity                                   | Major operating companies                                      | Location of main facilities  | Annual capacity                                   |
|---|--|--|---|
| Attapulgitite                               | Compagnie des Produits Chimiques et Matériaux                  | Open pit mining of 4 deposits at Nianing, 80 kilometers southeast of Dakar | *20,000 attapulgitite.                            |
| Do.   | Société Sénégalaise des Phosphates de Thiès (SSPT)             | Open pit mine 15 kilometers southwest of Thiès                             | *120,000 attapulgitite.                           |
| Cement                                      | Société Ouest-Africaine des Ciments                            | Limestone quarry and cement plant at Rufisque, 20 kilometers east of Dakar | 700,000 kiln output.                              |
| Mineral fuels:<br>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                                 | Oil refinery near Dakar  | 8,800 crude input.                                |
| Phosphates:<br>Aluminum phosphate           | SSPT   | Open pit mine 17 kilometers north of Thiès                                 | *410,000 aluminum phosphate ore, 350,000 clinker. |
| Calcium phosphate                           | Compagnie Sénégalaise des Phosphates de Taïba (CSPT)           | 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   | 100,000 calcium phosphate ore.                    |
| Salt  | Société Nouvelle des Salins de Siné-Saloum                     | Marine salt recovery ponds west of Kaolack                                 | *175,000 salt.                                    |

\*Estimate. NA Not available.

to test this, especially the possibility of significantly reducing the costs for the needed railing infrastructure. The Government was seeking financing for this feasibility study at yearend.

**Titanium.**—Following the October 1988 signing of an agreement with the Government, Du Pont Senegal, Inc., a subsidiary of E. I. du Pont de Nemours & Co., commenced detailed exploration of its concession for titaniferous sand deposits. Sampling south of Dakar began early in 1989, and a section of coastline north of Joal was drilled between June 1989 and February 1990. In March 1990, the drill rigs were moved north of Dakar to an area west of Kébémér. Reportedly, although the deposits south of Dakar were found to be too small for the company's needs, those to the north still showed promise, and exploration of them was to continue in 1991. The company was hoping to delineate a deposit capable of producing 100,000 mt/a of heavy-minerals concentrate containing mostly ilmenite, with minor rutile and zircon.

**Industrial Minerals.**—The output of the country's largest phosphate producer, CSPT, declined 7% to 2,039,000 tons of calcium phosphates. The decrease was attributed largely to relatively weak demand for the company's output, particularly on the European market. Sales to overseas customers fell almost 11% to 1,268,049 tons. Much of the decline was in sales to the EC, which fell 29% to 367,437 tons owing to continuing concerns about the high cadmium content of CSPT's phosphate. As in 1989, the Philippines was CSPT's largest customer, taking 359,474 tons, a 9% decrease. Exports to India increased almost 3% to 314,538 tons. Iran, a new customer, took 210,000 tons. Sales to Spain and Greece each declined about 25% and were 162,339 tons and 105,154 tons, respectively. Of great significance was the 92% decline in sales to France, which took only 10,500 tons and reflected the closure during the year of the Ambes fertilizer plant in that country. As in years past, almost all of CSPT's domestic sales were to ICS for the manufacture of fertilizers; sales to ICS rose 21% to 649,810 tons.

Production of calcium phosphate by SSPT increased 29% to 108,000 tons, in response to strong export demand. Exports rose 26% to 99,444 tons. Sales to Greece rose 70% to 45,162 tons, whereas sales to France fell slightly to 44,282 tons. The level

of calcium phosphate production in 1990, as in 1989, marked a significant change from the company's traditional emphasis on the production of aluminum phosphates. Aluminum phosphate, when calcined and ground, can be used directly as a fertilizer. In past years, because of high energy costs in Senegal, only about one-half of the material was calcined in country; the rest was sent to Europe where energy costs were lower. Demand for the raw product overseas had been declining since 1987, and the company reported no production or sales of this commodity in 1989 and 1990. Production did occur, however, albeit at reduced levels, solely to provide raw material for the calcined product, which the company calls clinker, and for small production of the calcined and ground product called Phospal. Although production of clinker fell significantly during the year, exports increased 14% to 98,380 tons; the production deficit was met from stockpiles. Exports were all to the EC.

Exports of phosphoric acid by ICS increased about 26% to 193,815 tons. Exports to India, traditionally the sole customer, increased 18% to 180,272 tons. Iran and Nigeria took 9,100 tons and 4,443 tons, respectively. Manufactured fertilizer exports increased 64% to 150,271 tons and were largely to West African countries and, unlike in 1989, to Europe. Sales to the EC increased ninefold to 59,877 tons, apparently owing to a temporary relaxation of cadmium-content restrictions pertaining to manufactured fertilizers. These restrictions had caused an 86% decline in ICS's exports to Europe in 1989. The EC announced at yearend 1990 that it would provide financial assistance to Senegal to help make its phosphate industry more competitive on the European market. The assistance, in the form of loans, was to be used in researching methods to reduce the cadmium content of both fertilizers and phosphate rock, and to lower the production costs at ICS, SSPT, and CSPT in order to partially compensate for the anticipated costs of reducing the cadmium levels.

**Mineral Fuels.**—Output of petroleum products from largely private-owned Société Africaine de Raffinage (SAR), although somewhat higher than in 1989, continued to be below demand, with the difference being met through imports. A small amount of crude oil, mostly natural gas condensate, has been produced since late 1987 from the Diam-Niadio gasfield east of Dakar, operated by Tullow Oil PLC

of Ireland. The gas output is burned in a power station 18 km east of Dakar. Toward yearend 1988, natural gas production reportedly was at a rate of 14,000 m<sup>3</sup>/d, but complete production data for 1988 and for 1989-90 are unavailable. Attempts to increase output by drilling additional wells in 1988 and 1989 were evidently unsuccessful.

There was no reported onshore geophysical exploration conducted in 1990; however, a 3,600-line-km offshore seismic-gravity-magnetics survey was run for the Government petroleum agency Société Nationale des Petroles du Sénégal in 1989. In addition, 800 line-km of seismic data covering the Dôme Flore area, 60 km offshore Casamance, was reprocessed for the Government. This geophysical work was done in preparation of a promotional package for a 6,500-km offshore block covering the Dôme Flore area. The block was opened to bidding in May 1990, and toward yearend, a 3-year agreement was signed with UNOCAL. Reportedly, the company was to do a seismic survey and was committed to drilling two exploration wells.

**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 since 1960, and the calcium phosphates near Thiès have been in production since 1974. As outlined by the Government,<sup>2</sup> phosphate deposits are known to exist in many parts of the country, and although many have been extensively sampled, few have shown sufficient continuity to be envisioned as economic, and fewer still have published reserves. Near Thiès, SSPT has reserves of aluminum phosphate of 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 concessions totaled about 4 Mmt grading about 29.5% (concentratable to 34%) P<sub>2</sub>O<sub>5</sub>. Approximately 27% of this inventory had been mined by yearend 1990. Remaining reserves of calcium phosphate at the Keur Mor Fall deposit exploited by CSPT are about 32 Mmt grading about 29% P<sub>2</sub>O<sub>5</sub>, concentratable to 37.5% P<sub>2</sub>O<sub>5</sub>. Reportedly, the stripping ratio at the mine is increasing. The adjoining Tobène deposit has reserves, according to the company, of about 50 Mmt, capable of being concen-

trated to 36.2%  $P_2O_5$ . 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%  $P_2O_5$ . Development of the Semmé phosphates, except on a very small scale for local consumption, would require the construction of raiing 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. Although resources in excess of 1 Mmt of heavy-mineral concentrates, dominantly ilmenite, have been delineated, the true reserves are not yet known. Quantitative results of Dupont's ongoing exploration program had not been made public as of yearend 1990.

Numerous gold occurrences are known in the Precambrian terrane of southeast Senegal. The Sabodala deposit, about 75 km north of Kédougou, is the only occurrence examined to date that may warrant exploitation. Société Minière de Sabodala, a joint venture between France's Bureau de Recherches Géologiques et Minières, 51%; and the Government, was formed in 1983 to explore and develop the deposit. 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. Although foreign companies were again examining the deposit during 1990 and were reported planning to set up a small pilot recovery plant, no quantitative results of their work had been made public as of yearend 1990.

Probably the most significant undeveloped mineral resources in Senegal are the iron occurrences of southeast Senegal, generally called the Falémé deposits, after the river that runs along the southern half of the Senegal-Mali border. An audit of past feasibility studies on the Falémé deposits was completed in 1990 and puts the reserves of the largest deposit (Koudékourou) at approximately 300 Mmt grading 60% iron. Exploitation of the deposit will require the construction of extensive raiing 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 production. According to the Government, reserves in this field total about 50  $Mm^3$ ; large-scale production from this field has yet to be achieved. The offshore Dôme Flore Field has been explored intermittently since 1958 and has been the subject of a number of border disputes with Guinea-Bissau. These disputes were largely resolved in 1986, leaving the known resources in Senegal territory. 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  $Mm^3$ , 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  $Mm^3$  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 58% of that of charcoal. In addition, there is a resource of approximately 15  $Mm^3$  of peat that is too sandy for burning, but which 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 1990 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. Railroad construction in Senegal commenced in 1881, largely for the export of groundnuts. In 1923, the line connecting Dakar with Bamako, Mali, was completed, and trade along this route led to Dakar's early development as a significant regional port. In recent years, more than 95% of the total raiing tonnage has been related to the transport of mineral commodities, including fertilizers. The bulk of 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 the present railroad infrastructure is adequate for current mining output, exploitation of the Falémé iron ore deposits in southeast Senegal will require the construction of a railroad from the deposit to the existing Dakar-to-Mali line. The line to Mali is being rehabilitated, but to medium-duty use rather than to the heavy-duty specifications necessary for safe and efficient iron ore transport. Senegal had about 14,000 km of roads in 1990, about 30% of which were paved. The country has about 900 km of navigable waterways, mostly on the Sénégal River, which forms the border between Senegal and Mauritania, and 115 km on the Saloum River as far as Kaolack.

Senegal has four main ports: Dakar, Saint-Louis, Kaolack, and Ziguinchor; the latter two are river ports that can handle ocean-going ships. Only Dakar is a significant mineral port, although some of the country's salt production is shiploaded at Kaolack. In 1990, Dakar had 43 docks of total length of 7,618 m and had a harbor entrance depth of 11 m. The port had facilities adequate for offloading approximately 1.5 Mt/a of crude oil and petroleum products, 220,000 mt/a of sulfur, and about 18,000 mt/a of ammonia. In 1988, the latest year for which data are available, trade through Dakar totaled about 5 Mmt. Imports of mineral commodities (mostly crude oil, petroleum products, and sulfur) amounted to 752,000 tons of this. Mineral commodity exports, including fertilizers, amounted to 2 Mmt. 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 210 MW in 1989, all of which was thermal. Production of electricity in 1989 was 760 GW h. Except for the burn-



ing 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 Mantanali was being held up over 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

Senegal's mineral economy will continue to be dominated by the exploitation of phosphate deposits. Exports of phosphates and manufactured phosphate fertilizers to some markets may continue to be hampered by concerns over cadmium. There are large phosphate reserves at or near the existing mines; consequently, the near-term exploitation of the Semmé phosphate deposits, which would require extensive infrastructure development, is unlikely. Assuming a positive outcome of the ongoing titaniferous sand exploration program, Senegal could become an exporter of ilmenite within 2 to 3 years of a decision to develop the deposits. 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. The high cost of imported fuel is a strong incentive for the exploitation of Senegal's large peat resources for electricity generation and for domestic heating purposes. However, installation of hydroelectric capacity at the Manantali Dam in Mali will, however, be a mitigating factor. The economics of exploiting the Falémé iron ore deposits are very uncertain given the high cost of constructing the necessary railing and port infrastructure and current world market conditions for iron ore. It is likely that the Sabodala gold deposit will be brought into production within a few years, and that further exploration in south-east Senegal will lead to the discovery of additional gold ore deposits.

### THE GAMBIA

In recent years, mining has been a negligible component of the Gambian economy,

which is dominated by tourism, agriculture, and the unregistered transshipment of goods into Senegal. Agricultural output declined dramatically in 1990 owing to a prolonged drought. Rice and cotton production reportedly fell by more than 50%; rice yields were aggravated by salt water influx to the fields. Production of mineral commodities in 1990 was limited to undocumented quantities of brick clay, laterite, sand and gravel, and cockle shells, for local construction purposes. Deposits of these construction materials are believed to be significant and could support a greater level of exploitation. And, The Gambia's significant glass sand deposits have yet to be exploited. Fewer than 200 persons were believed to be employed full time in mining. Reportedly, the Kanifing brick plant was sold early in the year as part of the Government's scheme to privatize state-owned companies.

The geology of The Gambia is dominated by Mesozoic and Cenozoic sedimentary rocks, deposited in a regional basin related to the opening of the Atlantic Ocean. There is believed to be some potential for the discovery of oil in this basin. Several thousand km of seismic surveys have been run over the past 30 years and a few petroleum exploration wells, all unsuccessful, drilled. In April 1990, the Government held talks with Texas-based oil companies regarding oil exploration in the country. Together with the Government of Senegal, the Government signed a \$9 million agreement with Petro Canada International Assistance Corp. for International Assistance for the funding of a new onshore seismic survey of both countries.

In the 1950's, titaniferous beach sands were mined. According to the Government, the remaining resource, at a 1% heavy-mineral cutoff, amounts to 20 Mmt grading 4.9% heavy minerals. At a 3% cutoff, the resource is 9 Mmt grading 8.6% heavy minerals. The heavy-mineral concentrates average 70.2% ilmenite, 15.9% zircon, 3.3% rutile, and 10.6% gangue minerals.

The Gambia has no railroads, but has about 3,100 km of highways, of which 14% are paved. The Gambia River is navigable for approximately 240 km by oceangoing ships of up to 5.5-m drafts. Electrical generating capacity, all from thermal plants, was 29 MW in 1990; production totaled 70 GW h. The Government plans to expand electricity output by about 15% annually.

### GUINEA-BISSAU

In 1990, construction materials represented the only mineral commodities exploited in Guinea-Bissau. Although the country has traditionally not been considered well-endowed with mineral resources, the Government continued prospecting for deposits. Such exploration efforts have confirmed the existence of significant deposits of bauxite and phosphate. Bauxite found in the Boé region along the border of Guinea and Guinea-Bissau grades about 44%  $Al_2O_3$ . Discussions were held with the Government of Guinea on joint development and exploitation of this material, but no agreements were signed. Phosphate resources grading 30%  $P_2O_5$  were found near Farim in the north-central part of the country. There were no agreements reached during discussions held with the Government of France to finance the development of these phosphate deposits. The main problem hampering development of the country's bauxite and phosphate resources is the lack of adequate infrastructure.

The Government, in an effort to promote investment, approved its first mining code in 1990. Under the code, a National Mining Fund was created, funded by taxes collected on mining activities. The fund was administered through the National Bureau of Geology and Mines for financing mineral development activities. Significant development of Guinea Bissau's mineral sector will depend on the willingness of local and foreign investors to develop the required infrastructure. A modern data bank at the National Bureau of Geology and Mines is available for use by potential investors in mining projects. An ongoing exploration program for petroleum in the Anetibené region is expected to continue.

<sup>1</sup>Where necessary, values have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF319=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

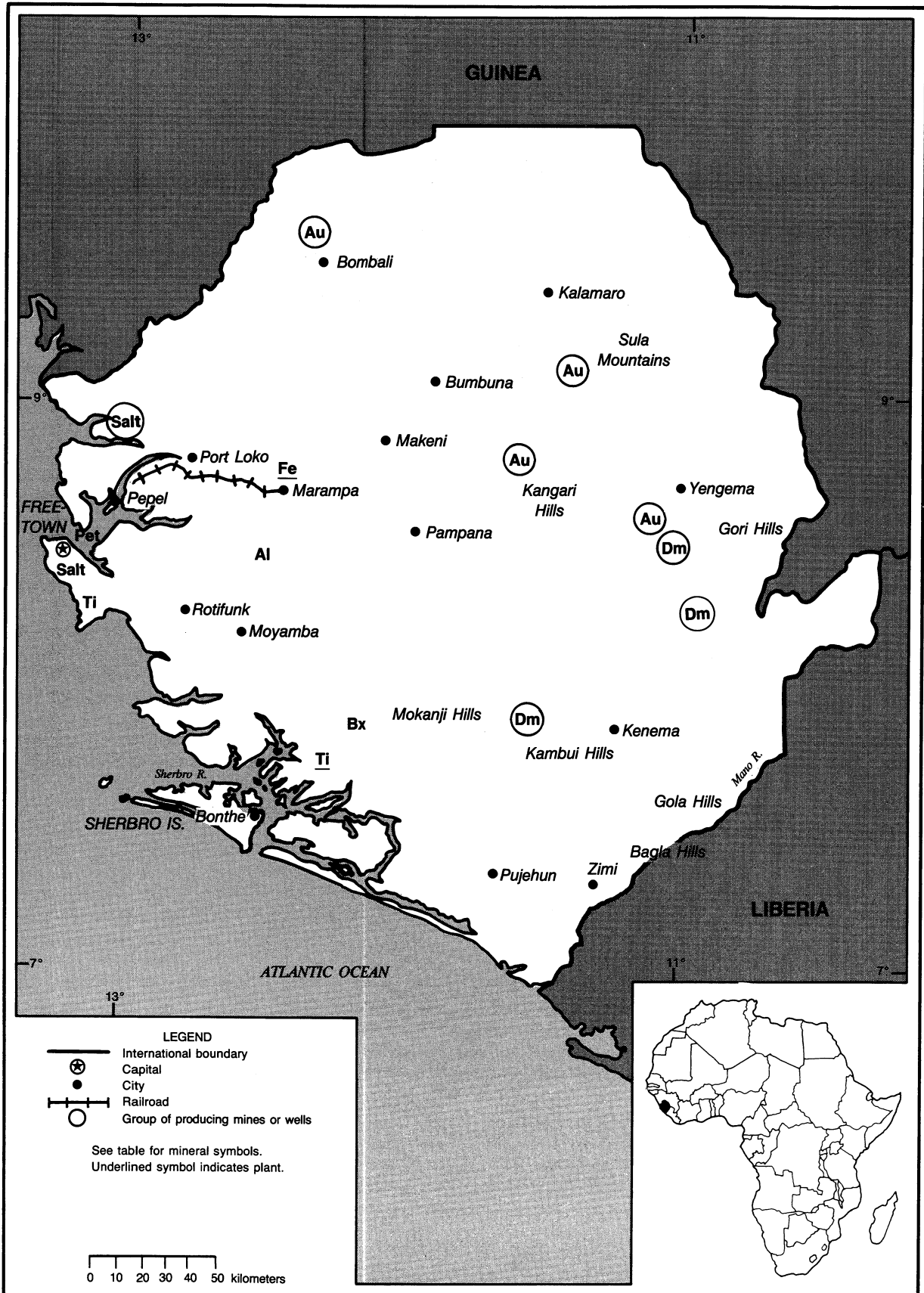
The Ministry of Economic Planning and  
Industrial Development Central Bank  
Building  
Banjul, The Gambia



# SIERRA LEONE

AREA 71,740 km<sup>2</sup>

POPULATION 4.2 million



# THE MINERAL INDUSTRY OF SIERRA LEONE

By Bernadette Michalski

**T**he production and export of mineral commodities, particularly rutile and ilmenite, bauxite, diamonds, and gold, in order of value, have traditionally sustained Sierra Leone's economy. The export of these mineral commodities is an important source of foreign exchange. 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. Revisions to the diamond and gold mining and trading regulations continue to be promulgated in an effort to reverse this situation.

## GOVERNMENT POLICIES AND PROGRAMS

The Government made a serious effort to comply with the recommendations for a more stable economy that were made by the International Monetary Fund and the World Bank.

An emergency session of Parliament created the Currency Control and Economic Sabotage Act on December 15, 1989. The law prohibited local currency hoarding, controlled certain commercial transactions, and permitted fines and/or incarceration for economic and commercial sabotage.

The Government announced a new floating foreign exchange system in April 1990. The system permitted commercial dealers to trade between themselves or with the Bank of Sierra Leone at a mutually agreed on exchange rate. The Bank of Sierra Leone determined the official transactions rate during each ensuing week.

The Government engaged a Netherlands customs valuation service, Special Services International, to ensure the integrity of the customs process and hopefully to raise revenues.

Sierra Leone's official foreign debts exceeded \$600 million including the \$150 million in arrears to the IMF. Some bilateral assistance has been canceled or delayed owing to outstanding arrears. In recogni-

tion of the Government's efforts at restructuring, Mobil Oil and Roayl Dutch Shell have forgiven a sizable portion of old petroleum debts.

## PRODUCTION

With the exception of rutile, which experienced a third successive record production year in 1990, other mineral output was relatively stable. The production of iron ore remained suspended since 1985, and the reactivation of the Marampa iron ore mine remained under consideration. Government efforts to curb diamond and gold smuggling have brought only very limited improvement to the reported official production levels for these commodities.

## TRADE

The value of Sierra Leone's mineral exports was estimated at \$180 million in 1990, equal to approximately 90% of total exports for the year. Rutile continued to be the nation's principal mineral export at \$110 million, with shipments destined for Western Europe and the United States. Bauxite exports earned approximately \$60 million in 1990. Illicit trading has limited official exports of diamonds to approximately \$10 million.

## STRUCTURE OF THE MINERAL INDUSTRY

The Government maintained total control of petroleum refining operations and a controlling interest in the diamond and gold mining industries. The mining of bauxite, rutile and ilmenite remained open to foreign investment.

## 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 planned for 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. The Government, however, began returning gold exporting activities to the private sector. Traders were permitted to retain 40% of export earnings while requiring that 60% be repatriated to the Central Bank of Sierra Leone at the official rate.

**Titanium.**—In 1990, rutile production from Sierra Rutile Ltd. attained a record level for the third consecutive year. Dredging operations were sustained throughout the year in the Pejebu deposit following the move from the depleted Bamba-Belebu deposit, about 4 km to the north, in 1989. Sierra Rutile Ltd. anticipates moving to the Lanti deposit after Pejebu is depleted, about early 1993. Preparation at Lanti proceeded on schedule with the establishment of access and service roads, construction of impoundment dams, and the excavation of a canal from Pejebu to Lanti. The Lanti deposit and its associated Gbeni deposit are expected to have a lifetime of 10 years at the current production rate.

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. Output was expected to be 56,000 mt/a of rutile and 83,000 mt/a of ilmenite for a projected production life of 12 years commencing in 1992.

**Zirconium.**—Engineering and process testwork were completed in 1989 on a plant to recover zircon and to a lesser extent rutile and ilmenite from both old mill tailings and current mine production from Sierra Rutile Ltd.'s mining operations. The wet

TABLE 1  
SIERRA LEONE: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity  | 1986   | 1987    | 1988    | 1989 <sup>2</sup> | 1990 <sup>2</sup>    |
|--|--------|---------|---------|-------------------|----------------------|
| Aluminum: Bauxite, gross weight thousand tons                    | 1,242  | 1,390   | 1,379   | 1,562             | <sup>2</sup> 1,430   |
| Diamond:   |        |         |         |                   |                      |
| Gem <sup>e</sup> thousand carats                                 | 215    | 214     | 12      | 90                | 66                   |
| Industrial <sup>e</sup> do.                                      | 100    | 100     | 6       | 39                | 12                   |
| Total do.  | 315    | 314     | 18      | 129               | 78                   |
| Gold kilograms   | 272    | 422     | 44      | 226               | 32                   |
| Gypsum <sup>e</sup>  | 4,000  | 4,000   | 4,000   | 4,000             | 4,000                |
| Iron ore   | —      | —       | —       | —                 | —                    |
| Petroleum refinery products:                                     |        |         |         |                   |                      |
| Liquefied petroleum gas thousand 42-gallon barrels               | 9      | 9       | 8       | 7                 | 6                    |
| Gasoline do.   | 270    | 250     | 225     | 190               | 180                  |
| Jet fuel do.   | 148    | 150     | 125     | 100               | 100                  |
| Kerosene do.   | 52     | 50      | 45      | 35                | 30                   |
| Distillate fuel oil do.  | 470    | 450     | 425     | 375               | 375                  |
| Residual fuel oil do.  | 355    | 360     | 350     | 300               | 300                  |
| Other do.  | 1      | 1       | 1       | 1                 | 1                    |
| Refinery fuel and losses do.                                     | 60     | 60      | 60      | 55                | 50                   |
| Total do.  | 1,400  | 1,330   | 1,239   | 1,063             | 1,042                |
| Salt <sup>e</sup> do.  | 200    | 200     | 200     | 200               | —                    |
| Titanium:  |        |         |         |                   |                      |
| Rutile ore and concentrate 96% TiO <sub>2</sub> , gross weight   | 97,100 | 113,300 | 126,332 | 128,198           | <sup>2</sup> 144,300 |
| Ilmenite ore and concentrate 60% TiO <sub>2</sub> , gross weight | —      | 5,600   | 42,118  | 62,310            | <sup>2</sup> 54,600  |

<sup>e</sup>Estimated. <sup>2</sup>Preliminary.

<sup>1</sup>Table includes data available through Sept. 30, 1991.

<sup>2</sup>Reported figure.

TABLE 2  
SIERRA LEONE: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

(Thousand metric tons unless otherwise specified)

| Major commodity                     | Major operating companies           | Location of main facilities                  | Annual capacity             |
|-------------------------------------|-------------------------------------|--|-----------------------------|
| Bauxite                             | Sierra Leone Ore and Mineral Co.    | Mokanji Hills near Moyamba                   | 1,600.                      |
| Diamond                             | National Diamond Mining Co., Ltd.   | Yengema region                               | NA.                         |
| Gold                                | do.                                 | do.  | NA.                         |
| Petroleum products thousand barrels | Sierra Leone Petroleum Refining Co. | Refinery at Freetown                         | 3,650.                      |
| Titanium                            | Sierra Rutile, Ltd.                 | Pejebu near the mouth of the Shrebro River   | 130 rutile.<br>65 ilmenite. |
| Do.                                 | Rotifunk Rutile Co.                 | Rotifunk 60 kilometers southeast of Freetown | 56 rutile.<br>83 ilmenite.  |

NA Not available.

processing section of the plant came on-stream in September 1990. High-grade zircon-bearing material, in the form of froth flotation concentrate, is being stockpiled until the completion of the zircon plant's dry section scheduled for mid-1991.

### Industrial Minerals

In an effort to maximize Government earnings and to reduce the level of illicit trading, the Government began returning diamond and gold exporting activities to the private sector. Traders were permitted to retain 40% of export earnings while requiring that 60% be repatriated to the Central Bank of Sierra Leone at the official rate.

The Sunshine Mining Co. of the United States has been granted a 20-year concession to extract and market diamonds from kimberlite deposits in the Koidu area. The deposits are projected to yield a total of 2.4 M carats of mostly gem-quality diamonds over a 15-year period. The first phase of the development schedule is set for mid-1991, with production startup by late 1992. Ore production rate is projected at 485,000 mt/a.

The Government efforts at restoring control encouraged the return of international diamond dealers. Five companies have been granted licenses in 1990: Muller, Lange, Lazare Kaplan International, Aslanian, and N. R. Scippa.

### Mineral Fuels

The Sierra Leone Petroleum Refining Co. of Freetown operated a 10,000-bbl/d-capacity refinery based on imported crude. Traditional crude oil suppliers have been

Nigeria and Iran, but overdue obligations have prompted Sierra Leone to seek a new supplier. Libya agreed to supply not only petroleum but also invest in agriculture, mining, and fishing.

### RESERVES

Rutile and ilmenite reserves described as proven and probable were reported by Sierra Rutile Ltd. as 239.3 Mmt averaging 1.57% recoverable  $TiO_2$  equivalent at yearend 1990. This represents an increase of more than 21 Mmt and an increase in average grade of all reserves by 0.01% over the reserves reported at yearend 1989. Reserves at the Rotifunk deposit were reported at 146 Mmt containing 0.6% rutile and 0.8% ilmenite.

### INFRASTRUCTURE

The nation's roadways totaled 7,400 km. Only 1,150 km of roadway was bituminous surfaced; the remainder was gravel or improved earth. A 43-km road link between Waterloo and Masiaka is to be rebuilt at a cost of \$13.9 million. Financing was attained 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. It will produce 50 MW of power for supply 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.

### OUTLOOK

Despite being endowed with rich mineral resources, a significant proportion of diamond and gold mining and trading activity is lost to Government revenue collection channels. Consequently, the nation continues to record deficits forcing heavy reliance on external financing.

The mining of titanium-bearing sands has met with success over recent years as Sierra Leone's rutile is of high grade with notably low radioactivity. Development programs must take into consideration high infrastructure and environmental restoration costs. The lake resulting from the mining operation at the Bamba-Belebu rutile-ilmenite deposit is to be developed as a significant source of fish for local consumption. A reforestation program oriented toward the rehabilitation of exposed tailings areas was successful, and plans are underway to extend the reforestation.

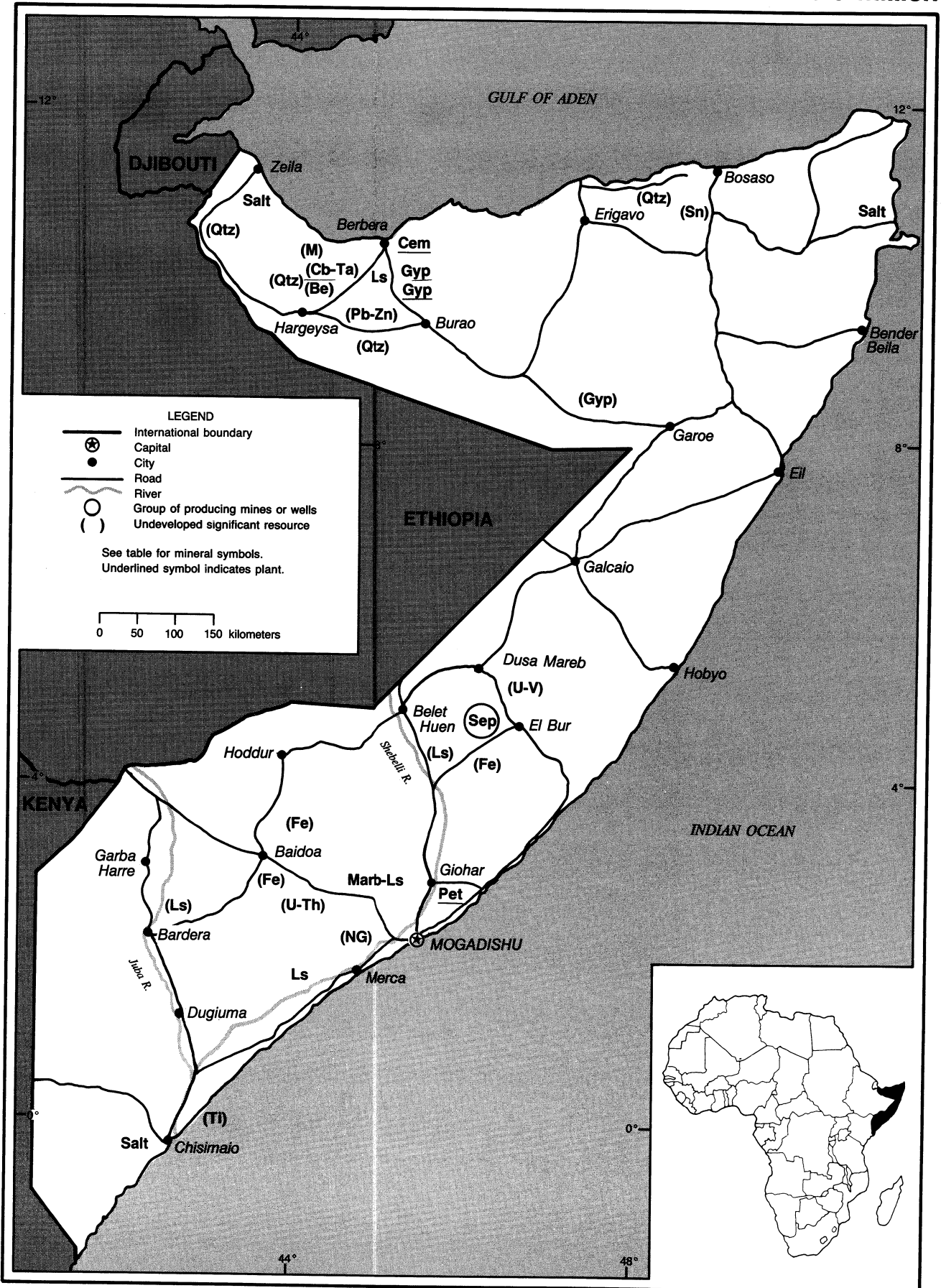
### OTHER SOURCES OF INFORMATION

Ministry of Mines  
Freetown, Sierra Leone  
Bank of Sierra Leone  
Freetown, Sierra Leone  
Nord Resources Corp.  
8150 Washington Village Drive  
Dayton, OH 45458  
Telephone: (513) 433-6307  
Fax: (513) 435-7285

# SOMALIA

AREA 637,660 km<sup>2</sup>

POPULATION 8.3 million



# THE MINERAL INDUSTRY OF SOMALIA

By Lloyd E. Antonides and Nene Ousmane Sow

**S**omalia's 1990 mineral output remained an insignificant part of the economy that depended primarily upon agriculture. Traditionally, agricultural products, including livestock, have contributed up to 60% of GDP, whereas the industrial sector, including the mining industry, never added more than 5%. In 1989, the latest year for which statistics are available, livestock alone accounted for 62% of the country's total exports and 35% of the GDP, which was \$1.7 billion.<sup>1</sup>

Somalia continued to have a chronic trade deficit and had an external debt of \$2 billion that could not be financed without foreign aid and periodic debt rescheduling. In addition, the country's economic problems were aggravated by years of civil unrest that resulted in collapse of the Government in early 1991. This has deterred foreign investment, despite the introduction of a new foreign investment law in 1987. The combination of the lack of investment capital, poor infrastructure, and security concerns have severely hindered exploration and development of mineral resources.

To assist the economic recovery of Somalia, the World Bank pledged \$18.5 million over the next 7 years, beginning in 1991, for the construction of roads and water supply facilities.

The mining sector remains marginal and largely undeveloped. Gypsum, limestone, sepiolite, and sea salt were the only minerals reported produced in recent years. Some stone and sand and gravel for construction as well as clays for brick manufacture were probably also produced. However, a variety of other potentially economic mineral deposits are known to exist in many parts of the country.

Gypsum is mined from a gypsum-anhydrite deposit in the Suriah Malableh hills south of Berbera; reserves in the area are estimated at 7 Mmt. Limestone quarries are also operated nearby. Both gypsum and limestone are used to supply a cement plant in Berbera, which has a production rate of 4,500 mt/a. Sepiolite, which is used in meerscham pipes and in decorative ware, is mined on an artisanal basis 370 km north of Mogadishu. The sepiolite deposit is hosted by marls and clays. Production is mostly from a 1- to 2-m-thick bed of white massive sepiolite overlain

by a 2- to 3-m-thick less pure, soft, earthy sepiolitic rock. The Mineral and Water Resource Department of Somalia estimated reserves in the worked area to exceed 2 Mmt and the resources of the whole area to be between 50 and 100 Mmt.

Oil exploration is currently the most active sector in the mineral industry, with many international oil companies having acquired leases. Some of these companies have sold out at least part of their share; for example, British Gas of the United Kingdom and Nippon Mining of Japan acquired 25% and 15%, respectively, of shares in Conoco's lease. Conoco, British Gas, and Pecten Somalia Corp. carried out seismic work in their concessions. Mobil Exploration Somalia Inc. and Pecten planned to spud the first wildcat hole in Somalia by early 1991. They were to share equally both the input costs and any output.

Construction of the 100-MW Bandera hydroelectric dam project on the Juba River, which was scheduled to start in mid-1989, appeared unlikely to come to fruition for some years. Reasons for the delay were the high cost of the project, estimated at \$400 million, and the need to conduct an environmental and social impact assessment. A new hydro-

electric power station in Hama near Mogadishu that will generate 10,000 kW is being financed by the EC. The cost was estimated at about \$10.5 million, with the facility projected to be completed in February 1991.

The economy of Somalia has been burdened by a lack of infrastructure and capital investment, as well as by civil unrest. However, political developments early in 1991, although not yet very promising, could lead to some degree of economic recovery and to new developments in the mining industry, particularly the petroleum sector.

<sup>1</sup>Because of lack of data, a meaningful conversion to U.S. currency is not possible for 1990. In 1989, the exchange rate averaged Somalia shillings (SoSh) SoSh490.68=US\$1.00.

## OTHER SOURCES OF INFORMATION

### Agencies

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 United Nations Plaza  
New York, NY 10017

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

(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>                        | 1986   | 1987   | 1988   | 1989 <sup>p</sup> | 1990 <sup>e</sup> |
|---|--------|--------|--------|-------------------|-------------------|
| Cement <sup>e</sup>                           | —      | 25,000 | 50,000 | 100,000           | 75,000            |
| Nitrogen: Ammonia, N content <sup>e</sup>     | 15,000 | 7,000  | —      | —                 | —                 |
| Petroleum refinery products:                  |        |        |        |                   |                   |
| Gasoline, motor<br>thousand 42 gallon barrels | 682    | 725    | 742    | 750               | 750               |
| Jet fuel                                      | 152    | 168    | 160    | 170               | 170               |
| Kerosene                                      | 77     | 70     | 77     | 80                | 80                |
| Distillate fuel oil                           | 537    | 612    | 597    | 600               | 600               |
| Residual fuel oil                             | 107    | 93     | 100    | 100               | 100               |
| Other <sup>3</sup>                            | 301    | 259    | 252    | 250               | 250               |
| Total   | 1,856  | 1,927  | 1,928  | 1,950             | 1,950             |
| Salt, marine <sup>e</sup>                     | 30,000 | 30,000 | 30,000 | 30,000            | 30,000            |
| Sepiolite, (meerscham) <sup>e</sup>           | 10     | 10     | 10     | 10                | 10                |

<sup>e</sup>Estimated. <sup>p</sup>Preliminary. <sup>r</sup>Revised.

<sup>1</sup>Includes data available through Nov. 4, 1991.

<sup>2</sup>In addition to the commodities listed, various crude construction materials (clays, sand and gravel, stone, et al.) presumably are produced, but available information is inadequate to make reliable estimates of output levels.

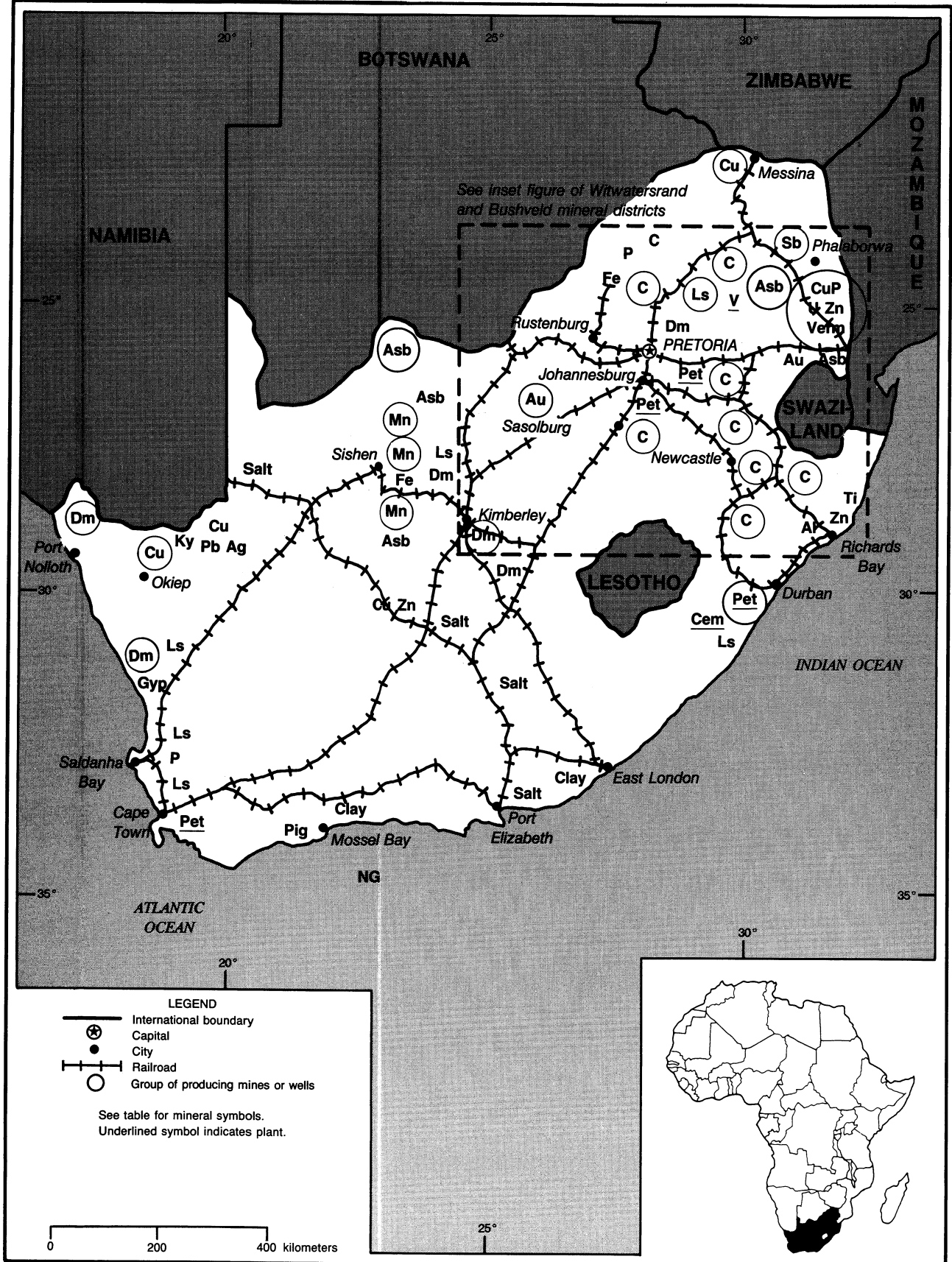
<sup>3</sup>Includes refinery fuel and losses.



# REPUBLIC OF SOUTH AFRICA

AREA 1,221,040 km<sup>2</sup>

POPULATION 40 million



# THE MINERAL INDUSTRY OF THE REPUBLIC OF SOUTH AFRICA

By Michael M. Heydari

**T**he Republic of South Africa<sup>1</sup> remained one of the most important producing and exporting nations for mineral commodities, even while subject to trade embargoes.<sup>2</sup> In 1990, the mining and quarrying industry accounted for 10.7% of the country's GDP at factor incomes at current prices of \$90.6 billion.<sup>3</sup> Mineral sales in 1990 were \$14.7 billion, up 2.7% from those of 1989. In terms of local currency (rand) receipts, gold remained static; coal revenues increased by about 8%; and chrome, copper, fluorspar, lead, platinum, tin, and zinc recorded declining prices and revenues. Total local sales were \$3.2 billion, of which coal was \$1.6 billion; copper, \$178 million; quarry products, \$186 million; and limestone and dolomite, \$160 million. Primary mineral exports, which accounted for 41% of total export earnings, totaled \$11.5 billion and accounted for 78.1% of total mineral sales. However, if the value of processed mineral products such as refined base metals, ferroalloys, iron and steel, and refinery products produced from coal are included, the contribution from the mining industry would be significantly higher.

The mineral industry was dynamic, with numerous changes in corporate ownership and joint ventures and active trading on the Johannesburg Stock Exchange. The industry remained dominated by six major mining investment groups: Anglovaal Ltd., Anglo American Corp. of South Africa Ltd. (AAC), Barlow Rand Ltd. (BRL), Gencor Ltd., Gold Fields of South Africa Ltd. (GFSA), and Johannesburg Consolidated Investment Co. Ltd. (JCI). These corporations had major holdings in each other and in various subsidiary companies.

Total income tax from gold mines alone was \$346 million. In 1990, an average of 697,000 workers were employed in the mining and quarrying industry; total mining wages exceeded \$4 billion. Total salaries, wages, and allowances for the gold and coal industry were \$2.9 billion. The Employment Bureau of Africa (Teba) continued to recruit unskilled and semiskilled workers throughout southern Africa for

members of the Chamber of Mines. Teba's contracts for these workers lasted an average of 14.5 months. About \$250 million was repatriated to Lesotho, Mozambique, Botswana, and Swaziland mainly as compulsory deferred pay.

## GOVERNMENT POLICIES AND PROGRAMS

The Government played an important role in the mineral industry. Its involvement was mainly in the areas of mineral resource management and industry support.

During 1990, the Department of Mineral and Energy Affairs (DMEA) was the primary Government entity with responsibility for oversight of the country's mineral industry. Within the department were the Government Mining Engineer, the Geological Survey, and the Minerals Bureau. South Africa's long mining history and its large and well-developed mining sector have led to a proliferation of laws affecting the industry. Laws relating to the mining industry and administered by DMEA included: the Mines and Works Act, 1956; the Precious Stones Act, 1964; the Mining Rights Act, 1967; the Mining Title Registration Act, 1967; the Mineral Technology Act, 1989; and the Alexander Bay Development Corporation Act, 1989. The Petroleum Products Act, 1977; the Nuclear Energy Act, 1982; the Coal Resources Act, 1985; and the Energy Act, 1987 regulated the exploration for and extraction of mineral fuels. The Precious Stones Act, 1964, regulated the prospecting for and mining of precious stones. The Mining Rights Act, 1967, provided for the prospecting and mining of precious metals, base metals, and petroleum. The country was the world's largest producer of tiger's eye gem stones, and the Tiger's Eye Control Act, 1977, oversaw the mining and sale of this semiprecious gem stone. The mining and processing of sand, gravel, stone, and quarry products, is regulated by the Physical Planning Act, 1967.

The Minerals Bureau had responsibility for collecting, classifying, and analyzing

mineral data to assist the Government in formulating policies on mineral development and provided mineral information to the industry.

The Geological Survey of South Africa had responsibility for geological mapping and basic studies relevant to the identification, nature, extent, and genesis of ore deposits. Information is released through reports and publications.

The Council for Mineral Technology (Mintek) 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 National Energy Council, formed under the Energy Act of 1987, advised the Minister of Mineral and Energy Affairs and Public Enterprises on matters relating to energy policy. It administered or implemented various Government policies related to energy, including the coal export program and the purchase and stockpile of crude petroleum.

At an early stage of South Africa's industrial development, the Government provided financial assistance for the establishment of a national steel producer, the South African Iron and Steel Corp. (Isacor), which was privatized in 1989. Later, through the Industrial Development Corp. (IDC), the Government financed the Phosphate Development Corp. (now known as Foskor) for the supply of phosphate, as well as Sasol, which converts coal to oil, and Alusaf for aluminum production. Alusaf and a major part of Sasol have also since been privatized.

The 1991 National Budget introduced a number of changes that are of significance to the mining industry, including far-reaching amendments to mining taxation rates. In a move welcomed by the mining

industry, the Government decided to short-circuit its intentions to make a phased transition to a single, new gold mining tax formula, which had been recommended by the 1988 Marais Technical Committee. The formula is expressed as  $y=61-(305/x)$ ;  $x$  being the percentage of total income from gold mining that is taxable. Originally due to have been introduced in phases over a recommended 7-year period (two phases were implemented in previous budgets), the formula was implemented in full. The tax rate for non gold mines was also amended in the 1991 budget. The effective tax rate became 50.88% compared with the previous rate of 54.5%. The 1991 budget also made provision for a drop in the rate of tax on non mining income, from 50% to 48%, and it was expected to continue to drop in the next few years to an ultimate target of 40%.

South Africa continued to negotiate with Britain, the United States, and the U.S.S.R. on the subject of participation in the Nuclear Non-Proliferation Treaty. Indications are that the treaty will be signed during 1991.

## PRODUCTION

The Republic of South Africa was one of the world's major producers and exporters of mineral commodities in terms of both quantity and diversity of minerals. In 1990, more than 60 different minerals were produced from a total of 1,041 mines and quarries. In 1990, there were 77 gold, 106 coal, and 63 diamond mines. Metals for which South Africa was among the world's leading producers included antimony, chromite, gold, manganese, PGM, titanium, uranium, vanadium, and zirconium. Industrial minerals of similar importance were andalusite, asbestos, diamond, fluorspar, pyrophyllite, and vermiculite. Owing to limited domestic consumption, most output was exported. South Africa exported minerals to 84 countries, the major recipients being in Europe and the Far East. However, increasing amounts of chromite, crude steel, diamond, dimension stone, gold, and manganese were being upgraded or consumed in higher value-added products locally. These products were then exported.

Mine output and the mining sector's contribution to the GDP have been declining for the past 5 years. In 1990, the contribution was 10.7% of GDP (down from 11% to 12% in previous years) and 41% of export earnings (down from 50%). Only chrome ore, iron ore, manganese ore, PGM, and

several industrial minerals achieved significantly higher production levels in 1990 than in 1985. In 1990, mining output declined by 1.6% mostly owing to lower coal and gold production as a result of decreased world demand. Production and exports of most base metals declined. In line with the softening of the world steel market, exports of chrome ore, ferroalloys, and manganese ore also fell.

The increasing costs of production continued to negatively impact the industry, while productivity increases have not kept pace with these costs. In June 1991, a wage settlement between the National Union of Mineworkers (NUM) and the Chamber of Mines resulted in an increase in wages at gold mines of an average of 6%, the lowest wage increase in recent years, and less than one-half the inflation rate. Low gold prices combined with higher production costs led to the lay off of 80,000 gold mine workers during 1989 and 1990.

## TRADE

Exports of minerals, as reported by the Minerals Bureau, were \$11.5 billion, of which coal, gold, and PGM accounted for 85%. According to Reserve Bank of South Africa, "net gold exports" amounted to about \$7 billion in 1990. At an average 1990 gold price of \$383.6 per troy ounce, this translates to exporting about 567 tons of gold or 94% of the country's gold output. Thus, South Africa's gold exports equaled 27% of world gold production in 1990. The country's share of world supply of PGM was as follows: platinum, 75%; palladium, 35%; and rhodium, 54%. With a total coal export of about 50 Mmt, South Africa was the third largest coal exporter (after Australia and the United States), accounting for 13% of total world coal exports.

Total imports by the United States from the Republic of South Africa in 1990 were about \$1.7 billion. Of this amount, more than 80% was mineral products, consisting primarily of chrome ore, diamond and other gem stones, ferrochromium, ferromanganese, ferrosilicon, manganese, and PGM. Restrictions on imports by the United States of South African coal, gold, iron and steel, and uranium remained in effect throughout 1990, but were lifted in June 1991. The EC also had restrictions on the importation of iron and steel into western Europe.

South Africa remained the largest export market for U.S. products and services in Sub-Saharan Africa. U.S. exports to South

Africa in 1990 were \$1.7 billion (equaling the U.S. imports from South Africa), representing 21% of South Africa's total import market. The United States was South Africa's third largest supplier, behind the Federal Republic of Germany and the United Kingdom. Principal U.S. exports to South Africa were mining equipment, chemicals, aircraft and parts, electronic data processing and related equipment, and office machinery.

## STRUCTURE OF THE MINERAL INDUSTRY

The Republic of South Africa's mineral industry differs from those of other large mineral-producing countries in that only six major mining houses (or investment groups) account for the majority of the country's mining and mineral processing activities. The groups 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 chamber is responsible for a variety of advisory and service functions, as well as technical research, which can be handled most effectively on a co-operative basis.

Apart from the six major mining houses, 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. Government participation was particularly pronounced in the synthetic fuels sector, which was based on domestic coal resources (Sasol III remains partly Government owned through IDC). It also was funding and overseeing the development of natural gas reserves offshore Mossel Bay.

The six major domestic mining investment groups that dominated the mining industry in the Republic of South Africa had highly diversified investments during 1990. About 34% of AAC's investments value (after adjustment for outside shareholders' interests in subsidiary companies) was in gold, followed by industry and commerce, 19%; PGM, base metals, and

TABLE 1

REPUBLIC OF SOUTH AFRICA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity  | 1986           | 1987         | 1988          | 1989 <sup>p</sup> | 1990 <sup>p</sup> |
|--|----------------|--------------|---------------|-------------------|-------------------|
| <b>METALS</b>  |                |              |               |                   |                   |
| Aluminum metal, primary                                    | 169,600        | 170,600      | '170,400      | '165,900          | '170,000          |
| Antimony concentrate:                                      |                |              |               |                   |                   |
| Gross weight   | '12,062        | 11,453       | 10,855        | 8,838             | 8,113             |
| Sb content   | '7,025         | 6,673        | '6,264        | '5,201            | 4,815             |
| Beryl concentrate (11% to 12% BeO) kilograms               | 3,133          | 135          | 72            | NA                | 1,000             |
| Cadmium, Cd content of cadmium cake                        | 30             | 33           | 37            | '40               | '40               |
| Chromite, gross weight:                                    |                |              |               |                   |                   |
| More than 48% Cr <sub>2</sub> O <sub>3</sub> thousand tons | 39             | 65           | 20            | '54               | 47                |
| 44% to 48% Cr <sub>2</sub> O <sub>3</sub> do.              | 2,294          | 2,241        | 2,721         | '2,583            | 2,383             |
| Less than 44% Cr <sub>2</sub> O <sub>3</sub> do.           | 1,574          | 1,483        | 1,503         | '2,314            | 2,188             |
| Total <sup>2</sup> do.                                     | <u>3,907</u>   | <u>3,789</u> | <u>4,245</u>  | <u>'4,951</u>     | <u>4,618</u>      |
| Cobalt:  |                |              |               |                   |                   |
| Mine output, Co content <sup>e</sup>                       | '250           | '380         | '300          | '300              | 350               |
| Refinery output:   |                |              |               |                   |                   |
| Metal, powder <sup>e</sup>                                 | '50            | '80          | '60           | '60               | 70                |
| Sulfate, contained cobalt <sup>e</sup>                     | '100           | '180         | '150          | '140              | 180               |
| Total <sup>2</sup>   | <u>153</u>     | <u>263</u>   | <u>206</u>    | <u>199</u>        | <u>249</u>        |
| Columbium-tantalum concentrate kilograms                   | —              | 8            | 140           | 20                | 6                 |
| Copper:  |                |              |               |                   |                   |
| Mine output, Cu content                                    | 184,205        | 188,088      | 168,452       | r/181,854         | 178,704           |
| Metal:   |                |              |               |                   |                   |
| Smelter  | '184,000       | '189,800     | '180,600      | '184,800          | 176,000           |
| Refined  | '143,200       | '146,500     | '136,700      | '144,200          | 133,000           |
| Gold, primary kilograms                                    | '640,000       | '607,000     | '621,000      | '607,500          | 605,400           |
| Iron and steel:  |                |              |               |                   |                   |
| Ore and concentrate:                                       |                |              |               |                   |                   |
| Gross weight thousand tons                                 | 24,483         | 22,008       | 25,248        | 29,958            | 30,291            |
| Fe content do.   | '15,914        | '14,297      | '16,461       | '19,461           | 19,689            |
| Metal:   |                |              |               |                   |                   |
| Pig iron do.   | '5,774         | '6,317       | '6,171        | '6,543            | 6,257             |
| Direct-reduced iron do.                                    | 789            | 844          | '730          | '840              | 860               |
| Ferroalloys, blast furnace and electric arc furnace:       |                |              |               |                   |                   |
| Chromium ferroalloys do.                                   | 925            | 965          | 994           | 1,036             | 1,022             |
| Ferromanganese do.   | 337            | 315          | 447           | '403              | 404               |
| Ferrosilicomanganese do.                                   | '270           | '282         | '248          | '258              | 234               |
| Manganese metal do.  | 33             | 32           | '37           | 40                | 35                |
| Ferrosilicon do.   | 83             | 83           | '87           | '93               | 78                |
| Silicon metal do.  | 35             | 34           | 39            | 36                | 36                |
| Ferrovanadium <sup>e</sup> do.                             | <sup>3</sup> 1 | 1            | 1             | '2                | 2                 |
| Total <sup>2</sup> do.                                     | <u>1,685</u>   | <u>1,712</u> | <u>'1,853</u> | <u>'1,868</u>     | <u>1,811</u>      |
| Crude steel do.  | '8,895         | '8,693       | '8,522        | '8,973            | 8,600             |
| Lead:  |                |              |               |                   |                   |
| Concentrate, Pb content                                    | 97,778         | 93,642       | 90,233        | 78,171            | 69,417            |
| Smelter, secondary   | 40,463         | 38,268       | 37,361        | '36,900           | 31,200            |
| Manganese:   |                |              |               |                   |                   |
| Ore and concentrate, gross weight:                         |                |              |               |                   |                   |
| Metallurgical: <sup>4</sup>                                |                |              |               |                   |                   |
| More than 48% Mn thousand tons                             | '1,090         | '970         | '1,108        | '1,228            | 2,102             |

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   | 1986          | 1987           | 1988           | 1989 <sup>p</sup> | 1990 <sup>p</sup> |                      |
|---|---------------|----------------|----------------|-------------------|-------------------|----------------------|
| <b>METALS—Continued</b>   |               |                |                |                   |                   |                      |
| <b>Manganese:—Continued</b>   |               |                |                |                   |                   |                      |
| <b>Ore and concentrate, gross weight:—Continued</b>                           |               |                |                |                   |                   |                      |
| <b>Metallurgical:<sup>4</sup>—Continued</b>                                   |               |                |                |                   |                   |                      |
| 45% to 48% Mn   | thousand tons | '379           | '492           | '674              | '1,357            | 610                  |
| 40% to 45% Mn   | do.           | '1,155         | '937           | '710              | '702              | 689                  |
| 30% to 40% Mn   | do.           | '1,467         | '749           | '1,405            | '1,518            | 917                  |
| Total   | do.           | <u>'4,091</u>  | <u>'3,148</u>  | <u>'3,897</u>     | <u>'4,805</u>     | <u>4,318</u>         |
| <b>Chemical:</b>  |               |                |                |                   |                   |                      |
| More than 65% MnO <sub>2</sub>  | do.           | 4              | 3              | 2                 | 1                 | 6                    |
| 35% to 65% MnO <sub>2</sub>   | do.           | '170           | '138           | '122              | '77               | 69                   |
| Less than 35% MnO <sub>2</sub>  | do.           | 16             | 5              | 2                 | —                 | 9                    |
| Total   | do.           | <u>'191</u>    | <u>'146</u>    | <u>'126</u>       | <u>'79</u>        | <u>84</u>            |
| Grand total <sup>2</sup>  | do.           | <u>'4,282</u>  | <u>'3,294</u>  | <u>'4,023</u>     | <u>'4,884</u>     | <u>4,402</u>         |
| <b>Nickel:</b>  |               |                |                |                   |                   |                      |
| Mine output, Ni content   |               | 31,800         | 34,300         | 34,800            | '34,000           | '34,000              |
| Metal, electrolytic   |               | '28,762        | '29,248        | '29,217           | 27,900            | 28,133               |
| Platinum-group metals, metal content of concentrate, matte, refinery products | kilograms     | '120,542       | '127,980       | '131,592          | '132,289          | 139,876              |
| <b>Silver:</b>  |               |                |                |                   |                   |                      |
| Mine output, Ag content   | do.           | 222,244        | 208,118        | 199,745           | '179,829          | 181,003              |
| Metal <sup>c</sup>  | do.           | 2,000          | 1,900          | 1,800             | 1,700             | 1,700                |
| <b>Thorium:</b>   |               |                |                |                   |                   |                      |
| Monazite <sup>c</sup>   |               | 1,000          | 1,200          | 1,200             | 1,200             | <sup>3</sup> 1,317   |
| <b>Tin:</b>   |               |                |                |                   |                   |                      |
| <b>Concentrate:</b>   |               |                |                |                   |                   |                      |
| Gross weight <sup>e</sup>   |               | 5,250          | 3,620          | 3,400             | 3,350             | 2,800                |
| Sn content  |               | 2,054          | 1,438          | 1,377             | 1,306             | 1,140                |
| Metal, primary <sup>5</sup>   |               | 2,001          | 1,508          | 1,389             | 1,307             | 1,152                |
| <b>Titanium:<sup>c</sup></b>  |               |                |                |                   |                   |                      |
| Rutile concentrate  |               | 55,000         | 55,000         | 55,000            | 60,000            | <sup>3</sup> 64,056  |
| Titaniferous slag   |               | 435,000        | 650,000        | 700,000           | 725,000           | <sup>3</sup> 672,000 |
| Uranium oxide (U <sub>3</sub> O <sub>8</sub> )                                |               | 5,460          | 4,735          | '4,480            | '3,472            | 2,675                |
| <b>Vanadium:</b>  |               |                |                |                   |                   |                      |
| Vanadiferous slag, gross weight <sup>e</sup>                                  |               | '68,000        | '72,000        | '80,000           | '80,000           | 70,000               |
| <b>V content:</b>   |               |                |                |                   |                   |                      |
| Of vanadiferous slag <sup>e</sup>   |               | 9,600          | 10,100         | 11,300            | 11,300            | 10,000               |
| Of V <sub>2</sub> O <sub>5</sub> and vanadate products <sup>c</sup>           |               | '7,030         | '5,840         | '6,330            | '7,270            | 7,100                |
| Total <sup>2</sup>  |               | <u>'16,628</u> | <u>'15,942</u> | <u>'17,631</u>    | <u>'18,567</u>    | <u>17,106</u>        |
| <b>Zinc:</b>  |               |                |                |                   |                   |                      |
| <b>Concentrate:</b>   |               |                |                |                   |                   |                      |
| Gross weight <sup>e</sup>   |               | 200,000        | 220,000        | 175,000           | 152,000           | 145,000              |
| Zn content  |               | 101,859        | 112,686        | 89,551            | 77,334            | 74,792               |
| Metal, smelter  |               | '80,803        | 96,051         | '85,193           | 84,997            | 92,341               |
| Zirconium concentrate (baddeleyite) and zircon <sup>c</sup>                   |               | 140,000        | 140,000        | 150,000           | '150,000          | <sup>3</sup> 151,536 |
| <b>INDUSTRIAL MINERALS</b>  |               |                |                |                   |                   |                      |
| <b>Aluminosilicates:</b>  |               |                |                |                   |                   |                      |
| Andalusite  |               | '181,624       | '218,560       | 259,556           | '284,617          | 283,677              |
| Sillimanite   |               | 1,330          | 1,243          | 781               | 170               | 256                  |

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                              | 1986                 | 1987                | 1988                 | 1989 <sup>P</sup>          | 1990 <sup>P</sup>  |
|--|----------------------|---------------------|----------------------|----------------------------|--------------------|
| <b>INDUSTRIAL MINERALS—Continued</b>   |                      |                     |                      |                            |                    |
| <b>Asbestos</b>                        |                      |                     |                      |                            |                    |
| Amosite                                | 36,009               | 26,026              | 20,325               | 26,124                     | 26,570             |
| Chrysotile                             | 91,001               | 101,722             | 113,468              | 115,420                    | 103,410            |
| Crocidolite                            | 11,852               | 7,326               | 11,885               | <sup>1</sup> 15,050        | 15,820             |
| Total                                  | <u>138,862</u>       | <u>135,074</u>      | <u>145,678</u>       | <u><sup>1</sup>156,594</u> | <u>145,791</u>     |
| Barite                                 | <u>8,653</u>         | <u>8,617</u>        | <u>8,735</u>         | <u>8,570</u>               | <u>2,490</u>       |
| Cement, hydraulic                      | 6,712                | 7,256               | 8,486                | <sup>8</sup> 7,700         | <sup>8</sup> 8,000 |
| <b>Clays:</b>                          |                      |                     |                      |                            |                    |
| Attapulgitic                           | 10,125               | 6,026               | 7,161                | 6,609                      | 7,628              |
| Bentonite                              | 48,265               | 48,953              | 66,750               | 62,987                     | 66,059             |
| Fire clay                              | 202,883              | 230,519             | 267,184              | 282,885                    | 232,393            |
| Flint clay                             | 130,721              | 106,915             | 139,112              | <sup>1</sup> 128,586       | 130,174            |
| Kaolin                                 | 126,129              | 151,730             | <sup>1</sup> 152,500 | 139,711                    | 132,421            |
| Corundum, natural                      | 9                    | 5                   | 2                    | 2                          | <sup>2</sup>       |
| <b>Diamond, natural:</b>               |                      |                     |                      |                            |                    |
| Gem <sup>c</sup>                       | <sup>4</sup> 4,500   | <sup>4</sup> 4,000  | <sup>3</sup> 3,800   | <sup>4</sup> 4,000         | 3,900              |
| Industrial <sup>e</sup>                | <sup>5</sup> 5,730   | <sup>5</sup> 5,050  | <sup>4</sup> 4,700   | <sup>5</sup> 5,120         | 4,800              |
| Total <sup>2</sup>                     | <u>10,228</u>        | <u>9,051</u>        | <u>8,504</u>         | <u>9,116</u>               | <u>8,708</u>       |
| Diatomite                              | 1,800                | 194                 | 199                  | 133                        | 2,798              |
| Feldspar                               | <sup>4</sup> 1,232   | <sup>5</sup> 0,930  | <sup>6</sup> 1,440   | <sup>5</sup> 2,964         | 56,124             |
| <b>Fluorspar:</b>                      |                      |                     |                      |                            |                    |
| Acid-grade <sup>e</sup>                | <sup>2</sup> 293,368 | 279,000             | 283,000              | 310,000                    | 262,000            |
| Ceramic-grade <sup>e</sup>             | <sup>7</sup> 7,703   | 7,000               | 8,000                | 9,000                      | 7,500              |
| Metallurgical-grade <sup>e</sup>       | <sup>3</sup> 32,814  | 30,600              | 37,420               | 49,340                     | 41,530             |
| Total <sup>2</sup>                     | <u>333,885</u>       | <u>316,606</u>      | <u>328,421</u>       | <u>368,340</u>             | <u>311,032</u>     |
| <b>Gem stones, semiprecious:</b>       |                      |                     |                      |                            |                    |
| Rose quartz                            | NA                   | NA                  | 44,165               | 47,210                     | 17,842             |
| Tiger's eye                            | <sup>3</sup> 51,000  | <sup>4</sup> 58,000 | <sup>4</sup> 54,000  | <sup>3</sup> 31,000        | 568,087            |
| Gypsum, crude                          | 404,205              | 349,079             | 372,169              | 406,743                    | 390,765            |
| Lime <sup>5</sup>                      | 1,944                | 1,582               | 1,916                | 1,939                      | 1,830              |
| Magnesite, crude                       | 61,186               | 74,961              | 74,088               | 75,695                     | 114,182            |
| <b>Mica:</b>                           |                      |                     |                      |                            |                    |
| Sheet                                  | —                    | —                   | —                    | —                          | —                  |
| Waste (scrap and ground)               | 2,509                | 970                 | 1,669                | 1,708                      | 1,765              |
| Nitrogen: N content of ammonia         | <sup>5</sup> 80,000  | 546,600             | 471,800              | 455,200                    | 456,200            |
| Phosphate rock, gross weight           | 2,920                | 2,623               | 2,850                | <sup>2</sup> 963           | 3,165              |
| <b>Pigments, mineral, natural:</b>     |                      |                     |                      |                            |                    |
| Ochers                                 | 1,340                | 621                 | 1,944                | 1,327                      | <sup>2</sup> 850   |
| Oxides                                 | 161                  | 147                 | 126                  | —                          | <sup>5</sup> 0     |
| Total                                  | <u>1,501</u>         | <u>768</u>          | <u>2,070</u>         | <u>1,327</u>               | <u>2,903</u>       |
| Quartz, quartzite, glass sand (silica) | 1,655                | 1,937               | 2,011                | 2,182                      | 1,986              |
| Salt                                   | 752,440              | 705,531             | 678,225              | 692,391                    | 728,110            |
| Silcrete                               | NA                   | NA                  | <sup>5</sup> 815     | <sup>5</sup> 4,079         | 1,244              |
| Sodium sulfate, natural                | 466                  | 241                 | 255                  | 15                         | <sup>2</sup> 0     |
| <b>Stone, n.e.s.:</b>                  |                      |                     |                      |                            |                    |
| <b>Dimension:</b>                      |                      |                     |                      |                            |                    |
| Granite                                | <sup>3</sup> 34,800  | <sup>3</sup> 79,200 | <sup>5</sup> 66,300  | <sup>6</sup> 26,800        | 713,400            |
| Marble                                 | <sup>6</sup> 900     | <sup>7</sup> 100    | <sup>8</sup> 600     | <sup>6</sup> 000           | 11,500             |

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                                  | 1986               | 1987           | 1988            | 1989 <sup>p</sup>           | 1990 <sup>p</sup>       |
|--|--------------------|----------------|-----------------|-----------------------------|-------------------------|
| <b>INDUSTRIAL MINERALS—Continued</b>       |                    |                |                 |                             |                         |
| Stone, n.e.s.:—Continued                   |                    |                |                 |                             |                         |
| Dimension:—Continued                       |                    |                |                 |                             |                         |
| Slate                                      | '39,300            | '39,200        | '42,300         | '33,900                     | 29,400                  |
| Crushed and broken:                        |                    |                |                 |                             |                         |
| Limestone thousand tons                    | '19,321            | '19,827        | '18,644         | '18,903                     | 19,946                  |
| Shale do.                                  | 526                | 354            | 422             | 398                         | 386                     |
| Sulfur:                                    |                    |                |                 |                             |                         |
| S content of pyrite thousand tons          | ' <sup>e</sup> 540 | '545           | 505             | '461                        | 452                     |
| Byproduct:                                 |                    |                |                 |                             |                         |
| Of metallurgy <sup>e</sup> do.             | '105               | 105            | 110             | 110                         | 110                     |
| Of petroleum <sup>e</sup> do.              | 110                | 110            | 120             | 120                         | 120                     |
| Total <sup>2</sup> <sup>e</sup> do.        | <u>'760</u>        | <u>'760</u>    | <u>735</u>      | <u>'<sup>3</sup>685</u>     | <u>'<sup>3</sup>683</u> |
| Talc and related materials:                |                    |                |                 |                             |                         |
| Talc                                       | 8,641              | 8,005          | 10,111          | '11,596                     | 11,179                  |
| Pyrophyllite (wonderstone)                 | 4,606              | 3,467          | 3,162           | 3,942                       | 2,759                   |
| Vermiculite                                | 193,657            | 228,863        | 209,177         | 224,500                     | 220,311                 |
| <b>MINERAL FUELS AND RELATED MATERIALS</b> |                    |                |                 |                             |                         |
| Coal:                                      |                    |                |                 |                             |                         |
| Anthracite thousand tons                   | 4,990              | 5,252          | 4,951           | 4,208                       | 3,622                   |
| Bituminous do.                             | '171,729           | 171,294        | 176,409         | '172,075                    | 171,161                 |
| Total <sup>2</sup> do.                     | <u>'176,718</u>    | <u>176,546</u> | <u>181,360</u>  | <u>'176,283</u>             | <u>174,784</u>          |
| Petroleum refinery products:               |                    |                |                 |                             |                         |
| Gasoline thousand 42-gallon barrels        | '37,230            | 36,865         | 36,865          | '37,000                     | '37,000                 |
| Jet fuel do.                               | '3,285             | 3,285          | 3,285           | '3,300                      | '3,300                  |
| Kerosene do.                               | '3,285             | 3,285          | 3,285           | '3,300                      | '3,300                  |
| Distillate fuel oil do.                    | '38,690            | 39,055         | 39,055          | '39,000                     | '39,000                 |
| Residual fuel oil do.                      | '23,725            | 23,725         | 23,725          | '24,000                     | '24,000                 |
| Lubricants do.                             | '2,555             | 2,555          | 2,555           | '2,500                      | '2,500                  |
| Other do.                                  | '16,060            | '16,060        | 14,965          | '15,000                     | '15,000                 |
| Refinery fuel and losses do.               | '8,030             | 8,030          | 7,665           | '8,000                      | '8,000                  |
| Total do.                                  | <u>'126,290</u>    | <u>125,925</u> | <u>'124,830</u> | <u>'<sup>e</sup>125,000</u> | <u>'125,000</u>         |

<sup>e</sup>Estimated. <sup>p</sup>Preliminary. <sup>r</sup>Revised. NA Not available.<sup>1</sup>Table includes data available through April 13, 1992.<sup>2</sup>Data may not add to totals shown because of independent rounding.<sup>3</sup>Reported figure.<sup>4</sup>The Republic of South Africa's Minerals Bureau has substantially revised the previously reported manganese production figures.<sup>5</sup>Domestic sales plus exports.

TABLE 2

REPUBLIC OF SOUTH AFRICA: APPARENT EXPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity                         | 1988   | 1989 <sup>p</sup> | Destinations, 1989 |   |
|-----------------------------------|--------|-------------------|--------------------|---|
|                                   |        |                   | United States      | Other (principal)                       |
| <b>METALS</b>                     |        |                   |                    |   |
| Aluminum: Metal including alloys: |        |                   |                    |   |
| Scrap                             | 2,573  | 2,637             | —                  | Netherlands 1,478; Japan 524.           |
| Unwrought                         | 70,999 | 39,919            | 1,463              | Japan 28,204; Netherlands 4,280.        |
| Semimanufactures                  | 11,378 | 10,345            | 8,620              | West Germany 1,044; United Kingdom 449. |

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)

| Commodity  | 1988             | 1989 <sup>a</sup> | Destinations, 1989 |                                     |  |
|--|------------------|-------------------|--------------------|-------------------------------------|--|
|  |                  |                   | United States      | Other (principal)                   |  |
| <b>METALS—Continued</b>                              |                  |                   |                    |                                     |  |
| <b>Antimony:</b>                                     |                  |                   |                    |                                     |  |
| Ore and concentrate                                  | 269              | 293               | —                  | Belgium-Luxembourg 178; France 115. |  |
| Oxides   | 4,057            | 165               | —                  | United Kingdom 100; Italy 60.       |  |
| <b>Arsenic: Oxides and acids</b>                     |                  |                   |                    |                                     |  |
|  | 1,017            | —                 |                    |                                     |  |
| <b>Cadmium: Metal including alloys, all forms</b>    |                  |                   |                    |                                     |  |
|  | 3                | 70                | 24                 | France 36; Belgium-Luxembourg 10.   |  |
| <b>Chromium:</b>                                     |                  |                   |                    |                                     |  |
| Ore and concentrate                                  | thousand tons    | 1,233             | 1,467              | 368                                 | Japan 597; West Germany 210.                                       |
| Metal including alloys, all forms                    |                  | —                 | 20                 | —                                   | All to Austria.  |
| <b>Cobalt:</b>                                       |                  |                   |                    |                                     |  |
| Oxides and hydroxides                                |                  | 8                 | —                  |                                     |  |
| Metal including alloys, all forms                    |                  | 520               | 238                | 223                                 | Austria 15.  |
| <b>Columbium and tantalum:</b>                       |                  |                   |                    |                                     |  |
| Ore and concentrate                                  | kilograms        | 957               | —                  |                                     |  |
| Metal including alloys, all forms value, thousands   |                  |                   | \$43               | \$29                                | — United Kingdom \$20; Japan \$9.                                  |
| <b>Copper:</b>                                       |                  |                   |                    |                                     |  |
| Ore and concentrate                                  |                  | NA                | 10,540             | —                                   | All to Japan.  |
| Matte and speiss including cement copper             |                  | 199               | 288                | —                                   | West Germany 175; United Kingdom 111.                              |
| Oxides and hydroxides                                |                  | 5                 | —                  |                                     |  |
| Sulfate  |                  | —                 | 20                 | —                                   | All to United Kingdom.   |
| Ash and residue containing copper                    |                  | 310               | —                  |                                     |  |
| <b>Metal including alloys:</b>                       |                  |                   |                    |                                     |  |
| Scrap  |                  | 4,648             | 7,081              | —                                   | West Germany 5,529; United Kingdom 486; Italy 414.                 |
| Unwrought  |                  | 92,417            | 98,048             | 3,379                               | West Germany 46,510; Italy 17,128; United Kingdom 12,207.          |
| Semimanufactures                                     |                  | 6,896             | 6,941              | 4,001                               | Hong Kong 1,841; United Kingdom 613.                               |
| <b>Gold:</b>   |                  |                   |                    |                                     |  |
| Waste and sweepings                                  | value, thousands | \$1,668           | \$14,130           | \$134                               | Switzerland \$7,987; United Kingdom \$3,824; West Germany \$1,689. |
| Metal including alloys, unwrought and partly wrought | kilograms        | NA                | 168,060            | ( <sup>b</sup> )                    | Italy 146,868; West Germany 9,236; United Kingdom 7,626            |
| <b>Iron and steel:</b>                               |                  |                   |                    |                                     |  |
| Iron ore and concentrate, including roasted pyrite   | thousand tons    | 11,503            | 14,566             | —                                   | Japan 4,852; United Kingdom 2,310; West Germany 1,800.             |
| <b>Metal:</b>  |                  |                   |                    |                                     |  |
| Scrap  |                  | 54,869            | 778                | —                                   | Spain 306; West Germany 233; United Kingdom 204.                   |
| Pig iron, cast iron, related materials               |                  | 367,367           | 162,799            | —                                   | Japan 147,654; Belgium-Luxembourg 9,357; Italy 3,000.              |
| <b>Ferroalloys:</b>                                  |                  |                   |                    |                                     |  |
| Ferrochromium  |                  | 582,642           | 792,849            | 73,880                              | Japan 282,992; West Germany 189,854; France 134,068.               |
| Ferromanganese                                       |                  | 266,028           | 225,720            | 122,445                             | Italy 26,314; France 18,078.                                       |
| Ferromolybdenum                                      |                  | 192,798           | 17                 | —                                   | Austria 15; Belgium-Luxembourg 2.                                  |
| Ferronickel  |                  | 112               | 115                | 17                                  | West Germany 98.   |
| Ferrosilicochromium                                  |                  | 7,406             | 2,380              | —                                   | Japan 2,361; United Kingdom 19.                                    |
| Ferrosilicomanganese                                 |                  | 182,722           | 145,676            | 48,524                              | Japan 41,856; United Kingdom 16,285.                               |

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)

| Commodity   | 1988    | 1989 <sup>p</sup> | Destinations, 1989 |  |
|---|---------|-------------------|--------------------|--|
|   |         |                   | United States      | Other (principal)  |
| <b>METALS—Continued</b>                                   |         |                   |                    |  |
| <b>Iron and steel—Continued</b>                           |         |                   |                    |  |
| <b>Metal:—Continued</b>                                   |         |                   |                    |  |
| <b>Ferrous alloys:—Continued</b>                          |         |                   |                    |  |
| Ferrosilicon  | 42,690  | 20,748            | —                  | Japan 16,786; Belgium-Luxembourg 1,665.                  |
| Silicon metal   | 32,205  | 14,261            | 774                | Japan 13,096.  |
| Unspecified   | 3,032   | 1,223             | —                  | Hong Kong 1,212.   |
| Steel, primary forms                                      | 404,763 | 21,796            | 6                  | Hong Kong 20,028; West Germany 1,567.                    |
| <b>Semimanufactures:</b>                                  |         |                   |                    |  |
| Bars, rods, angles, shapes, sections                      | 351,370 | 168,260           | —                  | Hong Kong 111,669; Portugal 27,111; Greece 13,880.       |
| Universals, plates, sheets                                | 153,651 | 43,300            | —                  | Hong Kong 38,642; Greece 3,004.                          |
| Hoop and strip  | 17      | 5,288             | —                  | United Kingdom 2,689; France 1,379.                      |
| Rails and accessories                                     | 6,687   | 76,550            | —                  | Spain 22,631; Greece 14,171; West Germany 13,404.        |
| Wire  | 13,192  | 358               | —                  | France 200; Hong Kong 158.                               |
| Tubes, pipes, fittings                                    | 64,387  | 37,222            | ( <sup>q</sup> )   | United Kingdom 7,696; West Germany 6,500; Ireland 4,288. |
| Castings and forgings, rough                              | 30      | 30,531            | —                  | Spain 10,382; Greece 7,435; West Germany 7,037.          |
| <b>Lead:</b>  |         |                   |                    |  |
| Ore and concentrate                                       | 38,981  | 95,527            | —                  | France 43,406; Japan 19,272; Italy 16,895.               |
| Oxides  | 1       | 38                | 26                 | West Germany 6; United Kingdom 5.                        |
| Ash and residue containing lead                           | 303     | —                 | —                  | —  |
| <b>Metal including alloys:</b>                            |         |                   |                    |  |
| Scrap   | 144     | 155               | —                  | United Kingdom 95; West Germany 60.                      |
| Unwrought   | 2,731   | 12,040            | —                  | Italy 7,298; Portugal 3,036.                             |
| Semimanufactures  | 278     | 115               | —                  | Hong Kong 59; United Kingdom 56.                         |
| <b>Magnesium: Metal including alloys:</b>                 |         |                   |                    |  |
| Scrap   | 13      | 69                | —                  | United Kingdom 62; Netherlands 6.                        |
| Unwrought   | 43      | —                 | —                  | —  |
| <b>Manganese:</b>   |         |                   |                    |  |
| Ore and concentrate: Metallurgical-grade<br>thousand tons | 2,031   | 1,944             | 55                 | Japan 1,027; Netherlands 322; Spain 182.                 |
| Oxides  | 1,480   | 4,673             | 2,405              | Belgium-Luxembourg 680; Spain 443.                       |
| Metal including alloys, all forms                         | 23,275  | 29,253            | 14,082             | Japan 8,531; West Germany 2,503.                         |
| <b>Molybdenum:</b>  |         |                   |                    |  |
| Ore and concentrate                                       | 2,104   | NA                | —                  | —  |
| Metal including alloys, scrap                             | —       | 3                 | —                  | All to United Kingdom.                                   |
| <b>Nickel:</b>  |         |                   |                    |  |
| Ore and concentrate                                       | —       | 1                 | —                  | Do.  |
| Matte and speiss  | 65      | —                 | —                  | —  |
| Ash and residue containing nickel                         | 48      | —                 | —                  | —  |
| <b>Metal including alloys:</b>                            |         |                   |                    |  |
| Scrap   | 16      | 1,141             | 13                 | United Kingdom 1,042.                                    |
| Unwrought   | 9,875   | 3,533             | 1,357              | Italy 662; Japan 622.                                    |
| Semimanufactures  | 41      | 718               | 593                | France 100; Italy 10.                                    |

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)

| Commodity  | 1988             | 1989 <sup>p</sup> | Destinations, 1989 |                   |  |
|--|------------------|-------------------|--------------------|-------------------|--|
|  |                  |                   | United States      | Other (principal) |  |
| METALS—Continued   |                  |                   |                    |                   |  |
| Platinum-group metals:                                       |                  |                   |                    |                   |  |
| Waste and sweepings  | value, thousands | \$18,470          | NA                 |                   |  |
| Metals including alloys, unwrought and partly wrought:       |                  |                   |                    |                   |  |
| Palladium  | kilograms        | 23,220            | 25,760             | 17,270            | United Kingdom 4,755; West Germany 2,098.      |
| Platinum   | do.              | 60,973            | 63,607             | 34,109            | United Kingdom 12,361; West Germany 11,605.    |
| Rhodium  | do.              | 3,972             | 4,386              | 2,580             | United Kingdom 1,403; France 129.              |
| Iridium, osmium, ruthenium                                   | do.              | 4,916             | 2,603              | 2,583             | Switzerland 20.                                |
| Unspecified  | value, thousands | \$198,027         | \$184,238          | —                 | Japan \$171,204; United Kingdom \$8,635.       |
| Silicon, high-purity   |                  | 63                | 17,496             | —                 | United Kingdom 8,097; West Germany 5,429.      |
| Silver: Metal including alloys, unwrought and partly wrought | kilograms        | 16,537            | 62,840             | 2,542             | United Kingdom 41,223; West Germany 19,042.    |
| Tin:   |                  |                   |                    |                   |  |
| Ore and concentrate  |                  | NA                | 2,945              | —                 | Japan 2,928.                                   |
| Metal including alloys:                                      |                  |                   |                    |                   |  |
| Scrap  |                  | —                 | 5                  | —                 | All to United Kingdom.                         |
| Unwrought  |                  | 318               | 451                | 10                | United Kingdom 301; West Germany 64; Italy 38. |
| Semimanufactures   |                  | —                 | 3                  | —                 | All to United Kingdom.                         |
| Titanium:  |                  |                   |                    |                   |  |
| Ore and concentrate  |                  | 38,900            | 86,595             | 46,252            | Belgium-Luxembourg 19,306; Netherlands 11,325. |
| Oxides   |                  | 1,325             | 252                | —                 | All to Hong Kong.                              |
| Metal including alloys:                                      |                  |                   |                    |                   |  |
| Scrap  |                  | —                 | 3                  | —                 | All to United Kingdom.                         |
| Semimanufactures   |                  | —                 | 14                 | —                 | Italy 7; Austria 5.                            |
| Tungsten:  |                  |                   |                    |                   |  |
| Ore and concentrate  |                  | 25                | —                  |                   |  |
| Metal including alloys:                                      |                  |                   |                    |                   |  |
| Scrap  |                  | 55                | 25                 | —                 | All to United Kingdom.                         |
| Unspecified  |                  | —                 | 62                 | 62                |  |
| Uranium and thorium:   |                  |                   |                    |                   |  |
| Ore and concentrate  |                  | NA                | 1,556              | —                 | All to France.                                 |
| Oxides and other compounds                                   |                  | 333               | —                  |                   |  |
| Vanadium:  |                  |                   |                    |                   |  |
| Ore and concentrate  |                  | —                 | 12,180             | —                 | All to Belgium-Luxembourg.                     |
| Oxides and hydroxides  |                  | 7,091             | 1,540              | —                 | Austria 1,533.                                 |
| Ash and residue containing vanadium                          |                  | NA                | 20,906             | —                 | All to Austria.                                |
| Metal including alloys, all forms                            |                  | 22                | 17                 | 17                |  |
| Zinc:  |                  |                   |                    |                   |  |
| Ore and concentrate  |                  | 18,623            | 18,314             | —                 | Japan 12,724; Belgium-Luxembourg 5,590.        |
| Oxides   |                  | 18                | 12                 | —                 | All to Spain.                                  |
| Metal including alloys:                                      |                  |                   |                    |                   |  |
| Scrap  |                  | 86                | 64                 | —                 | United Kingdom 43; West Germany 21.            |
| Unwrought  |                  | 1,023             | 2,733              | 301               | Hong Kong 1,029; West Germany 1,000.           |
| Semimanufactures   |                  | 377               | 1,062              | 152               | Portugal 620; United Kingdom 240.              |

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)

| Commodity  | 1988      | 1989 <sup>a</sup> | Destinations, 1989 |   |
|--|-----------|-------------------|--------------------|---|
|  |           |                   | United States      | Other (principal)   |
| <b>METALS—Continued</b>  |           |                   |                    |   |
| <b>Zirconium:</b>  |           |                   |                    |   |
| Ore and concentrate  | 82,256    | 119,073           | 20,833             | Japan 22,570; Netherlands 20,104.                         |
| <b>Metal including alloys:</b>   |           |                   |                    |   |
| Unwrought  | —         | 107               | —                  | Spain 40; Netherlands 34.                                 |
| Semimanufactures   | —         | 79                | —                  | All to Hong Kong.   |
| <b>Other:</b>  |           |                   |                    |   |
| <b>Ores and concentrates:</b>  |           |                   |                    |   |
| Of base metals   | 30,367    | —                 |                    |   |
| Of precious metals, n.e.s. value, thousands  | \$1,476   | —                 |                    |   |
| Oxides and hydroxides  | 1,814     | 25                | —                  | All to Spain.   |
| Ashes and residues   | 238,579   | 102,408           | ( <sup>d</sup> )   | West Germany 100,057.                                     |
| Base metals including alloys, all forms  | 1,203     | —                 |                    |   |
| <b>INDUSTRIAL MINERALS</b>   |           |                   |                    |   |
| <b>Abrasives, n.e.s.:</b>  |           |                   |                    |   |
| Natural: Corundum, emery, pumice, etc.   | 20        | 38                | —                  | West Germany 20; Italy 18.                                |
| Dust and powder of precious and semiprecious stones including diamond value, thousands | \$178     | \$8               | —                  | All to Hong Kong.   |
| Grinding and polishing wheels and stones   | 2         | 13                | —                  | United Kingdom 9; West Germany 3.                         |
| Asbestos, crude  | 123,152   | 98,518            | 1,040              | Japan 86,819; France 2,027.                               |
| <b>Clays, crude:</b>   |           |                   |                    |   |
| Bentonite  | 3,580     | 126               | —                  | All to Italy.   |
| Chamotte earth   | 6,659     | 8,558             | —                  | West Germany 5,319; United Kingdom 3,153.                 |
| Fire clay  | —         | 5,050             | —                  | All to West Germany.                                      |
| Flint clay   | 1,746     | —                 |                    |   |
| Kaolin   | —         | 20                | —                  | All to West Germany.                                      |
| Unspecified  | 46,683    | 46,749            | 9,456              | Japan 37,274.   |
| <b>Diamond:</b>  |           |                   |                    |   |
| <b>Natural:</b>  |           |                   |                    |   |
| Gem, not set or strung value, thousands  | \$345,755 | \$934,140         | \$38,575           | Belgium-Luxembourg \$846,167; Hong Kong \$46,031.         |
| Industrial stones do.  | \$16,918  | \$41,170          | \$554              | Belgium-Luxembourg \$38,499.                              |
| Dust and powder do.  | \$265     | \$234             | —                  | Austria \$95; West Germany \$88.                          |
| Synthetic: Dust and powder do.   | \$25      | —                 |                    |   |
| <b>Feldspar, fluorspar, related materials:</b>   |           |                   |                    |   |
| Feldspar   | 2,214     | 1,568             | —                  | Spain 1,461; Italy 65.                                    |
| Fluorspar  | 333,603   | 306,112           | 117,291            | West Germany 97,042; Japan 61,694.                        |
| Unspecified  | 24,844    | NA                |                    |   |
| <b>Fertilizer materials:</b>   |           |                   |                    |   |
| <b>Crude, n.e.s.</b>   |           |                   |                    |   |
|  | 1,805     | 2,781             | —                  | Belgium-Luxembourg 1,427; France 974.                     |
| <b>Manufactured:</b>   |           |                   |                    |   |
| Nitrogenous  | NA        | 116               | —                  | All to New Zealand.                                       |
| Phosphatic   | 2,499     | NA                |                    |   |
| Unspecified and mixed  | 54,864    | 52,754            | —                  | Spain 22,710; Italy 18,903; West Germany 5,525.           |
| Graphite, natural  | 340       | 513               | 58                 | United Kingdom 319; West Germany 82.                      |
| Kyanite and related materials  | NA        | 128,463           | —                  | West Germany 49,935; United Kingdom 43,662; Italy 13,586. |

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)

| Commodity  | 1988     | 1989 <sup>p</sup> | Destinations, 1989 |  |
|--|----------|-------------------|--------------------|--|
|  |          |                   | United States      | Other (principal)  |
| <b>INDUSTRIAL MINERALS—Continued</b>                         |          |                   |                    |  |
| Magnesium compounds:   |          |                   |                    |  |
| Oxides and hydroxides  | 43       | 256               | —                  | Spain 168; United Kingdom 88.                                  |
| Other  | 2        | —                 |                    |  |
| Mica:  |          |                   |                    |  |
| Crude including splittings and waste                         | 173      | 838               | —                  | United Kingdom 458; Japan 273.                                 |
| Worked including agglomerated splittings<br>value, thousands | —        | \$5               | —                  | All to Republic of Korea.                                      |
| Phosphates crude<br>thousand tons                            | 843      | 1,435             | —                  | Japan 530; Belgium-Luxembourg 384; West Germany 241.           |
| Phosphorus, elemental  | 1,605    | 174               | —                  | Belgium-Luxembourg 142; Spain 32.                              |
| Pigments, mineral:   |          |                   |                    |  |
| Natural crude  | —        | 699               | —                  | Belgium-Luxembourg 580; United Kingdom 119.                    |
| Iron oxides and hydroxides, processed                        | 56       | 41                | —                  | West Germany 21; Italy 20.                                     |
| Precious and semiprecious stones other than diamond:         |          |                   |                    |  |
| Natural<br>value, thousands                                  | \$61,673 | \$4,619           | \$461              | West Germany \$2,409; Hong Kong \$986; Japan \$640.            |
| Synthetic<br>do.   | \$28     | \$889             | \$2                | United Kingdom \$521; Belgium-Luxembourg \$366.                |
| Pyrite, unroasted  | NA       | 6                 | —                  | All to United Kingdom.   |
| Stone, sand and gravel:                                      |          |                   |                    |  |
| Dimension stone:   |          |                   |                    |  |
| Crude and partly worked                                      | 211,186  | 551,940           | ( <sup>e</sup> )   | Italy 290,389; Japan 87,430; France 53,331.                    |
| Worked   | 5,968    | 6,246             | ( <sup>e</sup> )   | Japan 2,490; United Kingdom 1,541; West Germany 1,496.         |
| Gravel and crushed rock                                      | 1,089    | 37                | 1                  | United Kingdom 36.   |
| Quartz and quartzite   | 843      | 3,418             | 131                | United Kingdom 3,024; Netherlands 74.                          |
| Sand other than metal-bearing                                | 14,103   | NA                |                    |  |
| Sand and gravel  | 116      | 26,282            | —                  | Belgium-Luxembourg 22,028; Spain 3,815.                        |
| Sulfur: Elemental, crude including native and byproduct      |          |                   |                    |  |
|  | 24       | —                 |                    |  |
| Talc, steatite, soapstone, pyrophyllite                      | 318      | 588               | 200                | West Germany 388.  |
| Vermiculite <sup>7</sup>                                     | 63,032   | 152,331           | 49,603             | France 22,696; West Germany 10,967; Italy 10,628.              |
| Other:   |          |                   |                    |  |
| Crude  | 47,571   | 48,555            | 885                | Japan 45,181.  |
| Slag and dross, not metal-bearing                            | 137,907  | 107,883           | 10,519             | Japan 96,538.  |
| <b>MINERAL FUELS AND RELATED MATERIALS</b>                   |          |                   |                    |  |
| Asphalt and bitumen, natural                                 | NA       | 66                | —                  | Portugal 32; Spain 31.   |
| Carbon:  |          |                   |                    |  |
| Carbon black   | 108      | —                 |                    |  |
| Gas carbon   | 100      | —                 |                    |  |
| Coal:  |          |                   |                    |  |
| Anthracite and bituminous<br>thousand tons                   | 14,512   | 31,402            | —                  | Japan 5,617; Italy 5,169; Spain 5,109.                         |
| Briquets of anthracite and bituminous coal                   | 1,727    | 1,157             | —                  | Ireland 1,010.   |
| Lignite including briquets<br>thousand tons                  | 4,293    | NA                |                    |  |
| Coke and semicoke  | NA       | 59,724            | —                  | United Kingdom 34,100; Italy 15,000; Belgium-Luxembourg 8,000. |

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)

| Commodity  | 1988  | 1989 <sup>p</sup> | Destinations, 1989 |                            |
|--|-------|-------------------|--------------------|----------------------------|
|  |       |                   | United States      | Other (principal)          |
| <b>MINERAL FUELS AND RELATED MATERIALS—Continued</b> |       |                   |                    |                            |
| <b>Petroleum:</b>                                    |       |                   |                    |                            |
| Crude<br>thousand 42-gallon barrels                  | 1,501 | 632               | ( <sup>8</sup> )   | All to United Kingdom.     |
| <b>Refinery products:</b>                            |       |                   |                    |                            |
| Liquefied petroleum gas                              | do.   | 215               | —                  | Do.                        |
| Gasoline   | do.   | NA                | 12                 | France 1.                  |
| Mineral jelly and wax                                | do.   | 228               | 45                 | West Germany 68; Japan 25. |
| Kerosene and jet fuel                                | do.   | NA                | 99                 |                            |
| Distillate fuel oil                                  | do.   | NA                | 3                  | Spain 24.                  |
| Lubricants   | do.   | 3                 | —                  | United Kingdom 4.          |
| Residual fuel oil                                    | do.   | 265               | 738                |                            |
| Bitumen and other residues                           | do.   | ( <sup>2</sup> )  | —                  |                            |
| Petroleum coke                                       | do.   | 59                | —                  | All to Ireland.            |

<sup>1</sup>Revised. <sup>p</sup>Preliminary. NA Not available.<sup>1</sup>Table prepared by Virginia A. Woodson. 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.<sup>2</sup>Unreported quantity valued at \$4,000.<sup>3</sup>Less than 1/2 unit.<sup>4</sup>Unreported quantity valued at \$65,720,000.<sup>5</sup>Unreported quantity valued at \$2,903,000.<sup>6</sup>Unreported quantity valued at \$876,000.<sup>7</sup>May include perlite.<sup>8</sup>Unreported quantity valued at \$151,000.

TABLE 3

REPUBLIC OF SOUTH AFRICA: APPARENT IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity   | 1988             | 1989 <sup>p</sup> | Sources, 1989 |   |
|---|------------------|-------------------|---------------|---|
|   |                  |                   | United States | Other (principal)                                     |
| <b>METALS</b>                                       |                  |                   |               |   |
| Alkali and alkaline-earth metals                    | 39               | —                 |               |   |
| <b>Aluminum:</b>                                    |                  |                   |               |   |
| Ore and concentrate                                 | 82               | 357               | —             | United Kingdom 225; Netherlands 132.                  |
| Oxides and hydroxides                               | 9,422            | 13,511            | 240           | Netherlands 4,389; United Kingdom 4,258; Japan 2,288. |
| <b>Metal including alloys:</b>                      |                  |                   |               |   |
| Scrap   | 61               | 853               | 755           | United Kingdom 82; Netherlands 16.                    |
| Unwrought   | 182              | 1                 |               |   |
| Semimanufactures                                    | 5,987            | 2,362             | 106           | Belgium-Luxembourg 1,272; Japan 938.                  |
| Unspecified   | 6                | —                 |               |   |
| <b>Antimony:</b>                                    |                  |                   |               |   |
| Oxides  | 25               | —                 |               |   |
| Metal including alloys, all forms                   | 10               | —                 |               |   |
| <b>Beryllium: Metal including alloys, all forms</b> |                  |                   |               |   |
| forms   | value, thousands | NA                | \$4           | —   |
|   |                  |                   |               | All from West Germany.                                |
| <b>Bismuth: Metal including alloys, all forms</b>   |                  |                   |               |   |
|   |                  | —                 | 5             | —   |
|   |                  |                   |               | All from United Kingdom.                              |
| <b>Cadmium: Metal including alloys, all forms</b>   |                  |                   |               |   |
|   | value, thousands | —                 | \$3           | —   |
|   |                  |                   |               | All from France.                                      |

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  | 1988   | 1989 <sup>a</sup> | Sources, 1989    |   |
|--|--------|-------------------|------------------|---|
|  |        |                   | United States    | Other (principal)   |
| <b>METALS—Continued</b>  |        |                   |                  |   |
| <b>Chromium:</b>   |        |                   |                  |   |
| Ore and concentrate  | 28     | —                 |                  |   |
| Oxides and hydroxides  | 348    | 59                | 5                | Belgium-Luxembourg 52.                                    |
| Metal including alloys, all forms                                    | 1      | 49                | ( <sup>2</sup> ) | United Kingdom 47; West Germany 2.                        |
| Cobalt: Metal including alloys, all forms                            | 7      | 71                | —                | United Kingdom 64; France 7.                              |
| Columbium and tantalum: Metal including alloys, all forms            | 3      | 5                 | ( <sup>2</sup> ) | Austria 4; United Kingdom 1.                              |
| <b>Copper:</b>   |        |                   |                  |   |
| Ore and concentrate  | —      | 600               | —                | All from Chile.   |
| Oxides and hydroxides  | 33     | 119               | —                | West Germany 79; Italy 40.                                |
| Ash and residue containing copper                                    | 2,904  | 2,039             | —                | West Germany 1,370; Belgium-Luxembourg 604.               |
| <b>Metal including alloys:</b>                                       |        |                   |                  |   |
| Scrap  | —      | 136               | 120              | Belgium-Luxembourg 16.                                    |
| Unwrought  | 112    | 5                 | 5                |   |
| Semimanufactures   | 4,202  | 679               | 83               | Belgium-Luxembourg 596.                                   |
| Unspecified  | 2      | —                 |                  |   |
| Gold: Metal including alloys, unwrought and partly wrought kilograms | 41     | 182               | ( <sup>3</sup> ) | United Kingdom 172; West Germany 10.                      |
| <b>Iron and steel:</b>   |        |                   |                  |   |
| Iron ore and concentrate excluding roasted pyrite                    | —      | 30                | —                | United Kingdom 20; Italy 10.                              |
| <b>Metal:</b>  |        |                   |                  |   |
| Scrap  | 1      | 203               | 193              | Italy 8; Netherlands 2.                                   |
| Pig iron, cast iron, related materials                               | 152    | 18,505            | 18,618           | United Kingdom 186.                                       |
| <b>Ferroalloys:</b>  |        |                   |                  |   |
| Ferrochromium  | 113    | 34                | —                | All from Japan.   |
| Ferromanganese   | NA     | 617               | —                | Belgium-Luxembourg 600; West Germany 17.                  |
| Ferromolybdenum  | NA     | 125               | —                | United Kingdom 122; West Germany 3.                       |
| Ferronickel  | —      | 40                | —                | All from United Kingdom.                                  |
| Ferrosilicochromium  | —      | 70                | —                | All from West Germany.                                    |
| Ferrosilicomanganese   | —      | 5                 | —                | All from Italy.   |
| Ferrosilicon   | 442    | 362               | 156              | France 105; United Kingdom 82.                            |
| Silicon metal  | 1      | 310               | 278              | Belgium-Luxembourg 20; United Kingdom 11.                 |
| Unspecified  | 95     | 1,911             | 51               | France 1,183; United Kingdom 477.                         |
| Steel, primary forms   | 1,406  | 1,844             | 15               | West Germany 1,342; United Kingdom 322.                   |
| <b>Semimanufactures:</b>   |        |                   |                  |   |
| Bars, rods, angles, shapes, sections                                 | 8,127  |                   |                  |   |
| Universals, plates, sheets   | 6,290  |                   |                  |   |
| Hoop and strip   | 271    |                   |                  |   |
| Rails and accessories  | 114    | 213,948           | 23,397           | West Germany 55,738; Japan 54,143; United Kingdom 22,588. |
| Wire   | 4,509  |                   |                  |   |
| Tubes, pipes, fittings   | 51,609 |                   |                  |   |
| Castings and forgings, rough   | 959    |                   |                  |   |
| <b>Lead:</b>   |        |                   |                  |   |
| Oxides   | —      | 18                | 2                | West Germany 15; United Kingdom 1.                        |

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  | 1988             | 1989 <sup>a</sup> | Sources, 1989    |   |   |
|--|------------------|-------------------|------------------|---|---|
|  |                  |                   | United States    | Other (principal)                       |   |
| <b>METALS—Continued</b>  |                  |                   |                  |   |   |
| <b>Lead:—Continued</b>   |                  |                   |                  |   |   |
| Metal including alloys:  |                  |                   |                  |   |   |
| Scrap  | 2,804            | NA                |                  |   |   |
| Unwrought  | 688              | 9                 | 9                |   |   |
| Semimanufactures   | 123              | 3                 | 3                |   |   |
| Lithium: Oxides and hydroxides                                 | —                | 54                | —                | All from United Kingdom.                |   |
| <b>Magnesium: Metal including alloys:</b>                      |                  |                   |                  |   |   |
| Unwrought  | —                | 120               | 115              | United Kingdom 5.                       |   |
| Semimanufactures   | 60               | 58                | —                | Italy 57; United Kingdom 1.             |   |
| <b>Manganese:</b>  |                  |                   |                  |   |   |
| Ore and concentrate: Metallurgical-grade                       | 5,708            | 7,597             | —                | All from Netherlands.                   |   |
| Oxides   | —                | 7                 | —                | United Kingdom 6; Belgium-Luxembourg 1. |   |
| Metal including alloys, all forms                              | —                | 11                | —                | France 8; West Germany 2.               |   |
| Mercury  | —                | 150               | 44               | Spain 78; United Kingdom 28.            |   |
| <b>Molybdenum:</b>   |                  |                   |                  |   |   |
| Ore and concentrate  | 105              | 18                | —                | All from Belgium-Luxembourg.            |   |
| Metal including alloys:  |                  |                   |                  |   |   |
| Semimanufactures   | 5                | —                 |                  |   |   |
| Unspecified  | 35               | 9                 | ( <sup>c</sup> ) | Austria 4; United Kingdom 3.            |   |
| <b>Nickel: Metal including alloys:</b>                         |                  |                   |                  |   |   |
| Unwrought  | —                | 21                | 21               |   |   |
| Semimanufactures   | 508              | 108               | 87               | Austria 21.                             |   |
| <b>Platinum-group metals:</b>                                  |                  |                   |                  |   |   |
| Waste and sweepings  | value, thousands | NA                | \$3              | —                                       | All from United Kingdom.                        |
| Metals including alloys, unwrought and partly wrought:         |                  |                   |                  |   |   |
| Palladium  | kilograms        | 63                | 161              | —                                       | United Kingdom 81; West Germany 80.             |
| Platinum   | value, thousands | \$2,019           | \$706            | —                                       | United Kingdom \$458; Belgium-Luxembourg \$169. |
| Rhodium  | do.              | \$410             | —                |   |   |
| Unspecified  | do.              | \$42              | \$94             | \$94                                    |   |
| <b>Rare-earth metals including alloys, all forms kilograms</b> |                  |                   |                  |   |   |
|  |                  | 379               | —                |   |   |
| Selenium, elemental  |                  | —                 | 8                | —                                       | All from United Kingdom.                        |
| <b>Silver:</b>   |                  |                   |                  |   |   |
| Ore and concentrate  |                  | NA                | 2                | —                                       | West Germany 1; Italy 1.                        |
| Waste and sweepings  | value, thousands | NA                | \$201            | \$201                                   |   |
| Metal including alloys, unwrought and partly wrought           | kilograms        | 16,537            | 9,811            | ( <sup>c</sup> )                        | West Germany 9,003; United Kingdom 695.         |
| <b>Tin:</b>  |                  |                   |                  |   |   |
| Oxides   |                  | —                 | 10               | —                                       | Japan 9; Italy 1.                               |
| Metal including alloys:  |                  |                   |                  |   |   |
| Unwrought  |                  | 1                 | 26               | —                                       | All from United Kingdom.                        |
| Semimanufactures   |                  | 15                | 41               | 2                                       | West Germany 22; United Kingdom 14.             |
| <b>Titanium:</b>   |                  |                   |                  |   |   |
| Oxides   |                  | 87                | 42               | 38                                      | United Kingdom 3.                               |

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   | 1988             | 1989 <sup>p</sup> | Sources, 1989    |  |
|---|------------------|-------------------|------------------|--|
|   |                  |                   | United States    | Other (principal)                                      |
| METALS—Continued  |                  |                   |                  |  |
| Tin:—Continued  |                  |                   |                  |  |
| Metal including alloys:   |                  |                   |                  |  |
| Scrap   | 27               | —                 |                  |  |
| Unwrought   | ( <sup>2</sup> ) | —                 |                  |  |
| Semimanufactures kilograms  | 16               | —                 |                  |  |
| Unspecified   | ( <sup>2</sup> ) | 12                | 3                | United Kingdom 6; West Germany 2.                      |
| Tungsten:   |                  |                   |                  |  |
| Ore and concentrate   | 18               | ( <sup>6</sup> )  | NA               |  |
| Ash and residue containing tungsten   | 20               | —                 |                  |  |
| Metal including alloys:   |                  |                   |                  |  |
| Semimanufactures  | 13               | —                 |                  |  |
| Unspecified   | 1                | 44                | 2                | France 27; West Germany 9.                             |
| Uranium and thorium: Metal including alloys,<br>all forms value, thousands                  |                  |                   |                  |  |
|   | —                | \$2               | \$2              |  |
| Zinc:   |                  |                   |                  |  |
| Oxides  | 61               | 5                 | 2                | United Kingdom 3.                                      |
| Blue powder   | 81               | —                 |                  |  |
| Matte   | 449              | —                 |                  |  |
| Ash and residue containing zinc   | —                | 1,056             | —                | West Germany 836; Belgium-Luxembourg 180.              |
| Metal including alloys:   |                  |                   |                  |  |
| Scrap   | NA               | 123               | —                | United Kingdom 57; Italy 41; Belgium-Luxembourg 25.    |
| Unwrought   | 143              | 242               | 42               | Belgium-Luxembourg 200.                                |
| Semimanufactures  | 23               | 9                 | 8                | Japan 1.   |
| Zirconium: Metal including alloys,<br>semimanufactures value, thousands                     |                  |                   |                  |  |
|   | —                | \$13              | —                | United Kingdom \$12; West Germany \$1.                 |
| Other:  |                  |                   |                  |  |
| Ores and concentrates   | 348              | —                 |                  |  |
| Oxides and hydroxides   | 70               | 14                | —                | United Kingdom 13; West Germany 1.                     |
| Ashes and residues  | 417              | 207               | ( <sup>7</sup> ) | All to United Kingdom.                                 |
| Base metals including alloys, all forms   | 12               | —                 |                  |  |
| INDUSTRIAL MINERALS   |                  |                   |                  |  |
| Abrasives, n.e.s.:  |                  |                   |                  |  |
| Natural: Corundum, emery, pumice, etc.  | 62               | 1,110             | 649              | Greece 315; Italy 76.                                  |
| Artificial:   |                  |                   |                  |  |
| Corundum  | 2,566            | 2,552             | 13               | West Germany 1,876; United Kingdom 427.                |
| Silicon carbide   | 49               | 869               | —                | Belgium-Luxembourg 320; United Kingdom 237; Spain 166. |
| Dust and powder of precious and semi-<br>precious stones including diamond value, thousands |                  |                   |                  |  |
|   | \$42             | \$523             | —                | United Kingdom \$522.                                  |
| Grinding and polishing wheels and stones  | 516              | 441               | (8/)             | West Germany 156; Italy 107; France 75.                |
| Asbestos, crude   | 19               | 96                | 96               |  |
| Barite and witherite  | 86               | 511               | 8                | United Kingdom 286; Spain 104; West Germany 73.        |
| Boron materials:  |                  |                   |                  |  |
| Crude natural borates   | 690              | 987               | 353              | Netherlands 634.                                       |
| Oxides and acids  | 36               | 88                | 65               | United Kingdom 18; West Germany 5.                     |

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  | 1988             | 1989 <sup>p</sup> | Sources, 1989     |  |   |
|--|------------------|-------------------|-------------------|--|---|
|  |                  |                   | United States     | Other (principal)  |   |
| <b>INDUSTRIAL MATERIALS—Continued</b>                |                  |                   |                   |  |   |
| Cement   | 4,048            | 24,089            | 955               | France 16,554; United Kingdom 3,860; Netherlands 1,156.      |   |
| Chalk  | 124              | 611,735           | 607,000           | France 3,913; United Kingdom 676.                            |   |
| Clays, crude:  |                  |                   |                   |  |   |
| Bentonite  | 375              | 2,834             | 1,799             | United Kingdom 852; Italy 161.                               |   |
| Fire clay  | 155              | 52                | —                 | All from West Germany.                                       |   |
| Kaolin   | 22,224           | 31,912            | 19,462            | France 10,207; United Kingdom 2,207.                         |   |
| Unspecified  | 6,542            | 6,933             | 6,483             | United Kingdom 318; West Germany 132.                        |   |
| Cryolite and chiolite                                | —                | 330               | 330               |  |   |
| Diamond:   |                  |                   |                   |  |   |
| Gem, not set or strung                               | value, thousands | \$55,015          | \$52,154          | \$52   | Belgium-Luxembourg \$52,017; West Germany \$44. |
| Industrial stones                                    | do.              | 9\$107            | \$1,272           | —  | Belgium-Luxembourg \$839; United Kingdom \$407. |
| Dust and powder                                      | do.              | —                 | \$625             | —  | United Kingdom \$441; West Germany \$181.       |
| Diatomite and other infusorial earth                 | 4,546            | 5,066             | 5,014             | Belgium-Luxembourg 34.                                       |   |
| Feldspar, fluorspar, related materials               | 8                | —                 |                   |  |   |
| Fertilizer materials:                                |                  |                   |                   |  |   |
| Crude, n.e.s.  | 9,770            | 2                 | —                 | All from Italy.  |   |
| Manufactured:  |                  |                   |                   |  |   |
| Ammonia  | 2                | —                 |                   |  |   |
| Nitrogenous  | 1,295            | 80,743            | —                 | Netherlands 52,897; Belgium-Luxembourg 16,316; Italy 10,604. |   |
| Potassic   | 34,813           | 50,410            | —                 | West Germany 46,226; France 4,165.                           |   |
| Unspecified and mixed                                | 289              | 842               | ( <sup>10</sup> ) | United Kingdom 383; Belgium-Luxembourg 382.                  |   |
| Graphite, natural                                    | NA               | 88                | 27                | United Kingdom 31; West Germany 15.                          |   |
| Gypsum and plaster                                   | 5,551            | 20,304            | 17                | Spain 14,193; West Germany 5,558.                            |   |
| Iodine   | —                | 3                 | —                 | All from West Germany.                                       |   |
| Lime   | 686              | 7,888             | —                 | France 7,547; Japan 300.                                     |   |
| Magnesium compounds:                                 |                  |                   |                   |  |   |
| Magnesite, crude                                     | 6                | 5                 | —                 | All from West Germany.                                       |   |
| Oxides and hydroxides                                | 2,890            | 21,523            | 1                 | Italy 19,389; Japan 1,189.                                   |   |
| Other  | NA               | 118               | —                 | All from West Germany.                                       |   |
| Meerschaum, amber, jet                               | ( <sup>2</sup> ) | —                 |                   |  |   |
| Mica:  |                  |                   |                   |  |   |
| Crude including splittings and waste                 | 20               | ( <sup>2</sup> )  | ( <sup>2</sup> )  |  |   |
| Worked including agglomerated splittings             | 51               | 31                | 1                 | Austria 19; United Kingdom 6.                                |   |
| Nitrates, crude                                      | 1,567            | —                 |                   |  |   |
| Phosphates, crude                                    | —                | 42                | —                 | West Germany 22; Italy 20.                                   |   |
| Pigments, mineral:                                   |                  |                   |                   |  |   |
| Natural, crude                                       | —                | 12                | —                 | Spain 7; United Kingdom 5.                                   |   |
| Iron oxides and hydroxides, processed                | 7,309            | 1,419             | 898               | Spain 322; Italy 163.  |   |
| Precious and semiprecious stones other than diamond: |                  |                   |                   |  |   |
| Natural  | value, thousands | \$252             | \$1,042           | \$61   | United Kingdom \$24; Belgium-Luxembourg \$16.   |
| Synthetic  | do.              | \$81              | \$80              | \$2  | West Germany \$44; Japan \$28.                  |

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                                  | 1988              | 1989 <sup>a</sup> | Sources, 1989    |  |
|--|-------------------|-------------------|------------------|--|
|  |                   |                   | United States    | Other (principal)                                      |
| <b>INDUSTRIAL MINERALS—Continued</b>       |                   |                   |                  |  |
| Pyrite, unroasted                          | 37                | —                 |                  |  |
| Quartz crystal, piezoelectric              | value, thousands  | \$54              | \$115            | \$55 Japan \$60.                                       |
| Salt and brine                             | 4                 | 52,261            | —                | France 26,057; Spain 24,450.                           |
| <b>Sodium compounds, n.e.s.:</b>           |                   |                   |                  |  |
| Soda ash, manufactured                     | 5,244             | 186,983           | 186,951          | West Germany 32.                                       |
| Sulfate, manufactured                      | 129               | 11,653            | ( <sup>2</sup> ) | United Kingdom 11,105; France 463.                     |
| <b>Stone, sand and gravel:</b>             |                   |                   |                  |  |
| <b>Dimension stone:</b>                    |                   |                   |                  |  |
| Crude and partly worked                    | 210               | 1,269             | ( <sup>2</sup> ) | Italy 533; Spain 477; France 120.                      |
| Worked                                     | 19                | ( <sup>11</sup> ) | NA               |  |
| Dolomite, chiefly refractory-grade         | 495               | 1,068             | —                | West Germany 818; United Kingdom 150.                  |
| Gravel and crushed rock                    | 6,203             | 1,183             | 926              | France 107; West Germany 100.                          |
| Quartz and quartzite                       | 2,819             | 23                | —                | West Germany 16; United Kingdom 7.                     |
| Sand other than metal-bearing              | 46                | 502               | 175              | West Germany 149; Belgium-Luxembourg 148.              |
| <b>Sulfur:</b>                             |                   |                   |                  |  |
| <b>Elemental:</b>                          |                   |                   |                  |  |
| Crude including native and byproduct       | 254               | 38,157            | 37,798           | West Germany 359.                                      |
| Colloidal, precipitated, sublimed          | —                 | 33                | 2                | United Kingdom 30.                                     |
| Dioxide                                    | —                 | 4                 | —                | All from West Germany.                                 |
| Sulfuric acid                              | 229               | 147               | 129              | West Germany 18.                                       |
| Talc, steatite, soapstone, pyrophyllite    | 811               | 3,252             | 355              | Belgium-Luxembourg 1,263; Italy 713; France 688.       |
| Vermiculite                                | NA                | 2,530             | —                | All from West Germany.                                 |
| <b>Other:</b>                              |                   |                   |                  |  |
| Crude                                      | 556               | 1,045             | 546              | West Germany 479; France 20.                           |
| Slag and dross, not metal-bearing          | 1,150             | 54                | —                | All from United Kingdom.                               |
| <b>MINERAL FUELS AND RELATED MATERIALS</b> |                   |                   |                  |  |
| Asphalt and bitumen, natural               | 257               | 262               | 262              |  |
| <b>Carbon:</b>                             |                   |                   |                  |  |
| Carbon black                               | 1,527             | 1,431             | 554              | West Germany 484; Netherlands 195; United Kingdom 178. |
| Gas carbon                                 | ( <sup>2</sup> )  | —                 |                  |  |
| Coal: Anthracite and bituminous            | 36                | 1,248             | —                | All from United Kingdom.                               |
| Coke and semicoke                          | 3                 | 4,181             | 30               | United Kingdom 4,149.                                  |
| Peat including briquets and litter         | 18                | 642               | —                | West Germany 604; Netherlands 38.                      |
| <b>Petroleum:</b>                          |                   |                   |                  |  |
| Crude                                      | 42-gallon barrels | —                 | 67               | 67   |
| <b>Refinery products:</b>                  |                   |                   |                  |  |
| Liquefied petroleum gas                    | value, thousands  | NA                | \$26             | \$26   |
| Gasoline                                   | 42-gallon barrels | 51,000            | 132,176          | — France 87,040; Belgium-Luxembourg 37,842.            |
| Mineral jelly and wax                      | do.               | 211,801           | 215,606          | 220 West Germany 162,838; Japan 30,134; Spain 13,143.  |
| Kerosene and jet fuel                      | do.               | 2,101             | 12,990           | 295 United Kingdom 11,571; Belgium-Luxembourg 1,116.   |
| Distillate fuel oil                        | do.               | 20,000            | 64,298           | — United Kingdom 58,673; West Germany 4,357.           |
| Lubricants                                 | do.               | 89,485            | 280,329          | 1,213 Austria 228,095; West Germany 22,113.            |

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  | 1988              | 1989 <sup>p</sup> | Sources, 1989 |                          |
|--|-------------------|-------------------|---------------|--------------------------|
|  |                   |                   | United States | Other (principal)        |
| <b>MINERAL FUELS AND RELATED MATERIALS—Continued</b> |                   |                   |               |                          |
| Nonlubricating oils                                  | 42-gallon barrels | 13                | —             |                          |
| Asphalt  | do.               | 309               | —             |                          |
| Bituminous mixtures                                  | do.               | 109               | 44,517        | 182 West Germany 44,335. |
| Petroleum coke                                       | do.               | 365,405           | 362,417       | 362,417                  |

<sup>p</sup>Preliminary. NA Not available.<sup>1</sup>Table prepared by Virginia A. Woodson. 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.<sup>2</sup>Less than 1/2 unit.<sup>3</sup>Unreported quantity valued at \$6,000.<sup>4</sup>Unreported quantity valued at \$14,000.<sup>5</sup>Unreported quantity valued at \$30,000.<sup>6</sup>Unreported quantity valued at \$4,000 exported by the United States.<sup>7</sup>Unreported quantity valued at \$37,000.<sup>8</sup>Unreported quantity valued at \$442,000.<sup>9</sup>Excludes 37,819 carats exported by the United Kingdom.<sup>10</sup>Unreported quantity valued at \$14,726,000.<sup>11</sup>Unreported quantity valued at \$11,000 exported by the United States.

TABLE 4

## REPUBLIC OF SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

(Thousand metric tons unless otherwise specified)

| Commodity  | Major operating companies                        | Location of main facilities                    | Annual capacity     |
|------------|--|--|---------------------|
| Aluminum   | Aluminium South Africa (Pty.) Ltd.               | Alusaf Aluminum Smelter, Richards Bay          | 170.                |
| Andalusite | Weedons Minerals (Pty.) Ltd.                     | Timeball Mine, near Thabazimbi                 | 120.                |
| Do.        | Annesley Andalusite (Pty.) Ltd.                  | Annesley Mine, Penge                           | 75.                 |
| Do.        | Cullinan Minerals Ltd.                           | Krugerspost Mine, near Lydenburg               | 50.                 |
| Do.        | Verref Mining (Pty.) Ltd.                        | Havercroft Mine, Penge                         | 36.                 |
| Do.        | Hoogenoeg Andalusite (Pty.) Ltd.                 | Hoogenoeg Mine, Pietersburg                    | 15.                 |
| Do.        | Purity Minerals (Pty.) Ltd.                      | Andafrax Mine, Groot Marico                    | 12.                 |
| Antimony   | Consolidated Murchison Ltd.                      | 50 kilometers west of Phalaborwa               | 9.5 Sb concentrate. |
| Asbestos   | Gencor Ltd.                                      | Penge Mine, west of Phalaborwa                 | 48 amosite.         |
| Do.        | do.  | Klipfontein, 50 kilometers south of Kuruman    | NA crocidolite.     |
| Do.        | Anglo Dutch Exploration & Mining Co. (Pty.) Ltd. | Stella Mine, 25 kilometers east of Barberton   | NA chrysotile.      |
| Chromite   | Vansa Vanadium SA Ltd.                           | Winterveld Mine, Steelpoort, E. Transvaal      | 1,000 ore.          |
| Do.        | Rand Mines Ltd.                                  | Henry Gould, 30 kilometers east of Rustenburg  | 640 ore.            |
| Do.        | do.  | Millsell Mine, 8 kilometers east of Rustenburg | 90 ore.             |
| Do.        | Lavino South Africa (Pty.) Ltd.                  | Grootboom Mine, near Lydenburg                 | 500 ore.            |

See footnotes at end of table.

TABLE 4—Continued

## REPUBLIC OF SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

(Thousand metric tons unless otherwise specified)

| Commodity              | Major operating companies                                     | Location of main facilities                             | Annual capacity                        |
|------------------------|---|---|--|
| Chromite               | Dilokong Chrome Mine (Pty.) Ltd.                              | Dilokong Mine, near Lydenburg, Lebowa                   | 480 ore.                               |
| Do.                    | Samancor  | Mooinooi Mine, 30 kilometers west of Brits              | 456 ore.                               |
| Do.                    | do.   | Grasvally Mine, near Potgietersrus                      | NA.                                    |
| Do.                    | Consolidated Metallurgical Industries (CMI)                   | Purity Mine, near Rustenburg                            | 360 ore; 252 concentrate.              |
| Do.                    | Chromecorp Technology (Pty.) Ltd.                             | Chroombronne Mine near Rustenburg                       | 576 ore; 432 concentrate.              |
| Coal                   | Anglo American Coal Corp. Ltd.                                | 13 collieries in eastern Transvaal and Natal            | 46,000 anthracite and bituminous.      |
| Do.                    | Trans-Natal Collieries Ltd.                                   | 12 collieries in eastern Transvaal and Natal            | 40,000 anthracite and bituminous.      |
| Do.                    | Rand Mines Ltd.   | Duvha Colliery, 18 kilometers southeast of Witbank      | 11,000 bituminous.                     |
| Do.                    | Rietspruit Opencast Services (Pty.) Ltd.                      | 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.                    | do.   | Secunda Collieries, 75 kilometers south of Witbank      | 31,000 bituminous.                     |
| Do.                    | Iscor Ltd.  | Grootegeeluk Mine                                       | 6,300 bituminous; 1,700 coking coal.   |
| Do.                    | do.   | Durnacol, Hlobane, and Tshikondeni Mines in Venda       | 1,800 coking coal.                     |
| Copper                 | Palabora Mining Co. Ltd.                                      | Palabora Mine and plant at Phalaborwa                   | 130 metal.                             |
| Do.                    | O'Okiep Copper Co. Ltd.                                       | O'Okiep Copper Mine Namaqualand, Cape Province          | 40.                                    |
| Do.                    | Black Mountain Mineral Development Namaqualand, Cape Province | Black Mountain Mine                                     | 2.5 Cu in concentrate.                 |
| Diamond million carats | De Beers Consolidated Mines Ltd.                              | 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 Western Cape province                 | 1.0.                                   |
| Do.                    | do.   | Premier Mine, 70 kilometers east of Pretoria            | 2.3.                                   |
| Do.                    | do.   | Venetia Mine, northern Transvaal                        | .1.                                    |
| Fluorspar              | Transvaal Mining and Finance Co. Ltd.                         | Buffalo Mine, 110 kilometers northeast of Pretoria      | 200 acid-grade fluorspar. <sup>e</sup> |

See footnotes at end of table.

TABLE 4—Continued

## REPUBLIC OF SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

(Thousand metric tons unless otherwise specified)

| Commodity       | Major operating companies                           | Location of main facilities   | Annual capacity                          |
|-----------------|---|---|--|
| Fluorspar       | Vergenoeg Mining Corp. (Pty.) Ltd.                  | Vergenoeg Mine, 90 kilometers east of Pretoria<br>fluorspar. <sup>e</sup>   | 200 acid- and metallurgical-grade        |
| Do.             | Phelps Dodge Mining (Pty.) Ltd.                     | Witkop Mine, 130 kilometers west of Johannesburg  | 75 acid-grade fluorspar. <sup>e</sup>    |
| Do.             | Van Den Heever Vloeispaat Werke                     | Van Den Heever Mine, 120 kilometers west of Johannesburg  | 50. <sup>e</sup>                         |
| Gold tons       | Anglo American Corp.                                | Freegold near Welkom, Vaal Reefs near Klerksdorp, Western Deep Levels 70 kilometers southwest of Johannesburg                             | 260 Au.                                  |
| Do.             | Goldfields of S.A. Ltd.                             | East Driefontein and West Driefontein 65 kilometers southwest of Johannesburg, Kloof 55 kilometers southwest of Johannesburg, and others  | 125 Au.                                  |
| Do.             | Gencor Ltd.   | Buffelsfontein near Klerksdorp, Beatrix 35 kilometers southeast of Wekom, Winkelhaak 120 kilometers southeast of Johannesburg, and others | 90 Au.                                   |
| Do.             | Rand Mines Ltd.                                     | Harmony Mine 20 kilometers southeast of Welkom, and others  | 55 Au.                                   |
| Do.             | Anglovaal Ltd.                                      | Hartebeestfontein Mine near Klerksdorp, and others  | 45 Au.                                   |
| Do.             | Johannesburg Consolidated Investment Co. Ltd.       | Randfontein Mine 20 kilometers west of Johannesburg, Western Areas Mine 30 kilometers southwest of Johannesburg and others                | 41 Au.                                   |
| Iron and steel: |   |   |  |
| Iron ore        | Iskor Ltd.  | Sishen Mine, 50 kilometers south of Hotazel   | 21,500 ore.                              |
| Do.             | do.   | Thabazimbi Mine, at Thabazimbi  | 2,500 ore.                               |
| Do.             | Highveld Steel and Vanadium Corp. (AAC)             | Mapochs Mine near Roossenekal   | NA titaniferous magnetite ore.           |
| Ferroalloys     | Samancor Ferrometals Ltd.                           | Witbank   | 320 ferrochromium.                       |
| Do.             | Samancor Tubatse Ferrochrome (Pty.) Ltd.            | Steeipoort  | 300 ferrochromium.                       |
| Do.             | Samancor Bathako Ltd.                               | Bophuthatswana Ruighoek Mine site   | 20 ferrochromium.                        |
| Do.             | Samancor ex-Middelburg Steel and Alloys (Pty.) Ltd. | Middelburg<br>Krugersdorp   | 300 ferrochromium.<br>120 ferrochromium. |
| Do.             | Consolidated Metallurgical Industries (Pty.) Ltd.   | Lydenburg<br>Purity in Rustenburg   | 210 ferrochromium.<br>120 ferrochromium. |
| Do.             | Chromecorp Technology (Pty.) Ltd.                   | Rustenburg  | 180 ferrochromium.                       |

See footnotes at end of table.

TABLE 4—Continued

## REPUBLIC OF SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

(Thousand metric tons unless otherwise specified)

| Commodity                        | Major operating companies                                 | Location of main facilities   | Annual capacity   |
|----------------------------------|---|---|---|
| Ferroalloys                      | Feralloys Ltd.<br>Associated Manganese Mines              | Machadadorp   | 110<br>ferrochromium.   |
| Do.                              | Samancor  | Meyerton plant<br>15 kilometers north of<br>Vereeniging   | 240 high-carbon<br>ferromanganese;<br>200<br>silicomanganese. |
| Do.                              | Transalloys, a division of<br>Highveld Steel and Vanadium | Witbank   | 20 low-carbon<br>ferromanganese;<br>175<br>silicomanganese.   |
| Do.                              | Feralloys Ltd.<br>Associated Manganese Mines              | Cato Ridge<br>in Natal  | 130 high-carbon<br>ferromanganese.                            |
| Do.                              | Iscor Ltd.  | Vanderbijlpark plant  | 4,300.  |
| Do.                              | do.   | Newcastle plant   | 2,000.  |
| Do.                              | do.   | Pretoria plant  | 800.  |
| Do.                              | do.   | Cisco plant   | 150.  |
| Do.                              | do.   | Corex plant in<br>Pretoria  | 300.  |
| Do.                              | Middelburg Steel and Alloys<br>(Pty.) Ltd.                | Middelburg stainless<br>steel plant   | 200<br>stainless steel. <sup>e</sup>                          |
| Manganese                        | Associated Manganese Mines of<br>South Africa Ltd.        | Blackrock, Gloria,<br>N'Chwaning Mines<br>near Hotazel  | 1,500 ore.  |
| Do.                              | Samancor Ltd. (Gencor Ltd.)                               | Mamatwan, and Wessels<br>Mines near Hotazel   | 3,000 ore.  |
| Platinum-group<br>metals<br>tons | Rustenburg Platinum Mines Ltd.                            | Rustenburg Mine near<br>Rustenburg, Union and<br>Amandelbult Mines near<br>Northam  | 70 PGM. <sup>e</sup>  |
| Do.                              | Lebowa Platinum Mines Ltd.                                | Atok Mine 70 kilometers north-<br>west of Lydenburg   | NA.   |
| Do.                              | Impala Platinum Ltd.                                      | Bafokeng North and Bafokeng<br>South Mines, Wildebeest-<br>fontein North and<br>Wildebeestfontein South<br>Mines 20 kilometers north of<br>Rustenburg | 40 PGM. <sup>e</sup>  |
| Do.                              | Western Platinum Ltd.                                     | 20 kilometers east of Rustenburg  | 10 PGM. <sup>e</sup>  |
| Do.                              | Eastern Platinum Ltd.                                     | 40 kilometers northeast of<br>Rustenburg  | 3 PGM. <sup>e</sup>   |
| Do.                              | Gazelle Platinum Ltd.                                     | Karee Mine 25 kilometers northwest<br>of Rustenburg   | 5 PGM. <sup>e</sup>   |
| Do.                              | Barplats Investments Ltd.                                 | Crocodile River Mine near<br>Brits  | 10 PGM.   |
| Pyrophyllite                     | Wonderstone 1937 Ltd.                                     | Gestoptefontein Wonderstone<br>Quarry near Ottsdal  | 4. <sup>e</sup>   |
| Titanium<br>concentrate          | Tisand (Pty.) Ltd.  | Opencast operations<br>near Richards Bay  | 125 rutile<br>concentrate;<br>1,280 ilmenite.                 |
| Titanium slag                    | Richards Bay Iron and Titanium<br>Corp.                   | Smelter at Richards Bay   | 1,000 slag.   |

See footnotes at end of table.

TABLE 4—Continued

## REPUBLIC OF SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

(Thousand metric tons unless otherwise specified)

| Commodity      | Major operating companies             | Location of main facilities                          | Annual capacity                             |
|----------------|---------------------------------------|--|---|
| Uranium tons   | Vaal Reefs Exploration and Mining Co. | Mine and plant near Klerksdorp                       | 2,000 uranium oxide. <sup>e</sup>           |
| Do. Mines Ltd. | Freestate Consolidated Gold           | Mine and plant near Welkom                           | 500 uranium oxide. <sup>e</sup>             |
| Do.            | Buffelsfontein Gold Mining Co. Ltd.   | Mine and plant 15 kilometers southwest of Klerksdorp | 400 uranium oxide. <sup>e</sup>             |
| Do.            | Hartebeestfontein Gold Mining Co.     | Mine and plant 5 kilometers southeast of Klerksdorp  | 400 uranium oxide. <sup>e</sup>             |
| Do.            | Palabora Mining Co. Ltd.              | Palabora Mine and plant at Palaborwa                 | 200 uranium oxide. <sup>e</sup>             |
| Vanadium tons  | Highveld Steel and Vanadium Corp.     | Mapochs Mine near Lydenburg                          | 23,700 vanadium pentoxide. <sup>e</sup>     |
| Do.            | Vametco Minerals Corp.                | Krokodilkraal Mine and plant near Brits              | 10,000 vanadium pentoxide. <sup>e</sup>     |
| Do.            | Transvaal Alloys Pty. Ltd.            | Wapadskloof Mine and plant near Witbank              | 2,250 vanadium pentoxide. <sup>e</sup>      |
| Do.            | Vansa Vanadium SA Ltd.                | Kennedy's Vale Mine and plant near Lydenburg         | 3,000 vanadium pentoxide; ceased operation. |
| Do.            | Rhombus Vanadium Holdings Ltd.        | Ba-Mogopa Mine and Usko plant near Brits             | 9,000 vanadium pentoxide.                   |
| Vermiculite    | Palabora Mining Co. Ltd.              | Palabora Mine and plant at Phalaborwa                | 230. <sup>e</sup>                           |
| Zinc           | Zinc Corp. of South Africa Ltd.       | Struisbult Springs Works Transvaal                   | 90 Zn.                                      |
| Do.            | Black Mountain Minerals Development   | Black Mountain Mine Namaqualand, Cape Province       | 26 Zn in concentrate.                       |
| Zircon         | Tisand (Pty.) Ltd.                    | Opencast operations near Richards Bay                | 300 zircon concentrate.                     |
| Do.            | Palabora Mining Co. Ltd.              | Palabora Mine and plant at Palaborwa                 | 13.2 baddeleyite. <sup>e</sup>              |
| Do.            | Phosphate Development Corp. Ltd.      | Palabora Mine and plant at Palaborwa                 | 12.5 baddeleyite. <sup>e</sup>              |

other mining except diamond and coal, 17%; financial services and property, 13%; diamond, 13%; and coal, 4%. Gencor Ltd. had 24% of its net asset value in investments and financial services; gold, 20%; energy, 15%; PGM, 11%; ferroalloys, 10%; forest products, 10%; manufacturing and marketing, 4%; other mining products except coal, 3%; coal, 2%; and others, 1%. GFSA's group asset value by sector was as follows: gold and PGM, 74%; financial and mining finance, 15%; other minerals, 7%; and cash (including dividends receivable and payable), 4%. JCI's net asset value by sector was as follows: industrial and property, 36%; PGM, 30%;

diamond, 13%; ferrochrome, base metals, and coal, 12%; mineral exploration and investment, 6%; and gold, 3%. Anglovaal Ltd. had 24% of its investments in minerals and metals excluding gold, 23% in gold, 16% in packaging and rubber, 12% in dry food and beverage, 9% in frozen food, 7% in diversified business, 6% in construction and electronics, and 3% in finance. Barlow Rand Ltd.'s net assets by sector were as follows: gold, 26%; coal, 26%; PGM, 20%; base metals, 14%; and property and other assets, 14%.

Inflation, rising costs, and lower dollar prices for most mineral commodities reduced 1990 profit margins at most mining

companies. The profits of mining firms in 1990 decreased overall by 25% compared with those of 1989, falling to the lowest levels in 6 years (8 years for gold mining firms). Gold mining profits fell as a result of increasing production costs (inflation rate of 14% in 1990) in the face of a slight decrease in the rand gold price (dollar gold price rose by 1% from its 1989 level). The real rand gold prices (using South Africa's consumer price index as deflator) fell by 13%.

The level of capital spending in mining increased by \$500 million since 1988, but annual capital expenditures in gold mining

actually fell by \$89.2 million over the same period. Moreover, mining's contribution to gross domestic fixed investment declined by 7% in real terms since 1988 and represented only 13.8% of South Africa's total fixed investment.

The average number of persons employed in the mining sector in 1990 was 697,000 compared with more than 741,000 in 1989. About 609,000 of the mine workers in 1990 were listed as unskilled and semi-skilled. A total of 470,000 workers were employed by member mines of the Chamber of Mines, including 378,000 at the gold mines and 37,000 on collieries. The underground gold mine members of the Chamber of Mines reported 505 deaths in 1990 compared with 492 in 1989. Total injuries reported were 7,576 compared with 8,396 in the same time periods. The death and injury rates per 1,000 employees for all members of the Chamber of Mines were 1.07 and 16.09, respectively, in 1990, and 1.01 and 16.91, respectively, in 1989.

## COMMODITY REVIEW

### Metals

**Aluminum.**—South Africa produced a little more than 1% of Western World output of aluminum in 1990. Primary production at Alusaf, the country's sole aluminum producer, increased by 2.5% to 170,000 tons, while secondary production from recycled metal reached 45,000 tons. In 1990, domestic consumption and exports were about 120,000 tons and 95,000 tons, respectively. Although the country produced about 70 basic primary and secondary alloys, it still imported about 4,000 tons of finished aluminum products—largely special alloys or forms.

**Antimony.**—Consolidated Murchison Ltd., the sole producer of antimony sulfide concentrate in South Africa, continued to reduce output. Owing mainly to a month-long strike by NUM, ore milled decreased by about 14.5% from the 1989 level of 457,063 tons to 390,765 tons. A total of 8,113 tons of concentrate was produced grading 59.35% antimony. Both plant recovery and average grade of ore milled improved from 83% to 84.6%, and from 1.37% antimony to 1.46%, respectively. Underground exploration development and diamond drilling totaling 2,694 m and 20,034 m, respectively, have been carried out by the company at the Athens, Monarch, and old Monarch shafts. This resulted in

the delineation of extensions to known ore reserves. Total employment at Murchison was about 650 surface workers and 700 underground workers, 350 less than that of the previous year. The industry was hurt by oversupply and price discounting of antimony in all forms by Chinese producers and a general decline in world demand.

**Arsenic.**—Arsenic trioxide is produced by two companies in South Africa, Gencor and Anglovaal. Gencor produces 99.5%-pure arsenic trioxide as a byproduct of its gold processing operations at Fairview Mine near Barberton in the eastern Transvaal. Anglovaal processes concentrates from its three eastern Transvaal gold mines, also in the Barberton district. The company is currently selling its output of arsenic trioxide, which is 96% to 97% pure, on the local market and to buyers in France. The Rand Mines group previously produced byproduct arsenic trioxide at its Barbrook gold mine, which is also in the eastern Transvaal. In 1989, prior to commissioning, it was estimated that Barbrook would be producing about 2,400 mt/a of arsenic trioxide. However, because of the low gold price, the mine is currently on care and maintenance. The mine has a stockpile of about 500 tons of arsenic trioxide, but it is of mixed grade and is regarded as unsalable.

**Chromite.**—The demand for chrome ore and alloys declined in 1990 due to contraction in the stainless steel market, as well as stockpile drawdown by consumers.

The largest chromite producer was Samancor, a Gencor Ltd. company, which owned nine mines in both the western and eastern belts of the Bushveld District, in addition to the Grasvalley Mine near Potgietersrus. Rand Mines operated Henry Gould Mine and Millsell Mine in the western belt, near Rustenburg. Vansa Vanadium operated the large Winterveld Mine, previously owned by the Rand Mines. Chromecorp Technology Ltd. (CCT) operated the Kroondal Mine, which was purchased from Chrombronne in mid-1987. Consolidated Metallurgical Industries (CMI) acquired the Purity Chrome Mine, near Rustenburg, in September 1990. The Purity Mine produced about 30,000 mt/month of chromite ore, and the company beneficiated the ore to about 21,000 mt/month of marketable products for sale or smelting. All the other chromite mines were operated by smaller companies.

About two-thirds of the Republic of South Africa's chromite output during 1990 was consumed in the production of chromium ferroalloys.

**Copper.**—The Palabora Mining Co. reported that the total ore and waste material loaded and hauled during 1990 amounted to 49.1 Mmt compared with 62.1 Mmt in 1989. The average mining rate of 165,301 mt/d was in line with the revised target established mid-year as a result of an improved waste-to-ore ratio. The average milling rate of 80,256 mt/d of ore achieved in 1990 was similar to that of 1989. The average ore grade of 0.506% Cu was above the planned grade of 0.504% and the grade of 0.492% achieved in 1989. The average concentrate grade at 38.7% Cu compares favorably with the 37.4% achieved during 1989. The average concentrate smelting rate of 909 mt/d represented a fall of almost 8% compared with the 1989 rate. This was due to a number of operational difficulties. Total anode production in 1990, including copper derived from purchased concentrates, amounted to 119,507 tons of fine copper, 5% less than the 1989 tonnage. Total production of refined copper cathode at Palabora was 116,005 tons, an 8% decline from 1989 levels, and was mainly due to reduced smelter output. The casting plant produced 63,508 tons of continuous cast copper rod, the volume required to meet the South African market demand. This compares with 69,646 tons produced during 1989.

**Gold.**—In spite of the widespread predictions earlier in the year of a sharp fall in South African production, 1990 output was less than 0.5% lower than that in 1989 at a total of 605.4 tons. South Africa produced more than twice as much gold as the next largest producer, the United States. It accounted for 35% of Western World and almost 30% of world gold output. For the year as a whole, the ore tonnage mined by the industry fell 2% and the average recovered gold grade rose more than 1% to 5.05 g/mt.

The gold mining industry lost more than 30,000 jobs in 1990, after having laid off almost 50,000 workers in 1989, as many mines implemented further rationalization programs such as curtailment of the North Shaft operations at JCI's Western Areas Mine and the 20% reduction in gold output from Rand Mines largest mine, Harmony. The 1990 wage negotiations were settled quickly with the NUM members receiving raises of between 14.5% and 17%. The depressed state of the industry led to more emphasis being placed on the preservation of jobs rather than high wage increases.

AAC halted all drilling activities in the area between the West Wits and Klerksdorp Goldfields known as the Potchefstroom gap.



The halt was due to ore grades disclosed by extensive drilling being considered too low, at projected gold prices, and the ore being too deep. Anglovaal continued its exploration in the so-called Bothaville gap between the Klerksdorp and Orange Free State Goldfields. JCI continued to evaluate the South Deep Project in a zone of particularly deep ore adjacent to, and down dip of, its Western Areas Mine. To raise funds for continued exploration of South Deep and to reimburse participants in the venture for expenditures previously incurred, South Deep Exploration Ltd. was formed. It was listed on the Johannesburg Stock Exchange in November 1990.

In mid-1990, Gencor announced opening a major new gold mine in the Orange Free State. The new mine, Weltevreden, lies immediately to the south of Vaal Reefs Mine and will exploit shallow ore from Ventersdorp Contact Reef. Weltevreden is expected to be brought into production by mid-1992. The cost of the mine will be comparatively low because its ore is shallow, lying at depths ranging from 100 m to 1,100 m below the surface.

**Iron and Steel.**—Total steel output by Iscor, which was privatized in October 1989, was 7.209 Mmt, of which the Vanderbijlpark plant produced 4.271 Mmt; Newcastle, 1.982 Mmt; Pretoria, 0.807 Mmt; and Cisco, 0.149 Mmt. Total sales by Iscor were 5.605 Mmt, up 3.6%, of which 53% was local sales and 47% exports. Local Iscor steel shipments dropped to the lowest level in 12 years by an alarming 13.6% off an already low base, to 2.97 Mmt, reflecting severe recessionary conditions, uncertainty caused by political change in South Africa, and on going civil unrest. Iscor's iron ore was provided by the Sishen and Thabazimbi Mines at the rate of 9.0 Mmt in 1990.

Iscor reported that the new Corex liquid-iron-producing facility at Pretoria, which was commissioned in November 1989, operated cost-effectively at its design capacity of 300,000 mt/a during 1990.

Iscor, in 1990, completed the 120,000-mt/a electrolytic chrome-plating line at Vanderbijlpark. The line produces chrome plate to supplement tinsplate primarily for the can manufacturing industry. It is expected to replace imports of about 36,000 mt/a of tinsplate. The company completed relining, refurbishing, and modernization of blast furnace D at the Vanderbijlpark works, which has improved production levels by 25%.

Middelburg Steel and Alloys, a Barlow Rand subsidiary, continued to be the country's only producer of stainless steel.

**Ferroalloys.**—Samancor opened the No. 5 furnace at the company's Tubatse ferrochrome works near Steelpoort in March 1990. The \$34 million expansion project was completed in 15 months. The new furnace increased the plant's capacity from 180,000 to 300,000 mt/a and made it the world's second largest ferrochrome producer—20,000 tons behind the leader, Samancor's Ferrometal works at Witbank.

Samancor and Highveld Steel and Vanadium Corp. planned to build a \$1.2 billion stainless steel complex in Witbank. The project sought to benefit from an accelerated depreciation scheme whereby the amortization may be taken immediately after the expenditures are incurred. This will result in about \$300 million cost savings to partners.

CMI commissioned a new ferrochrome furnace at its Lydenburg works in January 1990. Although the new furnace brought the plant's total ferrochromium capacity to 210,000 mt/a, downtime for existing furnaces was expected to limit the output to 170,000 mt/a.

Purity Ferrochrome, a new chromite and ferrochrome producer, started charge-grade ferrochrome production in June 1990 from two 33-MW furnaces, each capable of producing 60,000 mt/a of ferrochrome. The smelter is at Rustenburg near the company's chromium ore mine. The company invested about \$39 million to develop its mining and smelting operation. In September, Purity Ferrochrome, with a total annual ferrochrome capacity of 120,000 tons, was acquired by CMI for \$69.5 million. The Purity Ferrochrome plant will be used to process chrome from UG2 reef ore produced by Rustenburg Platinum Mines Ltd.

Middelburg was expected to have more than 400,000 mt/a of ferrochromium capacity by yearend 1990. Krupp SA (Pty.) Ltd. provided the engineering requirements to construct facilities to produce an additional 120,000 mt/a of ferrochrome for Middelburg. The facility would include a new rotary furnace for prereduction of chromite, an automatic furnace charging system, and installation of a new submerged arc furnace.

Chromecorp Technology Ltd. (CCT) completed its third 60,000-mt/a furnace in the first quarter of 1990 but did not fire it owing to the depressed state of the ferrochrome market.

Total ferrochrome capacity in South Africa stood at about 1.7 Mmt/a by yearend.

Increased competition from Chinese and U.S.S.R. silica manganese alternative raw materials in carbon steel manufacture reduced sales and prices of South African manganese alloys in the latter part of 1990. The total capacity of the three plants in South Africa producing ferromanganese is 0.7 Mmt/a, and the two electrolytic metal plants are capable of an output of 40,000 mt/a, should market conditions so permit.

**Iron Ore.**—In 1990, South Africa ranked eighth among iron ore producers. About 17 Mmt or 57% of production was exported, compared with 14.5 Mmt in 1989. The sharp increase in export may be attributed to iron ore supply disruptions in Liberia, as well as reduced demand for steel in South Africa, thus releasing some ore for export market.

Iscor's two iron mines, Sishen and Thabazimbi, supplied 100% of Iscor's needs, amounting to 9 Mmt/a. Exports of Sishen ore reached 14.3 Mmt, up from 13.5 Mmt in 1989, reflecting a continuing demand for high-quality iron ore. During the year, additional markets for iron ore in Eastern Europe and the Far East were developed. In what appeared to be essentially a barter deal, Iscor agreed to deliver 200,000 mt/a of iron ore to the Polish steelmaker Weglorkoks and import from Poland 120,000 mt/a of metallurgical coal. Iscor is gearing up for export of 15 Mmt in 1991.

Titaniferous magnetite ore was supplied to Highveld's iron and Vantra plants from its Mapochs opencast mine near Roossenekal, 140 km northeast of Witbank. Titaniferous magnetite was also recovered at the Palabora and Foskor Mines, where copper and phosphate rock, respectively, were produced as principal products.

Hematite ore was mined for use in the local cement industry by Garieb Minerale at its Aties Mine, 150 km northeast of Saldanha Bay in the Cape Province, and by Oranje Mynbou en Vervoer at Rietkuil Mine, 100 km southwest of Klerksdorp. G & W Minerals produced hematite from its Waterval Mine near Rustenburg for use as a pigment in red roofing and floor tiles.

Tisand (Pty) Ltd., a unit of Richards Bay Minerals (RBM), mined ilmenite-bearing beach sands north of Richards Bay. The resulting concentrates were used by the 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 South Africa's production of manganese ore is of

metallurgical-grade and is mined in the Northern Cape Province mainly by two companies, Samancor and Associated Manganese Mines Ltd., although a third company, National Manganese, is a small producer.

Approximately 85% of the South Africa's manganese ore output was from the Kalahari Field, where Samancor operated two mines and Associated Manganese three. Supplies of ore with a high manganese content were derived from two large mines, Nchwaning and Wessels.

Samancor's Hotazel Mine ceased production in June 1990 when ore reserves were depleted. However, its output was made up by increased production at the Wessels Mine, where development work on additional mining areas was due to be completed in 1991. Samancor's new 500,000-mt/a sinter plant at the Mamatwan Mine greatly contributed to the company's profit. The sintered ore was delivered to Samancor's ferromanganese plant in Meyerton. Manganese metal production, mainly by Samancor, represented 51.3% of world output.

**Nickel.**—Nickel is produced mainly as a byproduct of the PGM in South Africa. Production of nickel has remained fairly constant over the past 5 years.

AAC is studying the potential of a nickel-copper prospect on the Uitkomst farm near Barberton in the eastern Transvaal. If developed, the property could yield 17,000 mt/a of nickel. Anglovaal and Eastern Transvaal Consolidated Mines are reported to be investigating a nickel prospect on the adjacent Slaaihoek farm.

**Platinum-Group Metals (PGM).**—The first phase of the expansion program announced by Rustenburg Platinum Mines Ltd. (RPM) in April 1990 was due on-stream in October and involved the mining of an additional 30,000 mt/month of ore from the UG2 reef. A program to increase output from the Amandelbult section by 140,000 mt/month by mid-1992 was underway.

At the end of September 1990, RPM and Lebowa Platinum Mines Ltd. (LPM) jointly announced their decision to proceed with the development of a mine on the Platreef near Potgietersrus at an estimated capital cost of \$300 million to be shared between the partners. The mine is scheduled to reach full production of 200,000 mt/month by 1994.

LPM undertook the expansion of the commissioned during the year. During the

course of underground development at Northam, GFSA confirmed the extraordinary PGM grade of 10.1 g/mt, which will compensate for the working depth of up to 2 km below surface.

**Vanadium.**—Highveld Steel and Vanadium Corp. (Highveld), a unit of AAC and the world's largest individual vanadium producer, cut prices during 1990 because of a drop in Western vanadium consumption of about 10%. By the end of October 1990, about 9,000 tons of Highveld's vanadium capacity had been idled. By early 1991, Highveld was investigating the feasibility of beneficiating the vanadium pentoxide produced by its Vantra plant. The new beneficiation facility is likely to be built in association with some of Highveld's principal customers. The Mapochs Mine at Roosenekal in the eastern Transvaal was the main source of titaniferous magnetite ore used in the production of vanadium pentoxide and slag at Highveld's Witbank plant.

South African vanadium producers had a rough year after entry of Rhovan/Usko, a partnership of Rhombus Vanadium and Usko (formerly the Union Steel Corp.), into the arena as a major producer. The ore is upgraded at the Rhombus' Rhovan Mine, northwest of Brits in Boputhatswana, after which it is trucked to Vereeniging, where Usko extracts vanadium, utilizing the roast-leach process. Usko's planned capacity is 9,000 mt/a of vanadium pentoxide, which will make it the second largest producer in South Africa and the world. Until now, Highveld had supplied about one-half of the world's vanadium. The addition of a major new producer, in the face of a sluggish world demand, affected sales and profits of South African producers in 1990 and led to plant cutbacks and closures. Spot prices for vanadium pentoxide dropped below \$5.5 per kg (\$2.50 per pound) compared with nearly \$26.5 (\$12 per pound) a year earlier.

Vansa Vanadium SA Ltd., a subsidiary of Rand Mines Ltd. which had a 1989 output of about 2,300 tons of vanadium pentoxide, ceased production in November 1990 owing to low vanadium prices. Company profits had fallen 95% to about \$500,000 in the year ending September 1990. One of five companies in the Republic of South Africa that produced vanadium, Vansa accounted for about 7% of South Africa's total output. The company had been in operation only 2 years since commencing production in September 1988.

Several other vanadium producers mined magnetite around the rim of the Bushveld Complex. These companies all employed the roast-leach process to recover vanadium.

**Zircon.**—South Africa's major zircon producer is Richards Bay Minerals (RBM). The company exploits mineral sands on the Natal coast about 150 km north of Durban. Further deposits on both the east and west coasts are currently being assessed by several potential new producers. RBM reported that it had successfully commissioned its new dry mill. Only 1 month after commissioning, the company achieved output of its design capacity for rutile and zircon, bringing RBM's production capacity to 300,000 mt/a zircon and 125,000 mt/a of rutile.

The world's only significant source of primary zirconia is the Phalaborwa Complex in the northeastern Transvaal, where baddeleyite ( $ZrO_2$ ) is extracted as a byproduct of phosphate and copper production. 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 was recently commissioned by Foskor Ltd. to supplement the supply of baddeleyite with zirconia products manufactured from zircon sand.

## Industrial Minerals

**Diamond.**—Although South Africa is acknowledged as a leading producer of gem-quality diamond, it ranked but fifth after Australia, Zaire, Botswana, and the U.S.S.R. in the 1990 overall production of diamonds of various grades.

Diamond production declined in 1990. This was due almost entirely to the conversion of De Beers' Finsch Mine to an underground operation. Diamond mining in the Republic of South Africa is primarily by De Beers.

In 1990, De Beers Centenary AG, a Swiss-based company holding the non-South African interests of the De Beers Group, was established. Its inaugural year was highlighted by a \$5 billion sales agreement with the U.S.S.R., as well as a marketing agreement with Endiama (Angolan State Diamond Mining Co.). Formation of De Beers' Swiss subsidiary to separate the control of South African and non-South African interests received international attention in 1990 because the move was widely interpreted as a precaution against possible nationalization by a future South African Government.

In 1990, De Beers' South Africa's mines—Finch, Premier, Venetia, the Namaqualand and Kimberley Mines, and Koffiefontein—treated 24.5 Mmt of ore to recover 8.2 M carats of diamond. Kimberley Mines produced 574,188 carats from 3,931,000 tons against 762,843 carats from 4,388,000 tons in 1989. De Beers Mine, the smallest of the four mines De Beers operates in Kimberley, ended underground production in October 1990 as it exhausted its reserves. In 1989, the De Beers Mine had contributed 60,902 carats to the Kimberley Mine's total of 762,843 carats. Production from the dump-retreatment section accounted for about 45% of the total Kimberley Mines' production and is expected to increase in 1991.

Venetia, the new \$420 million diamond mine at Alldays, 150 km north of Potgietersrus in the northern Transvaal, has been described as De Beers' biggest ever single mine investment. The mine commenced production in September 1990. In late 1990 and early 1991, the diamond recovery grade amounted to 55.5 carats per 100 tons, considerably lower than initial expectations. At full production in 1993, the mine is expected to employ 750 people; the mine's operating life is expected to be at least 20 years.

The total tonnage treated at Koffiefontein Mine amounted to 1,785,000 tons, yielding 146,345 carats. The plant feed treated included surface dump material.

After almost 26 years of successful operations, conventional opencast mining of the Finsch pit ceased in September 1990 at a depth of 430 m. Limited production commenced from underground sources, supplemented by low-grade surface stockpiles and pit haulroad material. Tonnage mined and treated from all sources in the year was higher than that achieved in each of the preceding 3 years and amounted to 4,919,000 tons of ore compared with the 4,857,000 tons treated in 1989.

Total ore production from Namaqualand Mines, including tailings re-treatment and prospecting, yielded 932,392 carats at an average grade of 14.6 carats per 100 tons compared with 1,005,876 carats at an average grade of 16.8 carats per 100 tons in 1989. In total, 6,374,000 tons of ore was treated compared with 6,003,000 tons in 1989.

The total tonnage treated at Premier Mine was 7,407,000 tons, yielding 2,327,072 carats.

**Dimension Stone.**—The total mass of salable dimension stone produced in South Africa during 1990 was 0.43 Mmt, of which

“granite” (including gabbro, norite, syenite, dolerite, and tonalite) contributed 90.4%; slate, 6.9%; and marble, 2.7%.

In 1990, various colored “granites” were mined by 28 producers in several regions in South Africa. Marble was produced by two operators in the Vanrhynsdorp District, about 270 km north of Cape Town, whereas slate for roofing, flooring, and paving came mainly from quarries both west and east of Johannesburg in western Transvaal. Local sales of “granite” amounted to 18,200 tons in 1990. Local sales of marble increased 40% from 3,960 tons in 1989 to 5,600 tons in 1990. South Africa 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 is a major buyer of this material. Although an estimated 50% of total “granite” exports was to Europe, mainly Italy and Spain, much of it was reexported after further processing.

**Fluorspar.**—In South Africa, metallurgical-grade fluorspar is produced in lumpy and briquetted form. Acid and ceramic grades are recovered as flotation concentrates. During 1990, four mines were operative, of which two (Buffalo and Vergenoeg) were in the Bushveld Complex and two (Witkop and Van den Heever) in the dolomite area, 160 km west of Johannesburg. The Republic of South Africa's production of fluorspar, which peaked at 522,700 tons in 1980, was adversely affected by the consequent contraction in the world demand for the commodity and amounted to only 311,000 tons in 1990. As a result of increased competition from China and reduced world demand, total exports amounted to 245,700 tons, about 24% lower than those in 1989.

**Graphite.**—Initial exploration on the Steamboat graphite deposit in the far northern Transvaal has delineated resources of 2.5 Mmt, with a flake graphite content of 8.8% to a vertical depth of 100 m. Additional resources are indicated to the east for a distance of 3 km based on limited drilling and geophysical programs. Mintek has undertaken comprehensive beneficiation tests on samples of the ore resulting in product grades of more than 90% carbon at recoveries of graphite in excess of 90%. The deposit is about 150 km northwest of Potgietersrus.

**Phosphate.**—Foskor, the state-owned phosphate rock producer, reported a 7.6%

decline in local demand for phosphate fertilizer in the financial year to June 1991. This was due primarily to the late summer rains, which brought about a reduction of 300,000 ha in the grain acreage planted. The high rate of farmers indebtedness, the rising costs of agricultural inputs, and the depressed price levels for agricultural produce undoubtedly affected the fertilizer application adversely.

Foskor was able to maintain its phosphate rock export volumes at the same level as those of the previous year despite the fact that world trade in phosphate rock declined 13.7% in 1990.

## Mineral Fuels

The Government decided not to proceed with Natal's proposed \$39 million ethanol-from-sugar scheme, because of low world oil prices. It reported that a substantial increase in the price of oil will be required for interest in this project to be revived. The scheme originally proposed that a distillery capable of generating 200 ML/a of ethanol be built at Richards Bay.

The Southern Oil Exploration Co. (Soekor) 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. Crude petroleum has been discovered, though not in commercial amounts.

Work continued in the Soekor-Engen (Gencor) joint participation area (in the Bredasdorp basin, 100 km offshore south of Mossel Bay), and three more hydrocarbon discoveries were made, two of which are potentially commercial. One of these boreholes in block E, in which Engen had a 20% interest, yielded 7,700 bbl/d of oil and 96,000 m<sup>3</sup>/d of gas.

**Coal.**—According to the Minerals Bureau, total coal sales were 185.4 Mmt compared with 177.5 Mmt in 1989, of which 135.8 Mmt was domestic sales and 49.6 Mmt was exports. Domestic sales of coal, by sector, were as follows: electricity generation 73.5 Mmt compared with 69.6 Mmt in 1989; industry, including synthetic fuels, gas, chemicals, cement, and agriculture, 46.6 Mmt; metallurgy, 8.3 Mmt; home use, 6.9 Mmt; mining, 0.45 Mmt; and transport (steam), 0.07 Mmt. The country ranked third in the world in exports of coal after Australia and the United States. About 92% of all coal exports was through Richards Bay Coal

Terminal, 7% through Durban, and the remainder through Maputo in Mozambique.

Exports of anthracite were 3.4 Mmt in 1990 compared with 3.3 Mmt in 1989.

Coking coal production by Iscor Ltd. was 3.431 Mmt in the year ending June 30, 1991. Output was from the Grootegeluk Mine, 1.677 Mmt; Durnacol Mine, 0.992 Mmt; Hlobane Mine, 0.565 Mmt; and the Tshikondeni Mine, in Venda, 0.197 Mmt. Production of steam coal from Grootegeluk increased to 6.3 Mmt. Iscor sold 9.8 Mmt of coal to Eskom.

A new handling, crushing, and screening plant was commissioned at Iscor's Grootegeluk coal mine, north of Thabazimbi in the far northern Transvaal, thereby doubling the colliery's production of steam coal, all tied to Eskom's nearby Matimba power station. When fully commissioned in 1991, the power station will have an installed capacity of 3,990 MW, making it the largest dry-cooled facility of its kind in the world.

Iscor installed a pneumatic Bahrcell flotation plant at its Durnacol Colliery south of Newcastle. This successfully benefited and rendered usable fine coal that had previously been dumped in slimes dams. The plant is the first of its kind in Africa and the fourth in the world.

Sasol's Syferfontein Colliery near Secunda, 80 km south of Witbank, commenced the installation of a 42-km-long and 1.2-m-wide conveyor belt, the longest ever made in South Africa. It was designed to transport 20.7 Mmt/a from the coal mine to the Secunda synfuel plants.

Less efficient generating capacity totaling 4,260 MW was taken out of service at five Eskom power stations. At the same time, new coal-fired units totaling 1,892 MW were commissioned at three power stations.

**Natural Gas.**—South Africa's exploration corporation, Soekor, has discovered what is believed to be one of the country's highest ever gas yields off the coast of Mossel Bay. It was revealed by Soekor that reserves of 14.2 billion m<sup>3</sup> of gas are estimated to exist in the newly discovered field. Flow rates of about 900,000 m<sup>3</sup>/d of gas and 144 bbl/d of condensate have been measured.

The Mossel Bay Gas Project (Mossgas), the large synthetic fuels venture with private-sector participation, entered the hookup and commissioning phase. It remained on course to bring the first gas ashore during the second half of 1991 and to reach substantial production of oil and

diesel as well as associated products during the first half of 1992. Soekor played a major role in the early development of the project and will continue its involvement by operating the production platform, about 85 km south of Mossel Bay.

**Petroleum Refining.**—Six refineries in South Africa process imported crude oil and synthetic oil produced by Sasol; two are at Durban, one at Cape Town, one at Sasolburg, and two at Secunda.

Ethyl alcohol is produced as a byproduct by Sasol in amounts too large to be absorbed as solvents or feedstocks; it is added to premium-grade gasoline sold in the Transvaal and parts of the Orange Free State and Cape Province.

The history of the Sasol group of companies goes back to 1950 with the establishment of the first oil-from-coal venture. Since that time, the company 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.

A \$1.15 billion program for further diversification has been announced, comprising a number of projects, including the following:

- The phasing out of liquid fuels production at Sasol One and installation of additional facilities for the production of ammonia and high value products such as chemicals and waxes.

At Secunda, the installation of an n-butanol plant (by December 1991); a facility for the production of anode coke used in the aluminum industry; upgrading of the ethylene plant stem turbine; and construction of a plant to recover krypton and xenon.

Liquid fuels production at Secunda will not be materially affected by these developments and should continue to exceed original design capacity.

**Uranium.**—South Africa's uranium production continued to wind down in the face of slack demand and production cut-backs at gold mines that produce uranium as a byproduct. More than one-half of the country's 2,903 tons of yellow cake came from AAC's Vaal Reefs Mine, which produced 1,621 tons in 1990. Hartebeestfontein produced 329 tons; Buffelsfontein, 317 tons; Western Areas, 263 tons; and Freegold, 167 tons. The Palabora copper mine produced 109 tons.

Randfontein Estates canceled its sales contract with the French atomic agency and

transferred the contract to another, unnamed South African producer. Production at the Chemwes plant, jointly owned by Stilfontein and Buffelsfontein, ceased when Eskom terminated purchases of yellow cake. Another mine ceasing production was Driefontein Consolidated.

## Reserves

The country'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 quartzites, conglomerates, siltstones, and shales in an elongated basin. The basin (see figure 1) is between northern Cape Province and southern Transvaal Province and includes Johannesburg. 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, in Transvaal Province, 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 chromite, PGM, and vanadiferous magnetite. Cobalt, copper, and nickel are also found in the Bushveld Complex and are economically recovered 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, fluorspar, and tin. The Transvaal and Griqualand West Sequences, dating from about 2.6 billion years, are a 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.

The Minerals Bureau of the Republic of South Africa reported the country's total reserves in terms of reserve base for many mineral commodities.

The Minerals Bureau reported a reserve base of 50.8 Mmt for andalusite, sillimanite, and kyanite. This figure consisted almost entirely of andalusite. The reserve base of 4.8 Mmt contained lead 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

FIGURE 1  
SOUTH AFRICA: WITWATERSRAND AND BUSHVELD MINERAL DISTRICT

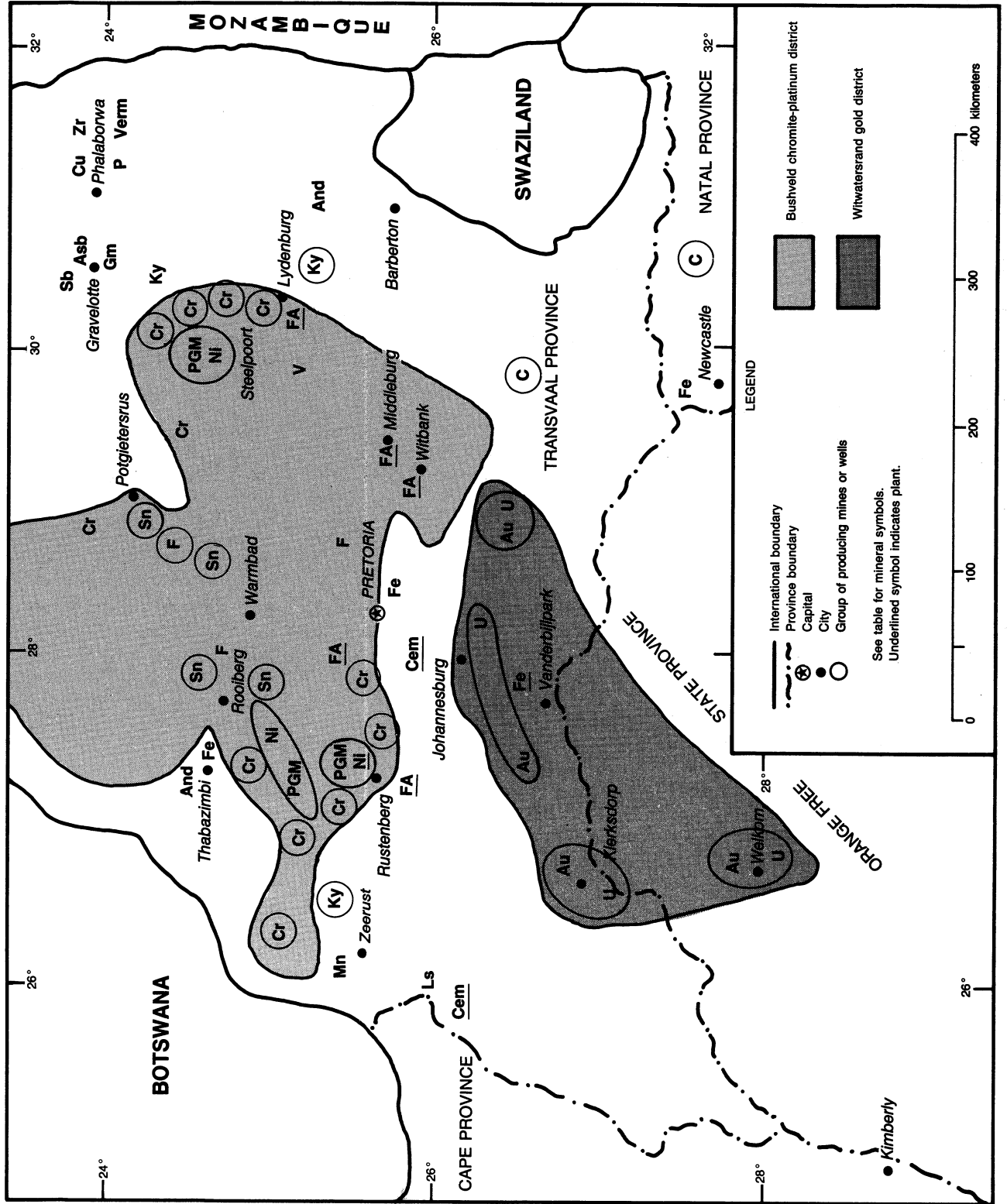


TABLE 5

**REPUBLIC OF SOUTH AFRICA:  
RESERVES OF MAJOR MINERAL  
COMMODITIES FOR 1990**

(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 <sup>1</sup>        | tons 40,000 Au.            |
| Gypsum                   | 86.                        |
| Iron ore                 | 5,900 contained Fe.        |
| Lead                     | 5 contained Pb.            |
| Manganese                | 4,000 contained Mn.        |
| Nickel                   | 11 contained Ni.           |
| Platinum-group<br>metals | tons 30,200 contained PGM. |
| Silver                   | tons 9,500 Ag.             |
| Titanium                 | 31 contained Ti.           |
| Vanadium                 | 8 contained V.             |
| Vermiculite              | 73.                        |
| Zinc                     | 15 contained Zn.           |
| Zirconium                | 7 contained Zr.            |

<sup>1</sup>Source: Economic Geology Research Unit of the Witwatersrand University.

zinc reserve base of 14.872 Mmt contained zinc was broken down to 11.768 Mmt of demonstrated reserves. Broken Hill's 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 430,860 tons. Demonstrated marginal reserves of zinc were 3.1 Mmt. The only potash production in South Africa was by Iscor at its Vanderbijlpark and Newcastle Works, where several kmt/a of 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 data for certain minerals. The Economic Geology Research Unit of the Witwatersrand University estimated that 40,000 tons of gold remained to be mined in the country,

compared with 42,000 tons mined to date. About 23,000 tons of the 40,000 tons would be derived from existing mines. Recovery of the remainder would involve development of new deep-level mines.

The recoverable reserves of coal in South Africa were estimated at 55 billion tons, compared with 58.4 billion tons estimated in 1982, ranking it seventh in the world. Most of South Africa's coal is of bituminous thermal-grade, with only 2% anthracitic and 1.6% of metallurgical quality. Only a few and uneconomic deposits of lignite have been recorded in the Southern Cape and KwaZulu.

Recoverable reserves of anthracite coal were 863 Mmt mainly in Natal Province in the Kliprivier and Zululand Coalfields. About 31% of the total reserve occurred at 15 to 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 occurred at 200 to 500 m depth in seams 0.7 to 2 m thick.

## INFRASTRUCTURE

The country had an extensive, well-maintained road and railroad system serving not only the Republic of South Africa, but also southern Africa. Public and private trucking firms handled road shipments for the mining industry. Spoornet, a spinoff of Transnet, the Government-owned railroad and road transport utility, moved nearly all of the country's bulk mineral shipments of ores and concentrates. It also moved finished goods from South African producers and landlocked countries to South African ports for export.

With a total of about 23,250 km, South Africa had more than twice the combined railway length of Angola, Botswana, Mozambique, Namibia, Zambia, and Zimbabwe. South Africa also had the most extensive stretches of electrified rail in the subcontinent.

Durban Harbor, which serves the Pretoria-Witwatersrand-Vereeniging commercial area, remained the busiest of the more than 80 ports on the African continent while Richards Bay handled the greatest volume of cargo.

The Richards Bay Coal Terminal (RBCT) at Richards Bay had a design capacity of 44 Mmt/a of coal and had operated with this capacity for about 13 years. In 1990, 45.5 Mmt of coal was shipped from RBCT. A \$122 million project to refurbish

the facility and improve efficiency was underway to expand throughput capacity to 53 Mmt/a.

The Government passed legislation permitting joint ventures between Government-owned harbor facilities and private companies. The Durban Coal Terminal Co. upgraded the aging Bluff Coaling Appliance at Durban to handle 5 Mmt/a by 1992. Coal exports from Durban were generally small consignments of sized or graded bituminous and anthracite coal destined for specific markets.

The Electricity Supply Commission's (Eskom) average price per kW·h sold remained at \$0.030. The mining industry consumed 33.4 MMW of electricity or 24.5% of Eskom's sales. Gold mines alone that were members of the Chamber of Mines consumed 24.1 MMW valued at about \$613 million. Nuclear power constituted 5.4% of South Africa's installed electricity generating capacity in 1990.

## OUTLOOK

Little growth in mineral production and exports is expected for 1991 because of slow growth prospects in the South African and Western economies. Further declines in gold production (and employment) are likely unless there is a significant increase in the gold price. In the longer term, diversification of the economy away from mining will probably continue, but it is unlikely that the current cyclical decline in the industry will last for long. With its large mineral resource base, South Africa has great potential for increasing mineral production under favorable economic conditions.

The sharp increases in costs that have occurred for transportation, electricity, water, and labor in the past few years will continue to weigh heavily upon the mining industry, particularly for deep level gold mines. However, full implementation of a revised taxation scheme should help counterbalance the fixed costs facing the industry.

The country should continue to expand downstream processing of its mineral materials to higher value products. The liberalization of trade in the former U.S.S.R. and Eastern Europe should also bode well for South African exporters.

The precious metals are expected to perform poorly in 1991, with dollar earnings for gold, PGM, and silver declining.

The international demand for diamond is expected to decline as a result of con-

tinuing world economic recession and loss of confidence in the market by American consumers. The price, as well as South Africa's export volume, is therefore expected to decrease, leading to a significant fall in revenue.

The slump in the world crude steel industry is expected to be reflected in declining export volumes of chrome ore and chromium alloys and static export volumes for other ferroalloys and iron ore.

Export (by mass) of copper, granite, zirconium minerals, phosphate rock, and alumino-silicates are expected to improve, as well as the dollar prices of the last-mentioned two commodities and cobalt. On the other hand, export of antimony, tin, and zinc concentrates are likely to be virtually discontinued as almost the entire output of these commodities is being processed locally.

The international supply and demand situation for steam coal is expected to remain tight. South Africa's coal export volume is expected to increase by 1%.

With its very large reserves and excess production capacity, South Africa is well placed to expand fluorspar production to meet future increases in world demand.

<sup>1</sup>Reference to South Africa and Republic of South Africa includes, unless otherwise specified, the 4 "independent" homelands of Bophuthatswana, Ciskei, Transkei, and Venda, as well as the 10 "nonindependent" tribal homelands, all within the boundary of the Republic of South Africa.

<sup>2</sup>The U.S. sanctions imposed under title III of the Comprehensive Anti-Apartheid Act of 1986 (CAAA) and the Rangel double-taxation amendment were lifted on July 10, 1991. As of that date, U.S. companies and citizens were no longer prohibited by the CAAA from making new investments in South Africa. However, other U.S. sanctions remained. The 1985 Gramm Amendment prohibits U.S. support for new IMF funding for South Africa. The United States maintains a ban on all exports to the South African military and police; a total ban on all export of arms, ammunition, and equipment for their manufacture and maintenance; a prohibition on the import of arms from South Africa; and controls on the manufacture or development of nuclear weapons. There were about 140 sanctions imposed at the state and local level in the United States on companies doing business with South Africa.

<sup>3</sup>Where necessary, values have been converted from South African rands (R) to U.S. dollars at the rate of R2.26=US\$1 for 1988, R2.62=US\$1 for 1989, and R2.59=US\$1 for 1990.

## OTHER SOURCES OF INFORMATION

### Agencies

Chamber of Mines of South Africa  
P. O. Box 61809  
2107 Marshallton  
Republic of South Africa

Council for Mineral Technology (Mintek)  
Private Bag X3015  
2125 Randburg  
Republic of South Africa  
Embassy of the Republic of South Africa  
Counsellor (Minerals & Energy)  
3201 New Mexico Ave., NW  
Washington, DC 20016  
United States of America  
Geological Survey  
Private Bag X112  
0001 Pretoria  
Republic of South Africa  
Minerals Bureau  
Private Bag X4  
2017 Braamfontein  
Republic of South Africa

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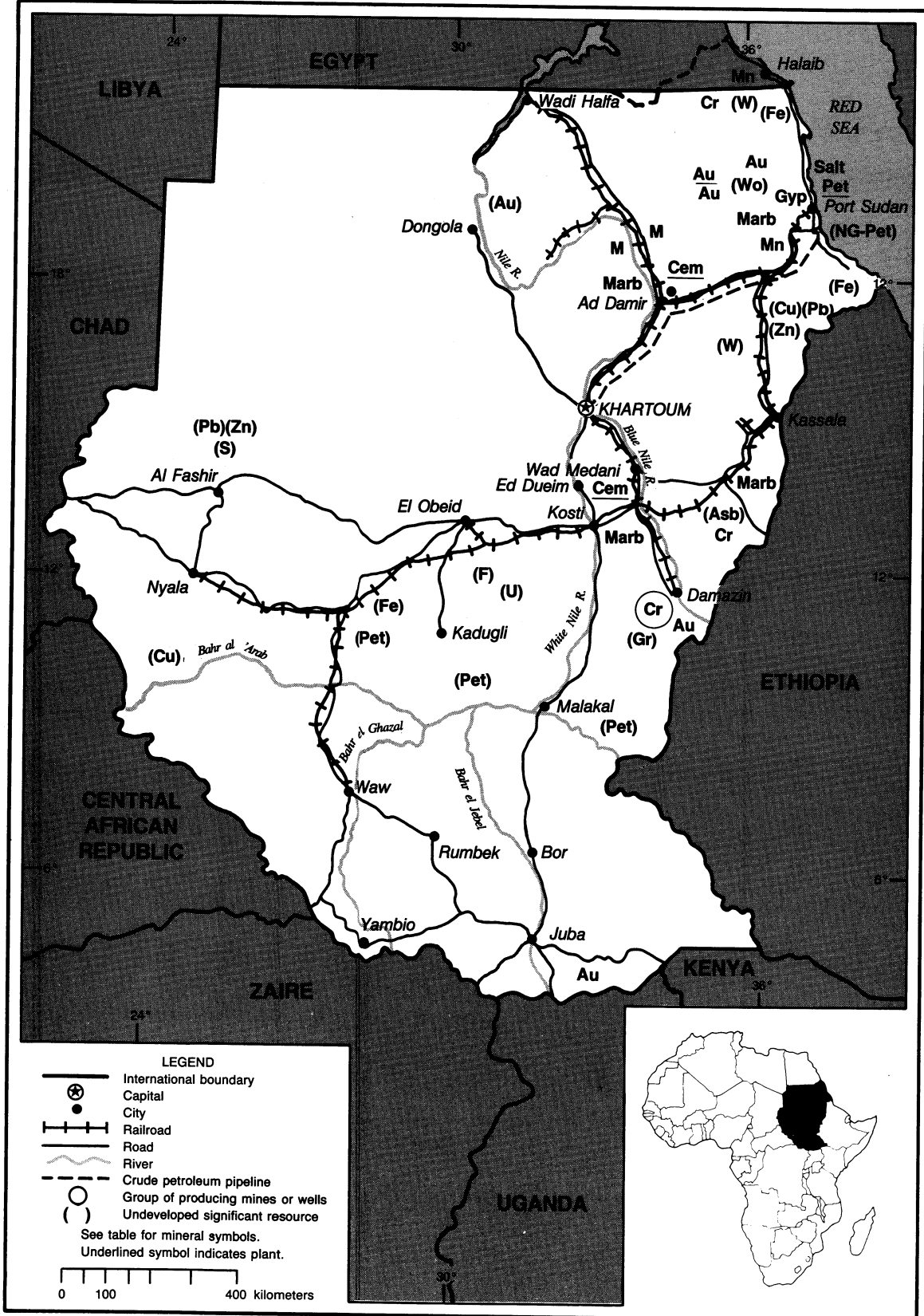




# SUDAN

AREA 2,505,810 km<sup>2</sup>

POPULATION 25.0 million



# THE MINERAL INDUSTRY OF SUDAN

By Lloyd E. Antonides

**T**he promising mineral potential of the Sudan, Africa's largest country and more than one-fourth as large as the United States, remained mostly unexploited in 1990. Political instability was probably the main reason for lack of development. Oil and gas, gold, chrome and manganese ores, and several industrial minerals had most attraction. Many of the solid minerals were found in the eastern highlands where transport distance to Port Sudan on the Red Sea was not a major obstacle. There was natural gas offshore near the port and oil in the south-central part of the country. However, the industry was not expected to be significant to Sudan's economy for some time.

The economy was in difficulty as it had been for many years owing to political turbulence, including civil war, state controls and mismanagement, and natural disasters. A Bank of Sudan estimate of GDP showed slightly less than \$10 billion<sup>1</sup> for the

fiscal year ending June 30, 1990, down about 6% from that of 1989. In constant prices it was stagnant. The trade deficit grew as exports decreased and imports increased. Agriculture, including livestock and forestry, which contributed more than 35% to the GDP and employed more than 75% of the work force, suffered markedly from the drought that continued into 1990, with many areas experiencing famine. Consumer price inflation for fiscal year 1990 was estimated at more than 50% and increased rapidly to about 300% in May 1991.

The Government change in 1989 did not slow the country's ever-deepening economic and political problems. Even foreign aid was being curtailed. But some actions early in 1991 indicated possibilities for future improvement. In politics, the Government finally declared a new Federal system of nine locally administered states. It also exempted the southern states from aspects of the legal code they opposed and announced release of political prisoners.

In economics, Government efforts were erratic. It remained heavily involved in all aspects of the economy, but by May 1991, it had taken steps to privatize some Government companies to liberalize trade and to decontrol exchange rates. The loosening of foreign exchange appeared to ease the shortage of essential commodities, but a currency change was considered necessary to curb the soaring inflation. The Government continued to declare the economic importance of petroleum and other minerals development, especially by private companies.

Mineral production was mainly cement, chromite, gold, gypsum, limestone, petroleum refinery products, and salt. Typically, mineral exports consisting of chromite, gold, and salt provided only a small fraction of 1% of export revenues, which mostly came from cotton and livestock. Petroleum refinery products and crude oil were by far the most significant commodity item imported.

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

(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>  | 1986                | 1987                 | 1988                 | 1989                | 1990 <sup>e</sup>    |
|---|---------------------|----------------------|----------------------|---------------------|----------------------|
| Cement, hydraulic <sup>c</sup>  | 150,000             | <sup>3</sup> 121,732 | <sup>1</sup> 140,000 | 150,000             | <sup>3</sup> 166,538 |
| Chromium: Chromite, mine output (48% Cr <sub>2</sub> O <sub>3</sub> ), gross weight | <sup>8</sup> 8,500  | 13,015               | 8,000                | 25,000              | <sup>3</sup> 12,500  |
| Gold, mine output, Au content <sup>c</sup> kilograms                                | <sup>5</sup> 50     | <sup>3</sup> 85      | <sup>3</sup> 300     | <sup>5</sup> 500    | 100                  |
| Gypsum and anhydrite, crude <sup>c</sup>  | 7,000               | 7,000                | <sup>3</sup> 5,000   | <sup>3</sup> 10,000 | 5,000                |
| Mica, all grades <sup>c</sup>   | <sup>5</sup> 5      | <sup>1</sup> —       | <sup>1</sup> —       | <sup>1</sup> —      | —                    |
| Petroleum refinery products: <sup>c</sup>   |                     |                      |                      |                     |                      |
| Liquefied petroleum gas thousand 42-gallon barrels                                  | <sup>1</sup> 100    | <sup>1</sup> 100     | 101                  | 100                 | 100                  |
| Gasoline do.  | <sup>1</sup> 1,100  | <sup>7</sup> 700     | 1,275                | 1,200               | 1,200                |
| Jet fuel do.  | <sup>5</sup> 500    | <sup>4</sup> 400     | 669                  | 500                 | 500                  |
| Kerosene do.  | <sup>1</sup> 100    | <sup>1</sup> 100     | 128                  | 100                 | 100                  |
| Distillate fuel oil do.   | <sup>1</sup> 1,900  | <sup>1</sup> 1,000   | 2,026                | 2,000               | 2,000                |
| Residual fuel oil do.   | <sup>2</sup> 2,100  | <sup>1</sup> 1,300   | 1,573                | <sup>1</sup> 1,500  | 1,500                |
| Other <sup>4</sup> do.  | <sup>2</sup> 200    | <sup>2</sup> 200     | 208                  | 200                 | 200                  |
| Total, including refinery fuel and loss <sup>c</sup>                                | <sup>6</sup> 6,000  | <sup>3</sup> 3,800   | 5,980                | <sup>5</sup> 5,600  | 5,600                |
| Salt  | <sup>4</sup> 40,000 | 51,662               | 150,000              | 91,000              | <sup>3</sup> 68,262  |

<sup>e</sup>Estimated. <sup>r</sup>Revised.

<sup>1</sup>Includes data available through July 1, 1991.

<sup>2</sup>In addition to the commodities listed, limestone (for cement, lime, agriculture, and construction aggregate and fill) and some crude construction materials (e.g., clays, sand and gravel, stone) presumably are produced, but available information is inadequate for reliable estimates of output; also, production of manganese ore (48% to 50% Mn) was reported for 1989 at 1,100 tons and 1990 at 60,000 tons.

<sup>3</sup>Reported figure.

<sup>4</sup>Includes refinery fuel and losses.

State-owned companies have been a major factor in the mineral industry of Sudan since the early 1970's. However, private firms have also operated since 1979.

Many larger mineral ventures have foreign participation. Small primitive operations are common. Copper mining was the objective of a joint venture between Armeno Re-

sources and the Government, which continued a multiyear evaluation of the Hofrat en Nahas deposit in western Sudan.

Gold production in the Sudan dropped

TABLE 2  
SUDAN: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

(Metric tons unless otherwise specified)

| Major commodity                             | Major operating companies   | Location of main facilities   | Annual capacity |
|---|---|---|-----------------|
| Cement                                      | Maspio Cement Co.   | Atbara, 275 kilometers northeast of Khartoum                                    | 150,000.        |
| Do.   | Nile Cement Co.   | Rabak, 250 kilometers south of Khartoum   | 100,000.        |
| Chrome ore                                  | Ingessana Hills Mines Corp.   | Gam Mine, 500 kilometers south-southeast of Khartoum                            | 15,000.         |
| Gold  | Joint venture between Minex Minerals (Sudan) Ltd., and Sudanese Mining Corp.                                | Gebeit Mine, 175 kilometers north-northwest of Port Sudan                       | 35,000 ore.     |
| Do.   | Bashken Mining Co. Ltd.   | Aberketeib Mine, 250 kilometers northwest of Port Sudan                         | 25,000 ore.     |
| Do.   | Joint venture between Bureau Recherches Geologiques et Minieres, Total Cia Miniere, and Sudanese Mining Co. | Hassai Mine, 400 kilometers west of Port Sudan                                  | 60,000 ore.     |
| Gypsum                                      | Khor Eit Gypsum Quarries  | Bir Eit Mine, 60 kilometers north of Port Sudan                                 | 20,000.         |
| Marble                                      | Pentco Engineering & Trading Co.  | Port Sudan and Gedaref, 375 kilometers east-southeast of Khartoum               | 100,000.        |
| Petroleum, crude million barrels            | Chevron Oil Co. of Sudan  | Unity, Heglig and other oil and gasfields, 750 kilometers southeast of Khartoum | 29.2 potential. |
| Petroleum refinery products million barrels | Port Sudanese Refinery Ltd.   | Port Sudan  | 8.7.            |

\*Estimated.

drastically for 1990 with the February shutdown of the Gebeit Mine operated by Minex (Greenwich Resources PLC) and the June closure of the Aberketeib Mine operated by Bashken Mining Co. Ltd. (Kenmare Resources PLC and others). No information was available on the status of the only other significant producer in 1989, the Hassai Mine operated by Bureau de Recherches Geologiques et Minieres (BRGM) since early 1987. The Gebeit Mine opened in November 1987, but Minex and its Government partner, Sudanese Mining Corp., reported unexpected low grades, low recovery, and high costs, forcing closure of the mine. The Akerketeib Mine opened in February 1989, but the partners claimed lack of supplies due to restrictions on imports as a major cause of the shutdown of the mine.

Cement production was expected to be improved at Nile Cement's Rabak plant, with

some new equipment delivered during the year by a Yugoslavian firm. It was to be installed by yearend 1991.

Petroleum concessions formerly held by a Sun Oil Co. subsidiary were being bid on by other companies according to the Government. Sun decided to halt exploration operations after 8 years of unencouraging results and left the country in May. Chevron Oil Co. of Sudan, with several discoveries since starting work in 1974, planned only seismic work in 1990 and was warned by the Government in May 1990 that two more wells were required by end of June 1991 to maintain its licenses. Results of subsequent negotiations were not available, but early in 1991, operations in at least one area were taken over by Government personnel and one well abandoned by Chevron in 1984 was producing at a very low rate. Two other foreign oil companies of the many that have looked

at possibilities were still operating in Sudan: Panoco, developing a gas condensate field offshore south of Port Sudan, and Total, waiting for resolution of southern hostilities.

Any significant change in the state of Sudan's minerals industry will probably be delayed until the political and economic environment improves.

<sup>1</sup>Where necessary, values have been converted from Sudan pounds (Ls) to U.S. dollars at the rate of Ls4.50=US\$1.00 in 1988-90, the official rate. However, according to Middle Eastern publications, the illegal market rate was about Ls20.00=US\$1.00 in May 1989 and Ls70=US\$1.00 in May 1990.

#### OTHER SOURCES OF INFORMATION

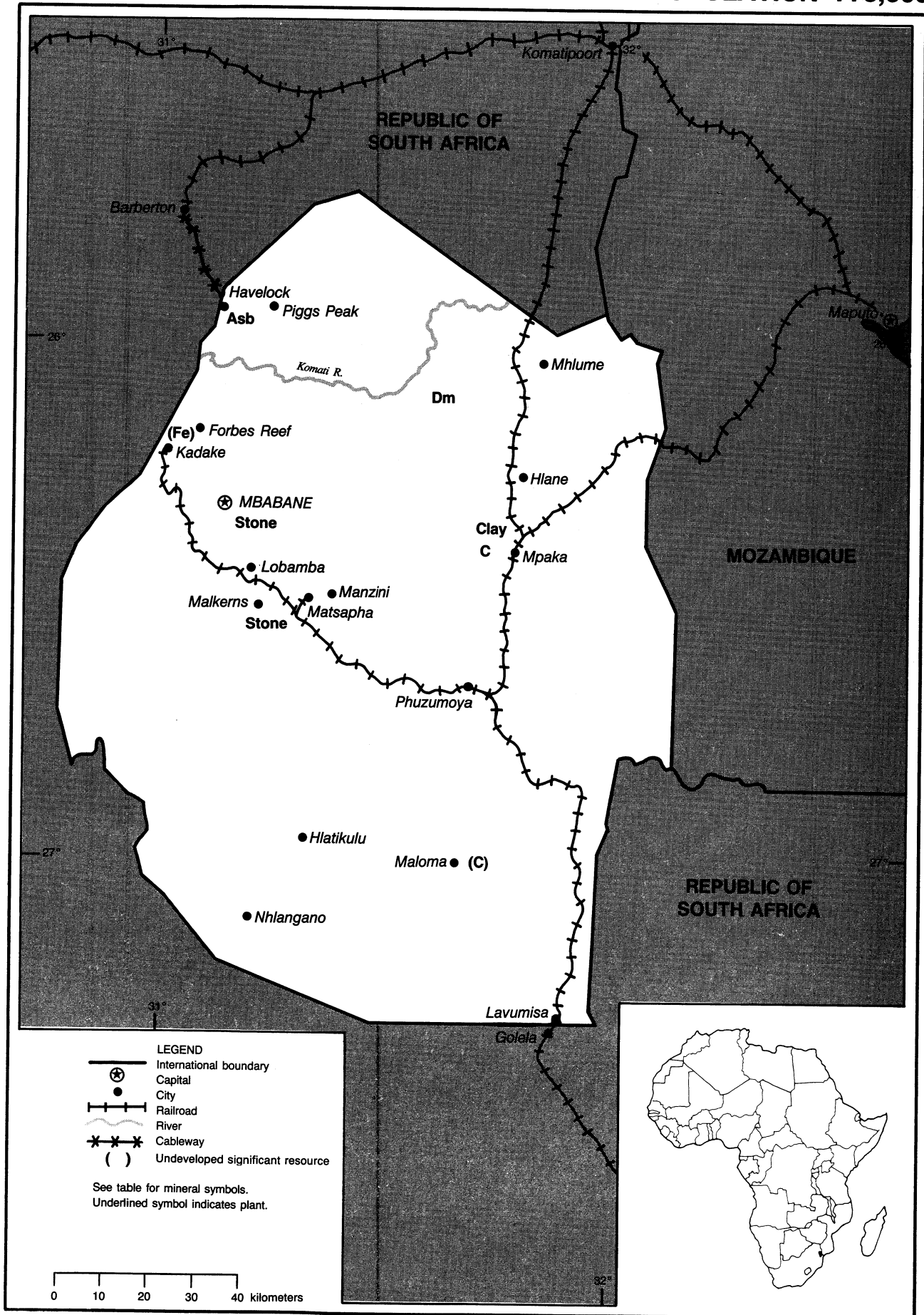
Ministry of Energy and Mining  
Republic of the Sudan  
Khartoum, Sudan  
Telex 22638



# SWAZILAND

AREA 17,360 km<sup>2</sup>

POPULATION 778,500



# THE MINERAL INDUSTRY OF SWAZILAND

By Hendrik G. van Oss

**M**ineral production is an important component of the Swaziland economy, which, nevertheless, is dominated by agriculture. Mineral commodity sales in 1990 were equivalent to approximately 4% of the country's estimated GDP of \$700 million<sup>1</sup> and about 4% to 5% of total exports. Revenues from mineral sales have traditionally been a major direct funding source for national health, housing, and scholarship programs. In 1990, mining sector wages, including those of Swazi miners in the Republic of South Africa, directly supported an estimated 15% of the Swazi population. Most of the country's railroads were built to service the mining industry.

Historically, Swaziland has been a significant regional producer of asbestos, iron ore, and gold, although only the first of these is still being mined. Coal mining at Mpaka commenced in 1964, and diamond mining at Dvokolwako commenced in 1984. Iron ore was mined at Ngwenya, 18 km northwest of Mbabane, from 1964 to 1977. However, prehistoric diggings on the Ngwenya deposit, for ochre, are believed to be the world's oldest mine workings. Swaziland produces a modest amount of brick clay, stone, and a variety of other construction mineral commodities, and has had past small production of barite, fluorospar, pyrophyllite, and tin (in cassiterite).

Swaziland's geology is dominated by Archean granitic rocks, which make up most of the western two-thirds of the country. Tin-bearing pegmatites in some of these rocks have given rise to alluvial tin deposits. Along the northwest Swaziland border is part of an Archean greenstone belt known in the Republic of South Africa as the Barberton Mountain Land. This terrane in Swaziland has hosted asbestos, barite, gold, and iron deposits. In east-central Swaziland, there is a 20-km-wide north-south belt of Karoo sedimentary rocks; these host Swaziland's large coal reserves and some occurrences of industrial minerals. The eastern one-third of the country is made up of a largely economically barren north-south belt of volcanic rocks forming the Lubombo Plateau.

In addition to being a rather steady source of revenues, the mining industry in Swaziland is an important source of employment. Approximately 2,500 Swazis were directly employed by the mining industry in Swaziland, equivalent to about 3% of the formal sector labor force. Rising concern over the unemployment levels in Swaziland has led to direct Government loan support of the ailing asbestos mine, the largest mining employer in the country, and to Government intervention in labor disputes at the Emaswati coal mine. A significant factor in Swaziland's relations with the Republic of South Africa is the approximately 18,000 Swazis employed in gold, coal, and platinum mines in that country. It is estimated that almost 15% of Swaziland's population is directly supported by mine wages, which are estimated to have totaled about \$70 million in 1989.

All minerals in Swaziland are vested in the King, in trust for the Swazi Nation. The Minerals Committee, appointed by the King in consultation with the Ministry of Natural Resources and Energy, oversees all mining matters. However, in late 1987, a separate committee was formed to renegotiate the royalty provisions of certain existing mine leases. In the past, certain construction materials, such as clay, sand and gravel, and stone, were treated differently from "minerals," such as asbestos and coal. However, the Mining (Amendment) Act of 1990 altered the definition of "mineral" to be all-inclusive; this change will allow a more uniform system of leasing and royalty payments. Applications for prospecting and mining licenses are made through the Geological Survey and Mines Department, which transmits them to the Minerals Committee.

Equity participation in mining ventures by the Swazi Nation is through the national trust organization Tibiyo Taka Ngwane (TTN), which was formed in 1968. TTN's equity share in mining ventures is commonly on the order of 40% to 50%, and through such holdings TTN became financially self-supporting in 1976. Since that time, in accordance with the Mineral Rights Taxation Regulations of 1976, all mineral royalties and lease revenues have been paid

to another national trust organization, Tisuka Taka Ngwane, for the support of housing and infrastructure development. In 1987, the Swaziland Industrial Development Co. Ltd. (SIDC) was set up as a private development finance company to promote private-sector projects, including mining, in Swaziland. SIDC can provide financing for up to 50% of a project's total cost and can take a minority shareholding of up to 35%, but will not participate in the management of a project.

The total reported value of mineral production increased 12% to \$24.12 million in 1990, although this only includes asbestos, coal, diamond, and stone. Based on the output of bricks made from local ball clay, the true total value of Swaziland mineral production in 1990 is estimated to have been at least \$30 million. Production of asbestos increased significantly in 1990, largely owing to continued exploitation of a high-grade ore body opened in 1989 at the Havelock Mine. Coal production at the country's single coal mine fell, however, owing to labor unrest. Diamond production, likewise from one mine, fell for the second year in 1990 largely as a result of technical problems associated with influx of ground water into the open pit. Unlike in 1989, however, the decline in production was not mitigated by increased world prices for diamond. Production of crushed stone responded to the continued strong demand in the construction sector; output increased despite continued inactivity at one of the country's two main quarries.

A clay quarry is operated near Mpaka by the Langa National Brickworks. Clay production data for 1990 were not available; however, the brick factory had an output in 1988 of 34.4 million units, about one-half of the factory's capacity. It is likely that subsequent output has been higher, in line with strong construction industry demand. The value of this output is estimated to be at least \$5 million.

Along with Botswana, Lesotho, and the Republic of South Africa, Swaziland is a member of the South Africa Customs Union, which provides for duty-free internal shipping, a common external tariff, and access to a market of about 35 million

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

(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>             | 1986    | 1987    | 1988    | 1989 <sup>P</sup> | 1990 <sup>P</sup> |
|------------------------------------|---------|---------|---------|-------------------|-------------------|
| Asbestos, chrysotile fiber         | 20,908  | 25,925  | 22,804  | 27,291            | 35,938            |
| Coal, anthracite                   | 172,145 | 165,371 | 164,845 | 165,122           | 150,967           |
| Diamond carats                     | 39,144  | *80,000 | 72,676  | 55,264            | 42,484            |
| Stone: Quarry product cubic meters | 120,723 | 96,114  | 107,205 | 128,463           | 155,347           |
| Tin, mine output, Sn content       | —       | —       | —       | —                 | —                 |

\*Estimated. <sup>P</sup>Preliminary.

<sup>1</sup>Includes data available through Dec. 16, 1991.

<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.

TABLE 2  
**SWAZILAND: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990**

(Metric tons unless otherwise specified)

| Major commodity     | Major operating companies                | Location of main facilities                                      | Annual capacity                      |
|---------------------|--|--|--------------------------------------|
| Asbestos            | Havelock Asbestos Mines (Swaziland) Ltd. | Underground mines at Bulembu, 5 kilometers southeast of Havelock | asbestos fiber: 40,000. <sup>e</sup> |
| Coal                | Emaswati Coal (Pty.) Ltd.                | Open pit and underground mine 5 kilometers southwest of Mpaka    | anthracite: 200,000. <sup>e</sup>    |
| Diamond, carats     | Dokolwayo Diamond Mines (Pty.) Ltd.      | Open pit mine at Dvokolwako, 45 kilometers northeast of Manzini  | 100,000. <sup>e</sup>                |
| Stone, cubic meters | Kwalini (Pty.) Ltd.                      | Crofthead Quarry near Malkerns                                   | 170,000. <sup>e</sup>                |
| Do.                 | Wales Crushers (Pty.) Ltd.               | Crushed stone quarry at Tonkwane Estates, Mbabane                | NA.                                  |

<sup>e</sup>Estimated. NA Not available.

persons. The Republic of South Africa dominates the Customs Union, and, as in years past, perhaps 75% of Swazi exports were sold to or transshipped through that country. Almost 90% of Swaziland's imports either originate in or transit the Republic of South Africa. Trade with the United States accounted for about 6% of total Swazi exports in 1990 and about 1% of imports. Trade with the United States did not involve a significant quantity of mineral commodities.

Swaziland's exports are estimated to have totaled about \$545 million in 1990. In terms of minerals, Government data show separately only the value of asbestos, coal, and diamond exports, which totaled \$22.4 million, up 10%. If the estimated value of brick exports is added, the true value of Swaziland's mineral commodity exports

was about \$27 million. All of the asbestos output, worth \$12.52 million, was exported through the Republic of South Africa, with about 60% destined for overseas customers, largely in east Asia and Japan.

Despite the decrease in coal production, sales revenues increased 30% to about \$4 million. Virtually all of the coal was exported. Much of the production was railed out through ports in the Republic of South Africa because of continued security problems with the railroad to Maputo, Mozambique. As in years past, almost all of the coal exports went to the Bamburi Cement Works in Kenya. The country's diamond output was auctioned in Antwerp, Belgium. Revenues decreased 25%, proportional to production, and amounted to about \$5.9 million or about \$138 per carat.

Approximately 20 to 25 million bricks are exported annually to the Republic of South Africa. Data on the value of this trade were not available, but the value can be estimated as between \$3 million and \$5 million.

Swaziland's imports in 1990 are estimated to have been about \$560 million. In 1989, the latest year for which data were available, imports of mineral commodities, virtually all of which were from the Republic of South Africa, totaled almost \$90 million. Because mineral fuels and lubricants accounted for about 75% of the total in 1989, it is likely that the increases in world petroleum prices in the second half of 1990 raised this component of Swaziland's imports significantly for the year. Imports of fertilizers, including phosphate rock,

amounted to about \$16 million in 1989, and coal imports of about 160,000 tons were estimated to have amounted to about \$5 million. Swaziland's imports of electricity from the Republic of South Africa amounted to about \$8 million in 1989 and were likely about the same in 1990.

The Havelock asbestos mine's reserves on its original concession were virtually exhausted by yearend, and the bulk of the company's asbestos production in 1990 was from higher grade reserves on a new concession called the Far West Area. According to the Government, reserves on this concession were adequate for 5 to 7 years of production and grade about 10% asbestos fiber. At planned fiber output levels, this would imply reserves of about 2.5 Mmt of ore. Operations on the new concession commenced in 1989 and were financed in part by loans from the Government totaling \$6.3 million. Despite this loan, access to the new, high-grade reserves, and a significant increase in 1990 in both production and revenues, the company was plagued by financial difficulties during the year. Although this was partly due to millings problems resulting from wetter than expected ore, and from labor unrest, the bulk of the financial problems appeared to result from the company's inability to control purchasing and labor costs. In April 1990, the company asked the Government for an

additional \$2.33 million loan. This was initially refused, the Government instead converting the loans made in 1988 and 1989 to non-paying preferred shares in the company. But in November, the Government agreed to the additional loan in order to prevent the mine's closure, and the subsequent loss of about 1,700 jobs and the only source of income for the remote town of Bulembu.

At yearend, a commission was appointed to look into the mine's finances; the commission concluded that further loans would be needed to keep the mine operating. The Government refused to consider additional loans, and in January 1991, the company announced that the mine would close at the end of the month. During the mandatory 3-month liquidation period, the Government sought buyers for the operation and even considered a plan to convert to tourist use the mine's 20.4-km aerial bucket cableway, by which the mine's output is exported to Barberton in the Republic of South Africa. However, at the end of April 1991, the Government announced that it had sold the Havelock Mine to Consolidated Mining Corp. of South Africa and that operations would resume in June, albeit with a reduced work force.

Coal production from the Emaswati coal mine at Mpaka fell significantly in 1990, largely because of several work slowdowns

during the year, which culminated in a 1-day strike in December. Labor relations were still unsettled in January 1991, and in mid-January, the company announced the suspension of operations for safety reasons. However, the mine resumed operations at the end of the month.

The Government is anxious to increase the exploitation of Swaziland's high-grade coal reserves, which are estimated to total about 1 billion tons, much of which is anthracite. In late 1989, a prospecting license was granted to Carbonex Co. of Denmark for an area of known anthracite resources near Maloma. The company drilled the property during the year and submitted a feasibility study to the Government in early 1991 in support of an application for a mining permit. The company's goal was to establish reserves adequate for a 20-year operation, mining 300,000 mt/a. The Government estimates that minable reserves on the concession total about 20 Mmt.

<sup>1</sup>Where necessary, values have been converted from Swazi emalangeni (E) to U.S. dollars at the rate of E2.59=US\$1.00.

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

Geological Survey and Mines Department  
P.O. Box 9  
Mbabane, Swaziland



# TANZANIA

AREA 945,090 km<sup>2</sup>

POPULATION 25.9 million



# THE MINERAL INDUSTRY OF TANZANIA

By David Izon

**T**anzania has not been a major producer of minerals either on a world or national basis. The major minerals produced included coal, diamonds, gold, salt, gem stones, kaolin, phosphate, salt, soda ash, and tin. Recent developments indicate that gold production may become significant to the Tanzanian economy in the foreseeable future. The minerals sector accounted for less than 0.3% of a GDP of about \$2.7 billion in 1990. The main foreign exchange earner was agriculture, accounting for 80% of total export earnings. The Government has embarked on a program to search for and develop new mineral deposits in an effort to promote industrial growth. To this end it was actively seeking technical and financial aid from foreign investors for the expansion of existing mines and development of new mineral deposits. In 1990, the industrial sector as a whole reported a productivity increase of about 4.8%, resulting from availability of raw materials and spare parts. In terms of value, diamonds are by far the most important mineral produced because they account for more than 85% of total mineral export earnings. The Government was able to pay most of its debts to the international monetary institutions, and the Government of Japan canceled an outstanding debt of \$3.3 million to Tanzania. There were no significant changes in investment patterns during 1990.

## GOVERNMENT POLICIES AND PROGRAMS

In 1990, Tanzania continued with the economic policies and programs of the Economic Recovery Program being implemented by the Government. In the industrial sector, policies were adopted to encourage exploration, development, and exploitation of mineral resources of the country. Priority was given to production of food that would make Tanzania self-sufficient and able to export food surpluses.

Gold sales were taken over by the Bank of Tanzania. The Government bought gold from private sources at competitive market prices and prohibited any direct sales by

mining companies or individuals. Ocelot International Inc. of Canada signed an agreement with the Government to develop the Songo Songo natural gas field. Natural gas from the Songo Songo Field was to be utilized at an ammonia plant being planned for Dar Es Salaam. Other programs focused on the development of the iron ore deposits in the Kipengere mountain range. However, to date, the Government's effort to acquire technical and financial aid for the above project has not been successful.

## PRODUCTION

Certain sectors of the mineral industry suffered from a lack of capital, adequate equipment, and infrastructure. Diamond operations were faced with dwindling reserves. Known reserves were reported to be approaching exhaustion at about 3.0 million carats. Gold was mainly mined by smallholders and often smuggled out of the country. The Buckreef gold mine was closed in August 1990, owing to a lack of capital and investors. The apparent increase in reported gold production was due to the gold buying program instituted by the Bank of Tanzania. There were noticeable production increases for gem stones, phosphate minerals, salt, and glass sand.

Exploration efforts for additional gas reserves continued during 1990. Coal production was mainly for domestic consumption as an alternative to oil imports and to reduce rural consumption of firewood as a primary fuel. The Kiwira coal mine operated at about 30% of capacity.

## TRADE

Tanzania's main trading partners were the Federal Republic of Germany, Italy, the Netherlands, the United Kingdom and neighboring east African countries. Total exports for 1990 were about \$420 million, and imports amounted to about \$1.3 billion, creating a negative trade balance of about \$880 million. Principal export products for 1990 were agricultural products and diamond. Tanzania's imports from the United States in 1990 amounted to about \$42

million, and exports in the same period amounted to \$16 million. Major import items were manufactured goods, machinery and transport equipment, and spare parts. Areas of particular interest to U.S. industries included mineral and oil exploration, industrial equipments, and other manufactured goods.

## 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. The State Mining Corp. (STAMICO) controlled the mineral industry and operated most mines and plants. Private companies have started to return since 1986. Significant investments since 1986 have been by Canadian-owned Placer Dome Kamaha Ltd., Cluff Mineral's Kabanga Nickel Co., Samax Co. of the United Kingdom, and the United Nations Revolving Fund for National Resources Exploration. The development of state-owned mining projects are frequently beset by lack of adequate local and foreign exchange financing.

Oil and gas prospecting was conducted by joint-venture agreements with foreign partners in equity sharing arrangements. The largest operating company was Shell Oil Co. of the United States.

## COMMODITY REVIEW

### Metals

Tanzania has no large-scale iron and steel industry but has requirements of about 500,000 mt/a and produce only 30,000 mt/a locally at the rolling mills in Tanga and Dar Es Salaam. The country is known to have iron ore deposits in the Kipengere (Lingaga) mountain range of Iringa region, along the northern edge of Lake Nyasa. The deposits were estimated to contain about 45 Mmt of ore grading 51% iron, 13% titanium, and 0.6% vanadium.

**Gold.**—Tanzania's gold deposits have not been developed to their full potential. Production for 1990 amounted to about

TABLE 1

**TANZANIA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>  | 1986             | 1987             | 1988             | 1989 <sup>3</sup> | 1990 <sup>4</sup> |
|---|------------------|------------------|------------------|-------------------|-------------------|
| Cement, hydraulic   | °300,000         | °300,000         | 189,390          | 540,000           | °540,000          |
| Clays:  |                  |                  |                  |                   |                   |
| Bentonite <sup>5</sup>  | 75               | 75               | 75               | 75                | 75                |
| Kaolin  | 1,600            | 1,446            | 528              | 1,554             | 2,021             |
| Coal, bituminous  | 20,000           | 2,860            | 3,349            | 46,000            | 51,569            |
| Diamond <sup>3</sup> carats   | 190,000          | 150,000          | °150,000         | °150,000          | 84,598            |
| Gem stones, precious and semiprecious excluding diamond: <sup>5,4</sup> kilograms | 650              | 4,400            | 9,400            | °11,398           | 38,700            |
| Gold, refined do.   | 85               | 201              | 52               | 116               | 1,629             |
| Gypsum and anhydrite, crude   | °14,000          | 24,648           | 19,570           | 5,895             | 36,155            |
| Lime, calcined and hydrated <sup>5</sup>  | 3,000            | 3,000            | 3,000            | 2,505             | 1,466             |
| Limestone, crushed  | NA               | 680,701          | 792,454          | 986,537           | 861,253           |
| Mica, sheet   | ( <sup>5</sup> ) | ( <sup>5</sup> ) | ( <sup>5</sup> ) | ( <sup>5</sup> )  | ( <sup>5</sup> )  |
| Petroleum refinery products:  |                  |                  |                  |                   |                   |
| Liquefied petroleum gas thousand 42-gallon barrels                                | 80               | 44               | 73               | 49                | °50               |
| Gasoline do.  | 800              | 909              | 784              | 835               | °800              |
| Kerosene do.  | 220              | 330              | 325              | 321               | °300              |
| Jet fuel do.  | 300              | 220              | 232              | 107               | °100              |
| Distillate fuel oil do.   | 1,050            | 1,069            | 1,088            | 1,097             | °1,000            |
| Residual fuel oil do.   | 1,750            | 525              | 1,771            | 1,543             | °1,500            |
| Other do.   | 300              | 540              | 320              | 321               | °300              |
| Total including refinery fuel and losses do.                                      | 4,500            | 3,637            | 4,593            | 4,273             | °4,050            |
| Phosphate minerals: Apatite   | 10,000           | 18,386           | 4,466            | 4,657             | 25,066            |
| Salt, all types   | 21,868           | 41,123           | 19,777           | 20,010            | 39,315            |
| Sand, glass   | NA               | 6,071            | 12,043           | 13,101            | 6,365             |
| Soda ash <sup>5</sup>   | 300              | 300              | 300              | 300               | 300               |
| Tin, mine output, Sn content <sup>5</sup>   | 2                | 2                | 2                | 15                | °15               |

°Estimated. °Preliminary. °Revised. NA Not available.

<sup>1</sup>Includes data available through Dec. 12, 1991.<sup>2</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>3</sup>Diamond figures are estimated to represent 70% gem-quality or semigem-quality and 30% industrial-quality stones.<sup>4</sup>Exports.<sup>5</sup>Less than 1/2 unit.

TABLE 2

**TANZANIA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990**

(Metric tons unless otherwise specified)

| Major commodity                                   | Major operating companies                           | Location of main facilities          | Annual capacity |
|---|---|--------------------------------------|-----------------|
| Cement  | Tanga Cement Co. Ltd.                               | Tanga                                | 500,000         |
| Do.   | Tanzania Portland Cement Co.                        | Wazo Hill,<br>near Dar Es Salaam     | 600,000         |
| Do.   | Mbeya Cement Co.                                    | Mbeya, southwest<br>of Dar Es Salaam | 250,000         |
| Coal  | State Mining Corp.                                  | Songwe-Kiwira                        | 150,000         |
| Diamond<br>Thousand carats                        | Williamson Diamonds Co.                             | Mwadui                               | 350             |
| Gold<br>Kilograms (ore)                           | Place Dome (Kahama) Ltd                             | Bulyanhula                           | 34,200          |
| Petroleum, refinery products<br>42-gallon barrels | Tanzania and Italian Petroleum<br>Refining Co. Ltd. | Dar Es Salaam                        | 17,000.         |

1,629 kg. Small-scale gold mining takes place in Musoma east of Lake Victoria, at Lupa southeast of Lake Rukwa, and at Mpanda east of Lake Tangayika. Mining is done mainly by STAMICO, and production from these small mines contributed to most of 1990's total output. Feasibility studies conducted by Placer Dome Inc. outlined a resource of about 10 Mmt, with an average mill feed grade of 11.82 g/mt of gold. The mine is expected to produce about \$70 million annually at peak output, with Placer Dome as the operator. The Government will be able to acquire up to 51% of Placer Dome after 10 years. The Government, in cooperation with the Federal Republic of Germany Government funding, is conducting extensive exploration projects around the Siga and Mbale hills.

The Bank of Tanzania was successful in buying gold back from artisanal miners. The total amount of gold bought in 1990 was about 1.7 tons. Gold sales increased in 1990, earning the country about \$35 million.

**Nickel.**—Infill drilling tests performed at the Kabanga in 1990 confirm previous data that the deposits were commercially viable. The deposits have an approximate reserve of 40.5 Mmt grading 1.05% nickel, 0.11% cobalt, 0.21% copper, and 0.31 grams combined gold and platinum per ton. A Vancouver-based company, Sutton Resources, through an agreement with Romanex International, will acquire 55% interest in the Kabanga nickel deposits. The nickel mines will be operated by Kabanga Nickel Co., a wholly owned subsidiary of Romanex when the property is fully explored. Kabanga Nickel Co. will form a joint venture with Sutton Resources after Sutton earns its 55% interest in the property. Sutton signed a Memorandum of understanding with the Government for exclusive rights to the entire Kabanga deposit in 1990.

### Industrial Minerals

**Diamond.**—The Mwadui Mines were operated by Williamson Diamond Mines Co. near Shinyanga, about 200 km south of Mwanza. Existing reserves were in very deep locations, which may prove very expensive to mine. Because of the gradual decline in production, Williamson Diamond Mining Co. was negotiating with the Government for permission to conduct large-scale prospecting in the country and in turn be given exclusive rights to diamond production.

**Phosphate.**—Phosphate production at Minjingu was suspended in December 1990 owing to lack of adequate market development. Production for 1990 was about 25,066 tons by STAMICO in association with Kone Corp. of Finland at Minjingu, at the southern end of Lake Manyara. The deposit, which is 100 km southwest of the railway terminal at Arusha, has been worked as an open pit mine. Output from the mine is used in the fertilizer plant operated at the Port of Tanga by Tanzania Fertilizer Co. The plant was estimated to be running at 45% of installed capacity before the mine was closed. The product was not well received by farmers in Kenya, the only country known to have imported phosphate from Tanzania.

### Mineral Fuels

**Coal.**—The country's only coal mine is at Kiwira, northeast of the Kipengere range. It operated at about 30% of capacity. The Chinese-built mine was expected to produce 150,000 tons of raw coal for production of 93,000 tons of processed coal annually, of which 82,000 tons was to be sold locally. Production in 1990 was about 51,569 tons. The Government is seeking export markets for the coal. It is anticipated that output could eventually rise to 180,000 mt/a in 1995. Nine known coal-fields located mainly in the southern part of the Rift Valley were estimated to contain about 1.2 billion tons of coal.

**Petroleum and Natural Gas.**—The country totally depended on imported oil for its refinery at Dar Es Salaam. Imported oil cost the country almost 60% of its foreign exchange earnings.

Exploration for hydrocarbons has been undertaken on the mainland of Tanzania between Lake Tangayika and Lake Rukwa. Offshore concessions by several foreign firms include those of Shell Oil Co., Esso Oil Co., Agip Oil Co., and Elf Aquitaine of France. No significant oil deposits were found.

However, large deposits of natural gas were found at the Songo Songo Field about 300 km southeast of Dar Es Salaam in the Indian Ocean. Ocelot International Inc. of Canada signed an agreement with the Government to develop the Songo Songo Field. The agreement, which is to be implemented between 1992 and 1994, would include field production and setting up of treatment plants and pipelines to transport the gas to mainland Tanzania.

Ocelot Inc. will provide funds for the preproduction capital cost and facilities of the project.

### Reserves

Tanzania was estimated to have natural gas reserves of approximately 41 billion m<sup>3</sup>. All of the reserves are offshore, and all were in the Songo Songo Field. 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 51% Fe. Gold ore reserves at the Bulyanhulu deposits were put at about 10 Mmt. Diamond reserves were estimated to be about 3.8 million carats, assuming 35.1 Mmt of soil and/or sand were excavated to a depth of 100 m at the rate of 3.5 Mmt/a. Phosphate reserves were about 10 Mmt. There were no officially reported reserve figures for tin and other minerals.

## INFRASTRUCTURE

Tanzanian's infrastructure is semideveloped, consisting of 3,600 km of total railroad and 50,000 km of roads that also link neighboring countries. Dar Es Salaam is the ocean terminus of the railway to Kigoma and Lake Tangayika and to Nwanza 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 while the TRC handles freight for Burundi, Rwanda, Uganda, and eastern Zaire. The roads have deteriorated to the extent that they are having a negative effect on the economy. Major ocean ports are at Dar Es Salaam, Mtwara, Tanga, and Zanzibar. Mwanza on Lake Victoria and Kigoma on Lake Tangayika are inland ports.

Most mining projects and mineral deposits are in remote areas where the infrastructure is extremely poor, making development very expensive. Tanzania relies largely on hydroelectric power for its electricity. The Tanzania Electric Supply Co. on the mainland and the Zanzibar State Fuel and Power Corp. on the island are responsible for all public power generation and delivery.

## OUTLOOK

Nonfuel minerals such as diamond will remain the mainstays of the economy for the immediate future. Further development of gold resources should enhance the importance of that commodity to the country's economy. The development of the Songo Songo natural gas fields is expected to continue on schedule as funding will be provided by Ocelot International Inc. of Canada. Petroleum exploration, currently underway and funded by the World Bank, may lead to further success. The Government's economic

recovery program should continue to improve the country's industrial growth.

Road and railroad improvement projects being implemented or studied will help to alleviate transportation problems now barring the efficient distribution of commodities. Recent Government policy to install toll roads in the country will raise additional funds. This funding is for development of remote mineral deposits and for maintenance of existing infrastructure. This would contribute to a more steady growth in the industrial sector. Foreign assistance in the mining industry is encouraging and is expected to continue as new deposits are found.

<sup>1</sup>Where necessary, values have been converted from the Tanzanian shilling (Tsh) to U.S. dollars at Tsh200=US\$1.00 in 1990.

## OTHER SOURCES OF INFORMATION

Ministry Water, Energy and Minerals  
P.O. Box 2000  
Dar Es Salaam, Tanzania

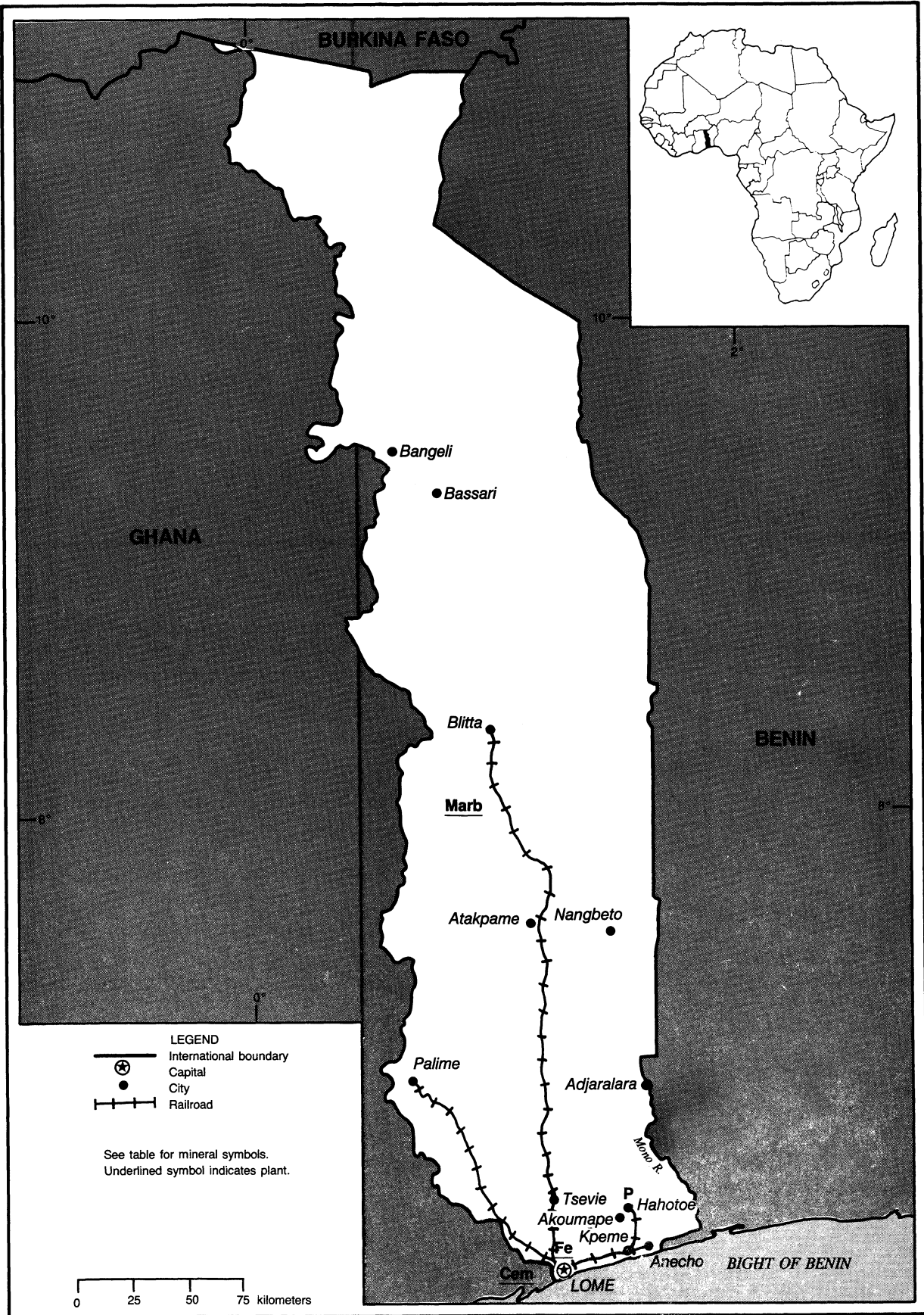
Ministry of Industries and Trade  
P.O. Box 9503  
Dar Es Salaam, Tanzania



# TOGO

AREA 57,000 km<sup>2</sup>

POPULATION 3.8 million



# THE MINERAL INDUSTRY OF TOGO

By Audie L. King

**T**he mining and production of mineral commodities continued to be Togo's most important industry. Phosphate rock production by the Government-owned phosphate company, Office Togolaise des Phosphates (OTP), continued to dominate the mining industry. Phosphate rock exports, however, fell sharply in 1990 owing to concerns over relatively high cadmium levels in the country's phosphate ore. Worries over the potentially negative environmental effects of cadmium caused phosphate exports to shift away from traditional markets in Western Europe and the United States. However, in recent years, Togo negotiated new foreign contracts for the delivery of its exceptionally high-grade phosphate rock. The Government of Togo expected record phosphate rock sales in 1991 owing to these contracts.

Although 1990 proved to be a difficult year for the mineral industry, output of Togo's other mineral commodities was mixed. The Government-owned cement factory continued its steady pattern of production growth. Meanwhile, the troubled marble industry continued to decline, suffering a 38% decline in production to 7,769 m<sup>2</sup>. The country's only marble producer reverted back to Togolese Government control in 1989 when it was unable to supply local demands. It had been owned and operated by a Norwegian company since it was privatized in 1986. Togo's only metal manufacturer, a U.S.-owned steel mill, reported that production increased by 35% in 1990 to 8,400 tons. The steel mill produces iron rods from imported semimanufactured metal.

Despite the lackluster performance of mining and mineral production, Togo's GDP grew by 2% in 1990. This growth rate was down from 3.6% in 1989 and 4.9% in 1988.

## GOVERNMENT POLICIES AND PROGRAMS

The International Development Association (IDA) approved a \$55 million credit for the country's fourth structural adjust-

ment program covering the period from 1990 to 1992. This portion of the ongoing project aimed to improve public-sector management by restructuring the Ministry of Planning and Mines, the Ministry of Economy and Finance, and the Ministry of Commerce and Transport. As one of its main goals, a legal framework was to be established within which public enterprises would be able to operate with greater autonomy. One of the first results of the new program came during a reshuffling of the cabinet on February 13, 1990, when Planning and Mines was split off from Trade and Transport to form a separate ministry.

Previous structural adjustment programs dealt primarily with privatization or simple liquidation of the state's loss making enterprises. Of 73 parastatal companies considered, 10 had been liquidated, 14 had been privatized, and 23 more were slated for privatization. The Government declared a continuing interest in the remaining 26 companies, including the national phosphate company. Since 1985, Togo had recouped about \$77 million, but it had made substantial losses on its original investment. Privatization stopped the outflow of Government funds but failed to create new jobs or attract new investment. The Government responded by offering further incentives to private investment. Export processing zones (EPZ), similar to those already operating successfully in 24 other countries, were set up in Togo beginning January 1, 1990. The EPZ granted custom-free imports and exports and tax exemptions for 10 years to companies that export at least 80% of their production. By the end of the EPZ's first year of operation, local business leaders were losing confidence in the Togolese business climate. Despite moderate success in attracting foreign investment, many felt that Lome's industrial free zones were losing out to similar zones in Cameroon, Egypt, and Morocco. By the end of 1990, Togo was moving toward multiparty democratic elections.

## PRODUCTION

The mineral industry accounted for an estimated 9% of the GDP in 1990 compared

with about 11.5% in 1989 and 10% in 1988. Mineral exports accounted for an estimated 38% of the nation's exports in 1990 compared with 46% in 1989 and 41% in 1988.

Declining world demand for Togo's phosphate ore was reflected in a downturn in production levels. Togo was experiencing the effects of losses of its traditional markets in Europe and North America owing to the relatively high levels of cadmium in its phosphate ore. Phosphate exports fell by 23.5% in 1990. Although OTP did not release official production figures, phosphate rock production probably fell accordingly because the domestic agricultural sector's consumption continued to account for only a small portion of the output. OTP was never able to reach its production capacity of 3.7 Mmt/a, even during 1988 and 1989 when world demand for its ore was high. OTP expects production to increase in coming years as it successfully negotiates new contracts. As a result of structural and financial difficulties, marble production fell sharply. The production of cement and iron rods from imported materials increased.

The mineral industry decreased in importance to Togo's economy in 1990. This was due mainly to a decrease in demand for Togo's phosphate ore, its most important mineral commodity.

## TRADE

Togo reinforced its open trade policies by enacting new laws in 1990 that simplified the tax and tariff structure and eliminated export taxes. Togo's port and other infrastructural improvements are among the best in west Africa, enhancing its status as a regional trading center. Most of the products approved for production under the new EPZ law will be aimed at the west African regional market. The country's products also enjoyed preferential entry into the United States under the Generalized System of Preferences and into the EC under the Lome Convention. Togo's trade balance worsened in 1990 when the value of exports decreased while imports increased.

Exports to the United States fell from \$5.8 million in 1988 to only \$2.8 million in 1989,



TABLE 1

TOGO: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

| Commodity <sup>2</sup>                        |                      | 1986    | 1987    | 1988                | 1989 <sup>p</sup>   | 1990 <sup>e</sup>    |
|---|----------------------|---------|---------|---------------------|---------------------|----------------------|
| Cement <sup>3</sup>                           | metric tons          | 348,000 | 369,579 | 377,838             | 389,070             | <sup>4</sup> 398,530 |
| Iron and steel, semimanufactures <sup>5</sup> | do.                  | 8,868   | 12,100  | 14,000              | 6,197               | 8,400                |
| Phosphate rock, beneficiated product:         |                      |         |         |                     |                     |                      |
| Gross weight                                  | thousand metric tons | 2,314   | 2,644   | 3,464               | <sup>3</sup> 3,355  | 2,570                |
| P <sub>2</sub> O <sub>5</sub> content         | do.                  | 840     | 960     | 1,257               | 1,270               | 973                  |
| Stone: marble, dimension                      | square meters        | 5,000   | 10,800  | <sup>e</sup> 11,000 | <sup>6</sup> 12,537 | <sup>4</sup> 7,769   |

<sup>e</sup>Estimated. <sup>p</sup>Preliminary. <sup>r</sup>Revised.

<sup>1</sup>Includes data available through Dec. 27, 1991.

<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>In 1984, production of domestic clinker ended. Since that time, all cement has been produced from imported clinker.

<sup>4</sup>Reported figure.

<sup>5</sup>Iron rod production from semifinished metal.

<sup>6</sup>Includes output of slabs, blocks, and crushed marble.

the latest year that such data were available, and consisted mainly of live animals and crafts. Imports from the United States, which consisted mainly of wheat, textiles, cigarettes, rice, and petroleum products, increased by more than 36% to \$27.9 million in 1989.

Cement produced in Togo was from imported clinker mainly from Angola, Spain, Norway, and Venezuela. Togo exported cement to Burkina Faso, Equatorial Guinea, Ghana, and Mali. In 1990, 344,000 tons of clinker was imported, and 398,000 tons of cement was produced. According to Ciments du Togo (Cimtogo), 125,355 tons was exported.

Phosphate rock remained Togo's principle foreign exchange earner. Togo was unable to maintain its market share of world exports in 1990. Although Togo had fewer phosphate buyers than in past years, the contracts were larger. Major importers of Togolese phosphates included Canada, France, India, Italy, the Philippines, and Spain. The United States imported 55,000 tons of phosphate ore in 1990.

## 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, the Societe Togolaise de Marbrerie et de Materiaux (Sotoma), had operations near the railway about 40 km

south of Blitta. Sotoma employed about 60 people. 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, near a large limestone deposit about 60 km northeast of the cement plant, shut down in 1984 when it was no longer able to compete with imported clinker. Cimtogo rapidly increased its production capacity since it first opened in 1971 from 120,000 mt/a to 500,000 mt/a based on strong domestic and regional demand.

## COMMODITY REVIEW

### Metals

The U.S.-owned steel company, Societe Togolaise de Siderurgie (STS), expanded

operations at its 12,000-mt/a rolling mill in Lome by inaugurating a 3,000-mt/a galvanized steel production plant, STS Metaux. The new plant, that began functioning in 1990, expanded the company into the area of metal fabrication, with an emphasis on telephone poles and high- and low-tension electrical towers. The plant employs 60 people. Output was contracted for sale both locally and for export.

STS applied for a site in the EPZ for a baling wire factory that would supply wire to the cotton industry throughout the region. The STS Metaux pylon plant was also seeking an EPZ status change. Future plans called for restarting the steel mill's arc furnace if STS is allowed to do so under the EPZ laws, which would provide the company with lower electricity rates.

### Industrial Minerals

**Marble.**—The state-run marble company, Sotoma, was partially privatized in

TABLE 2

## TOGO: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

(Thousand metric tons unless otherwise specified)

| Major commodity                  | Major operating companies                              | Location of main facilities   | Annual capacity    |
|----------------------------------|--|-------------------------------|--------------------|
| Cement                           | Ciments du Togo (Cimtogo)                              | Lome                          | <sup>e</sup> 500   |
| Iron                             | Societe Togolaise de Siderurgie (STS)                  | do.                           | <sup>e</sup> 20    |
| Marble<br>thousand square meters | Nouvella Societe Togolaise de Marbre (Nouvella Sotoma) | 40 kilometers south of Blitta | <sup>e</sup> 90    |
| Phosphate rock                   | Office Togolaise des Phosphates (OTP)                  | Near Hahotie and Akoumape     | <sup>e</sup> 3,800 |

<sup>e</sup>Estimated.

1986. The company's marble mining and production facilities were under the management of a Norwegian company for 3 years, but returned to state ownership in 1989. During 1990 Sotoma was able to generate some money through the sale of crushed stone, decorative bricks, and roofing materials. However, following a period of serious production and financial difficulties, Sotoma was forced to close in September 1991. The Government still hoped to find private investors to rent or buy its marble facilities.

**Phosphate.**—OTP experienced a serious decline in phosphate rock exports to its traditional Western European and North American markets because of concerns over the possible negative environmental impact of the relatively high cadmium content of its ores. The EC's share of Togolese phosphate exports, for example, has fallen from 90% in recent years to about 30% in 1989, the last year that these data were available. It was estimated that 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. Cadmium removal procedures were being investigated with grant money from the EC. For example, a pilot plant for removing cadmium from phosphoric acid by solvent extraction was being developed by the West German group Budenheim. A preferable method that was also under investigation would use a calcination process to volatilize cadmium from the ore before it leaves Togo. EC grants would also allow for improvements in OTP's ore drying process, with the aim of increasing productivity by as much as 26%.

OTP was working with the Bureau de Recherches Geologiques et Minieres (BRGM) of France on the development of a new mining area adjacent to the current workings. The planned development would allow for expansion in the mid-1990's if demand allowed for it, or would be available for phasing in production after the current mine is exhausted.

### Mineral Fuels

The state-owned petroleum complex a few miles from Lome was sold for \$20 million to Shell International in February 1990. The refinery was built in 1977 by the British company Humphery and Glasgow for \$52.9 million and operated for 4 years

before being shut down in 1981. The complex includes the dormant oil refinery and storage facility that Shell has leased and used as a depot since 1984. Shell will take a 60% share of the new company called Complex Petrolier de Lome (Compel), and the Government will retain a 40% share. There are currently no plans to restart the refinery because Shell believes that it would not be profitable. Shell has already invested \$10 million in improvements to the storage facilities and is said to be keeping the refinery in shape by running fluids through the pipes.

### Reserves

Industry sources estimate that Togo's total phosphate reserves were about 260 Mmt of commercial-grade ore. Togo was also reported to have had very large deposits of lower grade carbonate phosphates. The existing phosphate pit contained reserves for about 10 years at 1990 levels of mining of about 2.5 Mmt/a. 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 marble and 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. Relatively large deposits of iron ore, estimated to total 95 Mmt, occurred east of Bassari. The ore averaged more than 40% iron mainly as magnetite. These deposits were investigated periodically by the local Bureau National de Recherches Minieres 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, the highest point in the Atakora Mountains, near Palime, 100 km northwest of Lome. Manganese deposits were reported in the Bayega area in northern Togo.

### INFRASTRUCTURE

Togo had a good highway network that consisted of 1,762 km of paved roads. The network linked the capital, Lome, with neighboring Benin, Burkina Faso, and Ghana. Its port and airport facilities at Lome were among the most modern in the region. About 515 km of 1.0-m-gauge single-track railway connected Lome with the cities of

Anecho, Blitta, and Palime. 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.

The Nangbeto hydroelectric power station on the Mono River in southern Togo near the border with Benin will eventually produce 150 MW. Production of electricity started in September 1987 and was sufficient to meet 25% of the combined demand of Togo and Benin. A 15- to 20-MW hydroelectric plant was also proposed for Adjaralara, 75 km downstream on the Mono River.

Togo will remain largely dependent on electricity imported from Ghana's Akosombo hydroelectric plant. Most of the supply was purchased from Communaute Electrique du Benin, a company set up jointly by Benin and Togo in 1975.

In January 1991, France signed agreements that granted about \$13 million to the Togolese Electrical Power Co. to partially finance the rehabilitation of the country's electrical system and the extension of services.

### OUTLOOK

The Government remained optimistic that it would be able to maintain or increase its market share of world phosphate exports despite recent losses. If efforts to reduce cadmium levels in its phosphate ore fail, however, future contracts can be expected to be negotiated at lower prices. Togo's 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 liberal 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.

<sup>1</sup>Where necessary, values have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF272.26=US\$1.00.

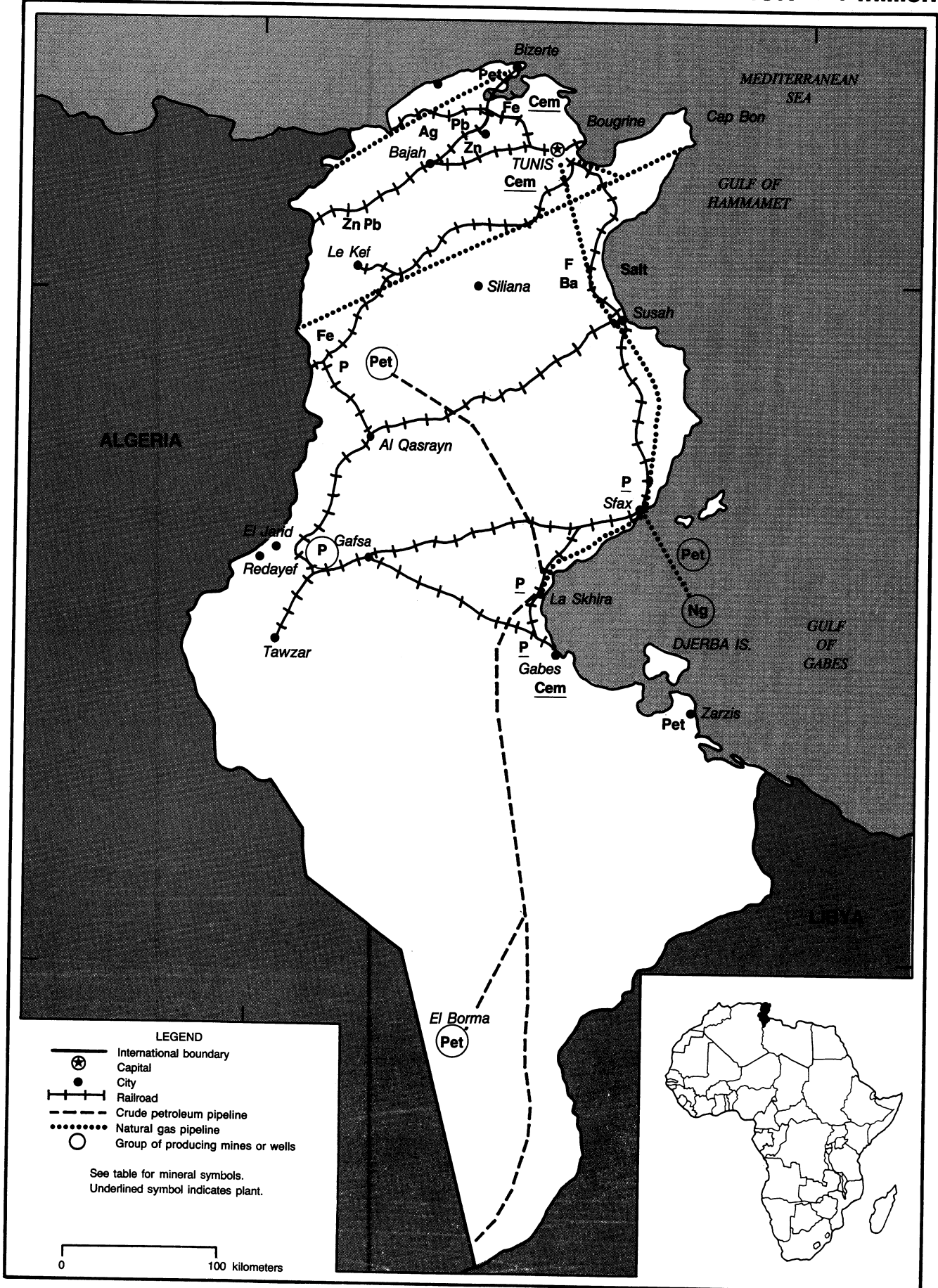
### OTHER SOURCES OF INFORMATION

Chambre de Commerce d'Agriculture et d'Industrie du Togo, Lome:  
Bulletin Mensuel, Monthly.

# TUNISIA

AREA 164,000 km<sup>2</sup>

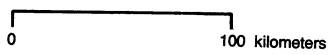
POPULATION 8.1 million



**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.



# THE MINERAL INDUSTRY OF TUNISIA

By Thomas P. Dolley

**T**he Gulf conflict and domestic political strife helped to generate mixed economic results in Tunisia for 1990. However, the mineral industry continued to play an important role in the Tunisian economy. Hydrocarbon production accounts for about 6% of total GDP. Phosphate rock and downstream chemical production accounts for about 4.5% of the GDP. The GDP for 1990 was estimated at \$12.5 billion.<sup>1</sup>

Production declined slightly throughout most of the mining sector, but the value of the mineral commodities produced, such as crude petroleum and phosphates, increased. Phosphate rock mining declined partially during the year owing to substantial flooding in early 1990 in these regions. Hydrocarbon production is the largest revenue earner in Tunisia, followed by textiles and phosphate rock.

Though diminutive in capacity when compared to its larger competitors, Tunisia has become the world's fifth largest producer of phosphate rock. Through careful business planning it has increased its downstream fertilizer production capacity.

## GOVERNMENT POLICIES AND PROGRAMS

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. Certain public-sector companies had been targeted by the Government for privatization; however, the mineral industry has not been initially affected to a great degree by this privatization.

Significant changes were made in 1990 to the laws governing hydrocarbon exploration and production in Tunisia. Adjudicated changes to the laws will allow the Government to further their policy of encouraging the discovery of new hydrocarbon sources, particularly marginal oilfields and natural gas, as current producing fields wind down. These changes were designed to provide flexibility in negotiations on petroleum exploration agreements between

foreign operators and the Government. There have been positive effects in the initial stages, exemplified by the increased investment and interest by some foreign petroleum exploration companies. Exploration agreements take three primary forms, the first being an exploration license that allows the operator to undertake geological investigations before making a full commitment; the second being an exploration permit allowing the operator the right to carry out seismic geophysical investigation with options for full prospection; and finally, a prospecting permit that allows the operator to carry out geological exploration and drilling for up to 5 years. The latter agreement nominally stipulates obligations by the operator and must be approved by law. If a hydrocarbon discovery is to be developed, a joint venture is signed with the Tunisian parastatal Enterprise Tunisienne d'Activities Petrolieres (ETAP). ETAP is obligated to cover its share of expenses if they choose to participate. Tax and royalty rates have been lowered under the new law, 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 that specified in the original statutes has been introduced. The Government has also streamlined the administrative procedures concomitant with the operator applying for an exploration permit.<sup>2</sup>

A pilot plant for minerals testing and evaluation was set up at Sidi Rezig under a Swedish aid program. Capitalized at \$2 million, the plant can perform flotation testing at a rate of 1 mt/h and preconcentration testing at a rate of 5 mt/h. The plant will be used as a training center for Tunisian mining specialists, primarily for testing and evaluation of barite, fluorite, iron, lead, phosphate, zinc, and other minerals exploited in Tunisia.

## PRODUCTION

Output of all industrial mineral commodities declined in 1990. The production

of the key mineral commodity of the nation, phosphate rock, decreased only slightly in 1990 following a minor resurgence in 1989. Additionally, crude petroleum's performance mirrored that of phosphate rock, with production declining slightly in 1990 after a minor rally in 1989. In the metals sector, zinc production declined, with lead and iron ore being the only mineral commodities that had enjoyed production increases.

The relative rise and fall of production within the mining sector of Tunisia is attributable in large part as a response to shifting global commodity prices. Prices and world production of some key industrial minerals dropped in 1990. Phosphate rock prices have remained stable for the past 3 years. Additionally, zinc prices suffered a large drop in 1990, and conversely, lead prices rose significantly.

## TRADE

The Government had planned to take advantage of the trading possibilities opened by the upcoming formation of a single European market. However, the goal of making Tunisia a major trade center in North Africa will have to await the settlement of the Gulf conflict. The EC took a greater share of Tunisian exports in 1990, amounting to 77% of the total, with the EC providing 70% of Tunisia's imports. Tunisian trade with other North African partners in the Arab Maghreb Union (UMA) remained insignificant and amounted to 8% of Tunisian exports and only 3% of Tunisian imports.

On April 27, 1990, Tunisia signed a Protocol of Accession to the GATT. Pending ratification by the Tunisian Legislative Assembly, the new agreement would set up free-trade zones, bind tariffs, and abolish import licenses.

Exemplifying a marketing strategy in the Tunisian phosphate rock sector, bulk phosphate rock exports are now insignificant when compared to phosphoric acid and finished fertilizer export markets. Increasingly, Tunisian phosphate rock is being used as feedstock to support a growing domestic

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

(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>                       | 1986             | 1987             | 1988             | 1989 <sup>p</sup>   | 1990 <sup>e</sup>   |
|--|------------------|------------------|------------------|---------------------|---------------------|
| <b>METALS</b>                                |                  |                  |                  |                     |                     |
| <b>Iron and steel:</b>                       |                  |                  |                  |                     |                     |
| Iron ore and concentrate, gross weight       |                  |                  |                  |                     |                     |
| thousand tons                                |                  |                  |                  |                     |                     |
| Metal:                                       | 311              | 295              | 325              | <sup>3</sup> 280    | <sup>3</sup> 291    |
| Pig iron                                     | <sup>3</sup> 149 | <sup>3</sup> 163 | <sup>3</sup> 128 | <sup>3</sup> 140    | 140                 |
| Steel, crude                                 | 186              | 196              | 150              | 194                 | <sup>3</sup> 200    |
| <b>Lead:</b>                                 |                  |                  |                  |                     |                     |
| Mine output, Pb content                      | 1,930            | 3,465            | 3,653            | <sup>3</sup> 2,702  | <sup>3</sup> 2,966  |
| Metal:                                       |                  |                  |                  |                     |                     |
| Primary <sup>4</sup>                         | 2,208            | 2,200            | 2,200            | 2,200               | 2,200               |
| Secondary <sup>e</sup>                       | 500              | 500              | 500              | 500                 | 500                 |
| Total <sup>e</sup>                           | 2,708            | 2,700            | 2,700            | 2,700               | 2,700               |
| Silver metal, primary                        | 1,555            | 1,555            | <sup>3</sup> 933 | <sup>3</sup> 933    | 930                 |
| Zinc, mine output, Zn content                | 4,488            | 4,500            | 8,500            | 8,500               | <sup>3</sup> 13,270 |
| <b>INDUSTRIAL METALS</b>                     |                  |                  |                  |                     |                     |
| Barite                                       | 15,718           | 14,412           | 18,868           | <sup>3</sup> 33,104 | <sup>3</sup> 30,885 |
| Cement, hydraulic                            | 2,984            | 3,400            | 3,228            | 3,228               | 3,300               |
| Clays, construction <sup>e</sup>             | 350              | 350              | 350              | 350                 | 350                 |
| Flourspar, chemical and metallurgical grades | 36,828           | 43,298           | 55,416           | <sup>3</sup> 53,575 | <sup>3</sup> 40,974 |
| Gypsum <sup>e</sup>                          | 100,000          | 100,000          | 100,000          | 100,000             | 100,000             |
| Lime   | 650              | 650              | 650              | 650                 | 650                 |
| Phosphate rock, gross weight                 | 5,951            | 6,390            | 6,103            | <sup>3</sup> 6,610  | <sup>3</sup> 6,258  |
| Salt, marine                                 | 415              | 425              | 485              | <sup>3</sup> 480    | <sup>3</sup> 402    |
| <b>MINERAL FUELS AND RELATED MATERIALS</b>   |                  |                  |                  |                     |                     |
| <b>Gas, natural:</b>                         |                  |                  |                  |                     |                     |
| Gross <sup>e</sup>                           | 436              | 391              | 368              | 388                 | <sup>3</sup> 374    |
| million cubic meters                         |                  |                  |                  |                     |                     |
| Marketed                                     | 218              | 195              | 184              | <sup>3</sup> 294    | 29                  |
| <b>Petroleum:</b>                            |                  |                  |                  |                     |                     |
| Crude  | 39,055           | 37,960           | 37,230           | <sup>3</sup> 37,595 | <sup>3</sup> 36,500 |
| thousand 42-gallon barrels                   |                  |                  |                  |                     |                     |
| <b>Refinery products:</b>                    |                  |                  |                  |                     |                     |
| Gasoline                                     | 1,825            | 1,800            | 1,800            | 1,800               | <sup>3</sup> 2,200  |
| do.  |                  |                  |                  |                     |                     |
| Kerosene                                     | 1,095            | 2,400            | 2,400            | 2,400               | 2,400               |
| do.  |                  |                  |                  |                     |                     |
| Distillate fuel oil                          | 3,650            | 3,000            | 3,000            | 3,000               | <sup>3</sup> 4,042  |
| do.  |                  |                  |                  |                     |                     |
| Other  | 730              | 400              | 400              | 400                 | 400                 |
| do.  |                  |                  |                  |                     |                     |
| Refinery fuel and losses                     | 1,095            | 200              | 200              | 200                 | <sup>3</sup> 111    |
| do.  |                  |                  |                  |                     |                     |
| Residual fuel oil                            | 4,380            | 4,000            | 4,000            | 4,000               | <sup>3</sup> 3,857  |
| do.  |                  |                  |                  |                     |                     |
| Total  | 12,775           | 11,800           | 11,800           | 11,800              | 13,010              |
| do.  |                  |                  |                  |                     |                     |

<sup>e</sup>Estimated. <sup>p</sup>Preliminary.

<sup>1</sup>Table includes data available through May 13, 1991.

<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 however, information is inadequate to make accurate estimates of output.

<sup>3</sup>Reported figure.

<sup>4</sup>From domestic and imported ores.

downstream production capacity. Triple superphosphate (TSP) exports from Tunisia now account for 27% of the global market; diammonium phosphate (DAP) exports account for approximately 6% of the global market, and phosphoric acid exports account for approximately 11% of the global market.

By the end of the decade of the 1980's, Tunisian phosphate rock exports accounted for 12% of the nation's total export earnings. Phosphate rock exports from Tunisia dropped dramatically in 1990, amounting to 592,400 tons, down about 50% from those of 1989. Tunisian exports of phosphoric acid and fertilizers to Western Europe have declined

in recent years owing to increased competition with Morocco and Tunisia's domestic demand for phosphoric acid. Tunisian phosphate rock exports to Western Europe declined from approximately 576 kmt in 1989 to about 407 kmt in 1990. In 1990, exports to Eastern European customers declined sharply due primarily to economic and political tur-

moil there. However, Tunisia has been increasingly active in opening new markets in China, Iran, and south and east Asia. Additionally, the usually common countertrade deals in the Tunisian phosphate industry have declined in 1990 due to higher global prices, and the product is increasingly being sold directly to international purchasers, often under extended credit terms. In the mineral fuels sector, Tunisia's crude petroleum ex-

ports fell to approximately 28 Mbbl in 1990.

France is Tunisia's largest trading partner, with receipts exceeding \$1.1 billion in 1989. In 1990, France accounted for 25% of Tunisia's exports and 28% of its imports. Italy accounted for 22% of Tunisian exports and 15% of Tunisian imports in 1990. Tunisian merchandise imports from the United States were valued at \$301.8 million in 1990, about 50% of which was agricultural

products. Conversely, only 1% of Tunisian exports was to the United States in 1990.

U.S.-made equipment for mining and construction continues to be a valued commodity in Tunisia. Additionally, U.S.-made environmental assessment and cleanup technology is needed in Tunisia. This is due to the increasing awareness of environmental pollution, particularly in the Gabes region where phosphate mining occurs.

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

(Metric tons unless otherwise specified)

| Commodity   | 1988             | 1989   | Destinations, 1989 |  |
|---|------------------|--------|--------------------|--|
|   |                  |        | United States      | Other (principal)  |
| <b>METALS</b>                                     |                  |        |                    |  |
| Alkali and alkaline-earth metals                  | —                | 1,016  | —                  | All to Libya.  |
| Aluminum: Metal including alloys:                 |                  |        |                    |  |
| Scrap   | 1,152            | 1,149  | —                  | Italy 485; West Germany 461; Spain 98.                   |
| Unwrought   | 502              | 513    | —                  | Italy 473; United Kingdom 40.                            |
| Semimanufactures                                  | 238              | 598    | —                  | Iraq 319; Morocco 100; Italy 71.                         |
| Copper:   |                  |        |                    |  |
| Matte and speiss including cement copper          | 1                | —      |                    |  |
| Metal including alloys:                           |                  |        |                    |  |
| Scrap   | 6,916            | 5,735  | —                  | Spain 1,717; West Germany 1,070; Netherlands 755.        |
| Unwrought   | —                | 1      | —                  | All to Libya.  |
| Semimanufactures                                  | 270              | 381    | —                  | Iraq 368, Libya 12.                                      |
| Iron and steel:                                   |                  |        |                    |  |
| Iron ore and concentrate including roasted pyrite | 4,429            | 5,693  | —                  | Netherlands 2,560; Italy 2,021; United Kingdom 1,112.    |
| Metal:  |                  |        |                    |  |
| Scrap   | 16,198           | 1,805  | —                  | Italy 1,200; France 482.                                 |
| Pig iron, cast iron, related materials            | 11               | —      |                    |  |
| Steel, primary forms                              | —                | 2,295  | —                  | All to Thailand.   |
| Semimanufactures:                                 |                  |        |                    |  |
| Bars, rods, angles, shapes, sections              | 5,970            | 8,629  | —                  | Libya 5,403; Côte d'Ivoire 836; Egypt 829.               |
| Universals, plates, sheets                        | 4,238            | 32,462 | —                  | Italy 22,140; U.S.S.R. 4,961; Egypt 1,189.               |
| Hoop and strip                                    | —                | 3      | —                  | All to Libya.  |
| Rails and accessories                             | 3                | —      |                    |  |
| Wire  | 319              | 1,457  | —                  | Algeria 655; Iraq 462; Morocco 250.                      |
| Tubes, pipes, fittings                            | 11,298           | 3,749  | —                  | Algeria 2,728.   |
| Castings and forgings, rough                      | 16               | 54     | —                  | Netherlands 24; Libya 14; unspecified 16.                |
| Lead:   |                  |        |                    |  |
| Ore and concentrate                               | 5,000            | 1,500  | —                  | All to Spain.  |
| Oxides  | —                | 8      | —                  | All to Libya.  |
| Metal including alloys:                           |                  |        |                    |  |
| Scrap   | 407              | 980    | —                  | Italy 876; Greece 101.                                   |
| Unwrought   | 240              | 1,055  | —                  | Egypt 850; Libya 120.                                    |
| Semimanufactures                                  | 171              | 4      | —                  | All to Libya.  |
| Nickel: Metal including alloys, semimanufactures  | value, thousands | \$1    | —                  | All to Iraq.   |
| Zinc:   |                  |        |                    |  |
| Ore and concentrate                               | 17,510           | 19,425 | —                  | Italy 9,350; Yugoslavia 7,625; Belgium-Luxembourg 2,450. |

See footnotes at end of table.

TABLE 2—Continued

TUNISIA:EXPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity   | 1988                              | 1989     | Destinations, 1989 |  |
|---|-----------------------------------|----------|--------------------|--|
|   |                                   |          | United States      | Other (principal)                                    |
| <b>METALS:—Continued</b>  |                                   |          |                    |  |
| <b>Zinc:—Continued</b>  |                                   |          |                    |  |
| <b>Metal including alloys:</b>                                      |                                   |          |                    |  |
| Scrap   | 66                                | 148      | —                  | Spain 102; France 46.                                |
| Unwrought   | 162                               | —        |                    |  |
| Semimanufactures  | 20                                | —        |                    |  |
| <b>Other:</b>   |                                   |          |                    |  |
| Ores and concentrates   | 7,406                             | 28,950   | —                  | Italy 19,950; Netherlands 6,200; West Germany 2,800. |
| Oxides and hydroxides   | —                                 | 60       | —                  | All to Algeria.                                      |
| <b>INDUSTRIAL MINERALS</b>  |                                   |          |                    |  |
| <b>Abrasives, n.e.s.: Grinding and polishing wheels and stones</b>  |                                   |          |                    |  |
|   | 41                                | 81       | —                  | Libya 50; Algeria 16.                                |
| Barite and witherite  | 3,851                             | 1,116    | —                  | All to Italy.  |
| Cement  | thousand tons 1,066               | 1,658    | —                  | Algeria 413; Spain 396; Cameroon 136.                |
| Chalk   | —                                 | 142      | —                  | All to Libya.  |
| Clays, crude  | 9                                 | 3        | —                  | Netherlands 2.                                       |
| <b>Diamond, natural: Gem, not set or strung</b>                     |                                   |          |                    |  |
|   | value, thousands \$7,561          | \$19,211 | —                  | All to Belgium-Luxembourg.                           |
| Feldspar, fluorspar, related materials                              | 15,000                            | 11,070   | —                  | All to Italy.  |
| <b>Fertilizer materials: Manufactured:</b>                          |                                   |          |                    |  |
| <b>Nitrogenous</b>  |                                   |          |                    |  |
|   | 87,927                            | 92,983   | —                  | France 52,368; United Kingdom 24,600; Spain 12,982.  |
| Phosphatic  | thousand tons 1,536               | 1,567    | —                  | Italy 320; France 209; Iran 155.                     |
| Gypsum and plaster  | 1,571                             | 2,654    | —                  | Côte d'Ivoire 1,600; Senegal 600; Libya 390.         |
| Lime  | 25                                | 50       | —                  | Greece 25; Libya 25.                                 |
| Phosphates, crude   | thousand tons 1,114               | 1,082    | —                  | Greece 185; France 155; Turkey 151.                  |
| <b>Precious and semiprecious stones other than diamond: Natural</b> |                                   |          |                    |  |
|   | value, thousands \$29             | —        |                    |  |
| Salt and brine  | 295,682                           | 483,450  | 53,501             | Italy 138,947; Iceland 60,895.                       |
| <b>Sodium compounds, n.e.s.: Sulfate manufactured</b>               |                                   |          |                    |  |
|   | —                                 | 604      | —                  | All to Libya.  |
| <b>Stone, sand and gravel:</b>                                      |                                   |          |                    |  |
| <b>Dimension stone:</b>   |                                   |          |                    |  |
| <b>Crude or partly worked</b>                                       |                                   |          |                    |  |
|   | 1,484                             | 2,222    | —                  | Libya 1,163; Italy 810.                              |
| <b>Worked</b>   |                                   |          |                    |  |
|   | 468                               | 792      | —                  | Libya 395; Spain 237.                                |
| <b>Gravel and crushed rock</b>                                      |                                   |          |                    |  |
|   | 354                               | 1,489    | —                  | Libya 1,439.   |
| <b>Quartz and quartzite</b>   |                                   |          |                    |  |
|   | 1                                 | —        |                    |  |
| <b>Sand other than metal-bearing</b>                                |                                   |          |                    |  |
|   | 11                                | 13       | —                  | West Germany 10; Italy 3.                            |
| Sulfur: Sulfuric acid   | 444                               | 1,519    | —                  | Libya 1,467.   |
| Talc, steatite, soapstone, pyrophyllite                             | 1                                 | —        |                    |  |
| <b>Other:</b>   |                                   |          |                    |  |
| <b>Crude</b>  |                                   |          |                    |  |
|   | (?)                               | 11       | —                  | Libya 9.   |
| <b>Slag and dross, not metal-bearing</b>                            |                                   |          |                    |  |
|   | 3,936                             | 1,542    | —                  | All to Italy.  |
| <b>MINERAL FUELS AND RELATED MATERIALS</b>                          |                                   |          |                    |  |
| <b>Carbon black</b>   |                                   |          |                    |  |
|   | —                                 | 1        | —                  | All to Libya.  |
| <b>Petroleum:</b>   |                                   |          |                    |  |
| <b>Crude</b>  |                                   |          |                    |  |
|   | thousand 42-gallon barrels 22,433 | 32,778   | 2,862              | Italy 14,724; France 7,110; Greece 4,833.            |

See footnotes at end of table.

TABLE 2—Continued

**TUNISIA: EXPORTS OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

| Commodity   | 1988             | 1989             | Destinations, 1989 |   |
|---|------------------|------------------|--------------------|---|
|   |                  |                  | United States      | Other (principal)                               |
| <b>MINERAL FUEL AND RELATED MATERIALS—Continued</b>   |                  |                  |                    |   |
| <b>Petroleum:—Continued</b>                           |                  |                  |                    |   |
| <b>Refinery products:</b>                             |                  |                  |                    |   |
| Liquefied petroleum gas<br>thousand 42-gallon barrels | 379              | 466              | —                  | Italy 462.                                      |
| Gasoline do.  | 603              | 843              | —                  | Netherlands 248; Portugal 187; Spain 187.       |
| Kerosene and jet fuel do.                             | 705              | 10               | —                  | All to United Kingdom.                          |
| Distillate fuel oil do.                               | 18               | 20               | —                  | Italy 4; France 2; bunkers 7.                   |
| Lubricants do.  | ( <sup>3</sup> ) | 1                | ( <sup>3</sup> )   | Mainly to Libya.                                |
| Residual fuel oil do.                                 | 2,295            | 2,438            | ( <sup>3</sup> )   | United Kingdom 591; Italy 577; Netherlands 451. |
| Bituminous mixtures do.                               | —                | ( <sup>3</sup> ) | —                  | Mainly to Libya.                                |

<sup>1</sup>Table prepared by Virginia A. Woodson.<sup>2</sup>Unreported quantity valued at \$15,000.<sup>3</sup>Less than 1/2 unit.

TABLE 3

**TUNISIA: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

| Commodity   | 1988             | 1989   | Sources, 1989    |  |
|---|------------------|--------|------------------|--|
|   |                  |        | United States    | Other (principal)                                    |
| <b>METALS</b>                                     |                  |        |                  |  |
| Alkali and alkaline-earth metals                  | ( <sup>2</sup> ) | 102    | —                | Algeria 100.   |
| <b>Aluminum:</b>                                  |                  |        |                  |  |
| Ore and concentrate                               | 26,308           | 35,171 | —                | Italy 15,388; France 5,847; Brazil 4,848.            |
| Oxides and hydroxides                             | 42               | 4,440  | —                | France 4,436.  |
| <b>Metal including alloys:</b>                    |                  |        |                  |  |
| Scrap   | 150              | 34     | —                | All from Libya.                                      |
| Unwrought   | 1,296            | 2,190  | —                | Egypt 1,097; Canada 996.                             |
| Semimanufactures                                  | 3,177            | 4,363  | 1                | Italy 1,548; Egypt 887; France 562.                  |
| <b>Chromium:</b>                                  |                  |        |                  |  |
| Ore and concentrate                               | 7                | 23     | —                | Netherlands 20; Italy 3.                             |
| Oxides and hydroxides                             | 40               | 39     | —                | West Germany 17; France 11.                          |
| Cobalt: Oxides and hydroxides value, thousands    | \$10             | \$1    | —                | All from France.                                     |
| <b>Copper:</b>                                    |                  |        |                  |  |
| Matte and speiss including cement copper          | 164              | 169    | —                | Italy 100; France 60.                                |
| <b>Metal including alloys:</b>                    |                  |        |                  |  |
| Scrap   | 130              | 35     | —                | Mainly from Libya.                                   |
| Unwrought   | 508              | 486    | —                | Italy 379; Poland 81.                                |
| Semimanufactures                                  | 8,264            | 8,672  | 3                | France 4,659; Belgium-Luxembourg 1,407; Italy 1,004. |
| <b>Iron and steel:</b>                            |                  |        |                  |  |
| Iron ore and concentrate including roasted pyrite | 46,511           | 88,202 | —                | Morocco 46,785; Spain 41,408.                        |
| <b>Metal:</b>                                     |                  |        |                  |  |
| Scrap   | 598              | 3,022  | 500              | Algeria 1,753; France 679.                           |
| Pig iron, cast iron, related materials            | 4,684            | 4,761  | ( <sup>2</sup> ) | West Germany 3,034; France 1,440.                    |

See footnotes at end of table.



TABLE 3—Continued

TUNISIA: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity  | 1988             | 1989    | Sources, 1989 |   |
|--|------------------|---------|---------------|---|
|  |                  |         | United States | Other (principal)                                 |
| <b>METALS—Continued</b>  |                  |         |               |   |
| <b>Iron and steel:—Continued</b>   |                  |         |               |   |
| <b>Metals:—Continued</b>   |                  |         |               |   |
| <b>Ferroalloys:</b>  |                  |         |               |   |
| Ferromanganese   | 627              | 44      | —             | Brazil 20; France 15; West Germany 9.             |
| Ferrosilicon   | 741              | 1,127   | —             | Egypt 1,030; Yugoslavia 50.                       |
| Unspecified  | 351              | 658     | —             | Belgium-Luxembourg 400; U.S.S.R. 121; China 52.   |
| Steel, primary forms   | 79,215           | 28,153  | —             | Spain 28,093.                                     |
| <b>Semimanufactures:</b>   |                  |         |               |   |
| Bars, rods, angles, shapes, sections   | 143,672          | 156,130 | —             | Turkey 48,280; Spain 47,643; East Germany 12,326. |
| Universals, plates, sheets   | 131,095          | 133,789 | 1             | Italy 55,349; France 13,712; West Germany 12,956. |
| Hoop and strip   | 3,789            | 5,374   | —             | France 1,166; Italy 1,115; Algeria 1,081.         |
| Rails and accessories  | 6,129            | 12,986  | —             | France 11,367; Austria 1,507.                     |
| Wire   | 3,040            | 2,804   | 8             | France 1,351; West Germany 466; Italy 450.        |
| Tubes, pipes, fittings   | 13,764           | 14,459  | 579           | Algeria 2,709; Italy 2,538; France 2,532.         |
| Castings and forgings, rough   | 104              | 28      | —             | Italy 17; France 10.                              |
| <b>Lead:</b>   |                  |         |               |   |
| Oxides   | 153              | 161     | —             | Spain 68; France 49; West Germany 33.             |
| <b>Metal including alloys:</b>   |                  |         |               |   |
| Scrap  | 1                | 1       | —             | All from Libya.                                   |
| Unwrought  | 3,714            | 4,078   | —             | Morocco 3,101; Greece 781.                        |
| Semimanufactures   | 3                | 6       | —             | France 4; Switzerland 2.                          |
| Magnesium: Metal including alloys, unwrought   | 6                | —       | —             |   |
| <b>Manganese:</b>  |                  |         |               |   |
| Ore and concentrate: Metallurgical grade   | 260              | 182     | —             | Gabon 160; Brazil 21.                             |
| Oxides   | 129              | 106     | —             | Belgium-Luxembourg 33; France 31; Greece 24.      |
| Mercury  | 10               | 12      | —             | Algeria 11; France 1.                             |
| <b>Nickel:</b>   |                  |         |               |   |
| Matte and speiss value thousands   | \$7              | —       | —             |   |
| Metal including alloys: Semimanufactures   | 76               | 43      | —             | France 25; Norway 6; Italy 4.                     |
| <b>Platinum-group metals: Metals including alloys, unwrought and partly wrought value, thousands</b> |                  |         |               |   |
|  | \$20             | \$9     | —             | France \$7; West Germany \$2.                     |
| Silver: Metal including alloys, unwrought and partly wrought do.                                     | \$373            | \$576   | —             | Morocco \$417; France \$94.                       |
| <b>Tin: Metal including alloys:</b>  |                  |         |               |   |
| Scrap  | 1                | —       | —             |   |
| Unwrought  | 30               | 47      | —             | Malaysia 15; West Germany 11; Indonesia 10.       |
| Semimanufactures   | 28               | 31      | —             | France 17; West Germany 13.                       |
| Titanium: Oxides   | 197              | 172     | 17            | Poland 45; France 43; Belgium-Luxembourg 30.      |
| Uranium and thorium: Metal including alloys, all forms value thousands                               | \$115            | \$82    | —             | China \$77; Italy \$3.                            |
| <b>Zinc:</b>   |                  |         |               |   |
| Oxides   | 281              | 428     | —             | France 279; West Germany 84; Spain 41.            |
| <b>Metal including alloys:</b>   |                  |         |               |   |
| Scrap  | ( <sup>2</sup> ) | 16      | —             | All from France.                                  |
| Unwrought  | 2,348            | 4,112   | —             | Belgium-Luxembourg 1,761; Algeria 1,271.          |
| Semimanufactures including dust  | 279              | 308     | —             | Italy 120; Algeria 99; West Germany 33.           |

See footnotes at end of table.

TABLE 3—Continued

TUNISIA: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity  | 1988             | 1989     | Sources, 1989    |  |                               |
|--|------------------|----------|------------------|--|-------------------------------|
|  |                  |          | United States    | Other (principal)  |                               |
| <b>METALS—Continued</b>  |                  |          |                  |  |                               |
| <b>Other:</b>  |                  |          |                  |  |                               |
| Ores and concentrates  | 21               | 36       | —                | Italy 31; Spain 5.                                       |                               |
| Oxides and hydroxides  | 149              | 132      | 63               | West Germany 36; France 13.                              |                               |
| <b>INDUSTRIAL MINERALS</b>   |                  |          |                  |  |                               |
| <b>Abrasives, n.e.s.:</b>  |                  |          |                  |  |                               |
| Natural: Corundum, emery, pumice, etc.                                 | 5,019            | 7,239    | —                | Turkey 4,183; Italy 2,162; France 793.                   |                               |
| Artificial: Corundum   | 266              | 317      | —                | France 193; Italy 122.                                   |                               |
| Dust and powder of precious and semi-precious stones including diamond |                  |          |                  |  |                               |
| value, thousands   | \$38             | \$43     | —                | Belgium-Luxembourg \$34; West Germany \$4.               |                               |
| Grinding and polishing wheels and stones                               | 463              | 326      | ( <sup>3</sup> ) | Italy 179; France 37; Spain 29.                          |                               |
| Asbestos, crude  | 5,825            | 6,181    | —                | Canada 3,069; Greece 2,227; Zimbabwe 600.                |                               |
| Barite and witherite   | 147              | —        |                  |  |                               |
| <b>Boron materials:</b>  |                  |          |                  |  |                               |
| Crude natural borates  | 4                | 1        | —                | All from France.   |                               |
| Oxides and acids   | 45               | 64       | —                | Italy 54; France 7.                                      |                               |
| Bromine <sup>4</sup>   | 112              | 8        | —                | West Germany 7; Switzerland 1.                           |                               |
| Cement   | 5,661            | 2,348    | —                | Italy 2,113; France 177.                                 |                               |
| Chalk  | 2,710            | 3,336    | —                | Italy 2,242; France 973.                                 |                               |
| Clays, crude   | 37,731           | 39,730   | —                | Turkey 17,220; France 6,731; United Kingdom 5,634.       |                               |
| Cryolite and chiolite  | 2                | 2        | —                | All from France.   |                               |
| <b>Diamond, natural: Gem, not set or strung</b>                        |                  |          |                  |  |                               |
| value, thousands   | \$15,102         | \$19,910 | —                | Belgium-Luxembourg \$14,135; Tanzania \$4,775.           |                               |
| Diatomite and other infusorial earth                                   | 795              | 763      | —                | Algeria 467; France 249.                                 |                               |
| Feldspar, fluorspar, related materials                                 | 4,839            | 3,855    | —                | China 1,805; Turkey 1,091; Italy 810.                    |                               |
| <b>Fertilizer materials:</b>   |                  |          |                  |  |                               |
| <b>Crude, n.e.s.</b>   |                  |          |                  |  |                               |
|  | —                | 41       | —                | All from France.   |                               |
| <b>Manufactured:</b>   |                  |          |                  |  |                               |
| Ammonia  | 232,126          | 276,711  | —                | U.S.S.R. 186,592; Saudi Arabia 33,892; Mexico 15,055.    |                               |
| Nitrogenous  | 42,299           | 16,988   | —                | Bulgaria 9,008; Poland 4,875; France 2,485.              |                               |
| Phosphatic   | ( <sup>5</sup> ) | 2        | 2                |  |                               |
| Potassic   | 45,500           | 11,132   | —                | Italy 5,125; Belgium-Luxembourg 3,000<br>U.S.S.R. 2,999. |                               |
| Unspecified and mixed  | 64               | 28       | 5                | West Germany 17; France 5.                               |                               |
| Graphite, natural  | 19               | 6        | —                | West Germany 5; France 1.                                |                               |
| Gypsum and plaster   | 299              | 150      | —                | All From France.   |                               |
| Lime   | 19               | —        |                  |  |                               |
| Magnesium compounds, unspecified                                       | 958              | 812      | —                | Greece 433; Netherlands 180; Italy 104.                  |                               |
| <b>Mica:</b>   |                  |          |                  |  |                               |
| Crude including splittings and waste                                   | 9                | 10       | —                | Norway 6; France 4.                                      |                               |
| Worked including agglomerated splittings                               | ( <sup>5</sup> ) | 3        | —                | Mainly from France.                                      |                               |
| Phosphates, crude  | value, thousands | \$1      | \$4              | —  | West Germany \$3; France \$1. |
| Pigments, mineral: Iron oxides and hydroxides, processed               | 258              | 415      | —                | West Germany 305; Italy 43; Spain 37.                    |                               |
| <b>Precious and semiprecious stones other than diamond:</b>            |                  |          |                  |  |                               |
| Natural  | value, thousands | \$14     | \$1              | —  | All from Spain.               |

See footnotes at end of table.

TABLE 3—Continued

**TUNISIA: IMPORTS OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

| Commodity  | 1988             | 1989             | Sources, 1989    |   |
|--|------------------|------------------|------------------|---|
|  |                  |                  | United States    | Other (principal)                           |
| Precious and semiprecious stones other than diamond:—Continued |                  |                  |                  |   |
| Synthetic value thousands                                      | \$59             | \$148            | \$16             | Turkey \$102; France \$30.                  |
| Pyrite, unroasted  | 30               | 32               | —                | Italy 29; France 3.                         |
| Salt and brine   | 73               | 241              | 9                | West Germany 185; United Kingdom 40.        |
| Sodium compounds, n.e.s.:                                      |                  |                  |                  |   |
| Soda ash, manufactured   | 10,747           | 25,055           | —                | Bulgaria 19,638; Spain 2,834.               |
| Sulfate, manufactured  | 51,798           | 10,237           | —                | Turkey 4,665; Spain 3,413; Italy 1,570.     |
| Stone, sand and gravel:  |                  |                  |                  |   |
| Dimension stone:   |                  |                  |                  |   |
| Crude and partly worked  | 16,120           | 26,589           | —                | Italy 29; France 3.                         |
| Worked   | ( <sup>6</sup> ) | 113              | —                | West Germany 185; United Kingdom 40.        |
| Dolomite, chiefly refractory grade                             | 254              | 154              | —                | Italy 104; France 50.                       |
| Gravel and crushed rock  | 16,746           | 45,861           | —                | Italy 39,168; Greece 6,568.                 |
| Quartz and quartzite   | 1,018            | 868              | —                | Belgium-Luxembourg 601; Italy 179.          |
| Sand other than metal-bearing                                  | 586              | 123              | ( <sup>3</sup> ) | France 85; Italy 20; Turkey 15.             |
| Sulfur:  |                  |                  |                  |   |
| Elemental:   |                  |                  |                  |   |
| Crude including native and byproduct thousand tons             | 1,305            | 1,234            | 41               | Canada 216; Poland 216; Iran 209.           |
| Colloidal, precipitated, sublimed                              | 106              | 130              | —                | All from West Germany.                      |
| Sulfuric acid  | 6,543            | 776              | —                | Libya 757.                                  |
| Talc, steatite, soapstone, pyrophyllite                        | 1,222            | 1,262            | —                | France 574; Jordan 300; Spain 158.          |
| Other:   |                  |                  |                  |   |
| Crude  | 16               | 172              | —                | France 171.                                 |
| Slag and dross, not metal-bearing                              | —                | 1                | —                | All from Switzerland.                       |
| <b>MINERAL FUELS AND RELATED MATERIALS</b>                     |                  |                  |                  |   |
| Asphalt and bitumen, natural                                   | 10               | 122              | —                | Italy 106; China 9.                         |
| Carbon black   | 2,449            | 3,560            | —                | Italy 2,146; Spain 510; France 489.         |
| Coal: Anthracite and bituminous                                | 28,505           | 11,588           | 2,967            | France 4,780; Netherlands 2,199.            |
| Coke and semicoke  | 96,459           | 110,935          | —                | Egypt 50,101; Italy 27,877; Algeria 25,327. |
| Peat including briquets and litter                             | 24               | 30               | —                | All from France.                            |
| Petroleum:   |                  |                  |                  |   |
| Crude thousand 42-gallon barrels                               | —                | 4,073            | —                | Iraq 3,406; Syria 667.                      |
| Refinery products:   |                  |                  |                  |   |
| Liquefied petroleum gas do.                                    | 12,455           | 16,908           | ( <sup>3</sup> ) | Algeria 14,194; France 1,246.               |
| Gasoline do.   | ( <sup>3</sup> ) | ( <sup>3</sup> ) | —                | Mainly from Belgium-Luxembourg.             |
| Mineral jelly and wax do.                                      | 9                | 8                | ( <sup>3</sup> ) | West Germany 4; France 3.                   |
| Kerosene and jet fuel do.                                      | 1,272            | 1,649            | —                | Italy 987; Greece 486.                      |
| Distillate fuel oil do.  | 3,232            | 4,118            | —                | Italy 2,047; Greece 1,030; U.S.S.R. 655.    |
| Lubricants do.   | 58               | 205              | ( <sup>3</sup> ) | Greece 144; Algeria 43.                     |
| Residual fuel oil do.  | 6,381            | 4,703            | ( <sup>3</sup> ) | Italy 163; Spain 86; Greece 49.             |
| Bitumen and other residues do.                                 | 259              | 326              | —                | Italy 2,976; Romania 669; Spain 513.        |
| Bituminous mixtures do.  | 3                | 3                | —                | France 2; Spain 1.                          |
| Petroleum coke do.   | ( <sup>3</sup> ) | ( <sup>3</sup> ) | —                | All from United Kingdom.                    |

<sup>1</sup>Revised.<sup>2</sup>Table prepared by Virginia A. Woodson.<sup>3</sup>Unreported quantity valued at \$5,000.<sup>4</sup>Less than 1/2 unit.<sup>5</sup>May include iodine and fluorine.<sup>6</sup>Unreported quantity valued at \$10,000.<sup>7</sup>Unreported quantity valued at \$14,000.

## 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. 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. By yearend 1991, it is expected that SIAPE and SAEPA will merge to form one integrated company. 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 as a 45% to 50% equity partner.

## COMMODITY REVIEW

### Metals

Though a marginal producer in worldwide lead-zinc production, higher global zinc prices of \$1,700 per ton have stimulated increased interest in Tunisia's base metal resources. A program of mineral exploration and the reexamination of closed mines were priorities during the year.

Metallgesellschaft AG of the Federal Republic of Germany was awarded partnership by the reorganized Tunisian parastatal Office National des Mines to jointly develop an underground lead-zinc mine at Bougrine in northwestern Tunisia. An 8- to 12-month feasibility study was being undertaken. Metallgesellschaft maintained a 50% equity partnership in the project, with the remainder held by Office National des Mines in conjunction with financing by the Tunisian Bank for Economic Development and the Tunisian-Kuwaiti Bank for Development. Bougrine had estimated reserves of 6 Mmt of ore grading 12% zinc and 3% lead. The initial project investment was estimated at \$40 million, with a production startup slated for 1993 at 80,000 to 100,000 mt/a of zinc concentrate and 10,000 mt/a of lead concentrate. Additionally, discussions on reopening the Megrine smelter continued in 1990.

Plans were unveiled during the year for a joint venture between Tunisia and Bulgaria to develop a lead-zinc deposit at Lahdoun in northwestern Tunisia. Purportedly capitalized at \$13.2 million, the project is expected to eventually yield 120,000 mt/a of lead and zinc ore.

### Industrial Minerals

Following the construction of the first fertilizer plant in North Africa in 1952, Tunisia has become a major player in the global phosphate fertilizer market. CPG registered its first profit in a decade in 1989 of approximately \$10.5 million.

Despite a slight decline in output, investment and restructuring continued unabated in the sector.

In early 1990, heavy flooding hit the southern region of Tunisia where the primary phosphate mining region is located, and production was truncated. CPG mined phosphate rock from eight operations, with seven of these in the Gafsa/Sehib area. One of CPG's major downstream products, phosphoric acid, is a vital component in the production of fertilizers. Tunisian production capacity for phosphoric acid rose to more than 1 Mmt in 1990 and was produced at five different plants, the most important being located at La Skhira. This plant is capable of producing 330 kmt/a of phosphoric acid and superphosphoric acid at a capacity of 165 kmt/a. Globally, Tunisia is one of the few nations that can produce superphosphoric acid. Tunisian downstream fertilizer production is predominantly centered on diammonium phosphate (DAP) and triple superphosphate (TSP). Production capacities are 439 kmt/a P<sub>2</sub>O<sub>5</sub> of TSP at Gafsa and Sfax and 370 kmt/a P<sub>2</sub>O<sub>5</sub> of DAP at Gabes. An additional production capacity of 185 kmt/a of DAP is slated to come on-line in 1993.

Tunisian phosphate rock beneficiation is predominantly through dry separation at six sites; however, washing of the rock is becoming increasingly common. The new open pit phosphate rock mine at Kef Eddour is approximately 10 km northwest of Metlaoui and 40 km west of Gafsa. The phosphate deposits of Kef Eschfaier lie to the east of Kef Eddour and the Naguiss deposit to the west of Kef Eddour. In mid-

TABLE 4

### TUNISIA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

(Thousand metric tons unless otherwise specified)

| Major commodity                  | Major operating companies  | Location of main facilities  | Annual capacity                              |
|----------------------------------|--|--|--|
| Barite, fluorite                 | Société Tunisienne d'Expansion Miniere                                   | Zirba Mine   | 3 barite, 40 fluorite.                       |
| Cement                           | do.  | Bizerte, Gabes, Tunis  | 2,500.                                       |
| Iron                             | do.  | Djebel Djerissa iron mine, El Fouladh steel mill                   | 145<br>180.                                  |
| Lead, zinc                       | do.  | Fedj Hassen Mine, Bou Jaber, 3 Pb, Zn, concentrate Megrine smelter | 4 Pb, Zn, concentrate.<br>30 Pb concentrate. |
| Petroleum, crude million barrels | Elf Aquitaine, Entreprise Tunisienne d'Activités Pétrolières (ETAP)      | Ashart offshore oilfield   | 9.1.   |
| Do.                              | Agip-Tunisia, Société Italo-Tunisienne d'Exploitation Pétrolière (SITEP) | El Borma Oilfield  | 26.  |

1990, CPG awarded a contract to Neyrtec of France for the construction of two washery lines at the Kef Eddour site to aid in the beneficiation of the phosphate rock. Each line will be capable of processing 2.6 Mmt/a of bulk phosphate rock. A Roloflux rotary scrubber washes the crushed and screened phosphate rock to disperse clay and break up large blocks. Oversize material would then be screened and drained prior to disposal. Undersize material would be cycloned with the greater than 80-micron-size fraction being further treated to remove additional clay. Marketable product would be in the 50-micron to 70-micron-size range, and dewatering would take place on a belt filter. The flowsheet of the plant at Kef Eddour featured continuous control of cutting size and water circulation and overflow.

### Mineral Fuels

Recent hydrocarbon discoveries helped to slow Tunisia's slide toward import fuel dependence in 1990. Renewed interest in exploration in Tunisia highlighted the year due in part to the Government's more favorable terms toward foreign operators. Many international oil companies have shifted activities to Tunisia, including Amoco Oil Co., Conoco Oil Co., and Walter International of the United States and British Gas of the United Kingdom. The Government hopes that new discoveries will offset declining reserves at producing hydrocarbon fields. Increased global demand for natural gas during the year has also helped to support exploration in that arena.

In November 1990, the Ezzaouia Field, once considered marginally economic and located near the tourist island of Djerba, came on-stream. Discovered by Marathon Oil of the United States in 1986, the field is expected to produce an estimated 3.5 Mbb/a.

Near the Tunisian-Algerian border, production of natural gas decreased to 304 Mm<sup>3</sup> at the El Borma Field in 1990. Conversely, at the smaller Cap Bon Field, natural gas production doubled to 2.6 Mm<sup>3</sup> during the year. Historically, the bulk of Tunisian natural gas production comes from the El Borma Field, which is the largest discovery to date and the leading oilfield in Tunisia. Tunisia's first commercial oil production occurred at El Borma in 1964, and the field currently produces 55,000 bbl/d. Production from this field is declining by about 5% per year despite the use of secondary recovery methods.

Italy's Azienda Generali Italiana Petroli S.p.A. (AGIP) has reevaluated its 1988 discovery of the offshore Maamoura oilfield in the Gulf of Hammamet. This reservoir is in the massive Abiod chalk of Late Cretaceous age with low porosity and permeability. However, for the first time in Tunisia the increasingly utilized technique of horizontal drilling is being evaluated on the Abiod chalk. The Abiod formation is continuous over much of northern and eastern Tunisia, including offshore, and is predominantly subsurface with a few outcrops within the territorial boundaries of the country. The formation is present in many wells and is a major target for both oil and natural gas by many operators.

Elf Aquitaine Tunisie, a subsidiary of France's Elf Aquitaine, produced approximately 4.23 Mbb of crude petroleum in 1990. Because the figure represented a decline in production from last year, Elf signed for three exploratory concessions in 1990 and is considering the initiation of production after drilling on its offshore Ashtart permit.

### 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. Petroleum and natural gas, Tunisia's other major mineral commodities, required further evaluation to determine reserve potential.

### INFRASTRUCTURE

Railways were the primary mode of transportation of phosphate rock to chemical plants or seaports. Iraq's invasion of Kuwait and the subsequent economic fallout have slowed plans to develop a free port at Zarzis, which included the construction of a factory to recycle waste aluminum and an oil port capable of accommodating tankers of 25,000 dwt. Production of electricity in Tunisia increased to 4,897 GW hours in 1990.

The Sejnane Dam near Bizerte is to be completed under a \$35 million contract by Yugoslavia's Hidrotehnika and is 40% supported by Yugoslavian financing. The company has already worked on five other

dams around the country. Construction of the earthwork dam was abandoned by the original contractor, Italy's Vianini, in 1989, after demands for a revision of payments by the contractor. Complications stemmed from geological difficulties coupled with problems involving mortar and structural joints. The Government rejected Vianini and approached Hidrotehnika to complete the project. The Yugoslav company began work in March 1990 and is expected to complete the project in 1992. The dam is 850 m long and 58 m high.

### OUTLOOK

The Government hopes to attract more foreign investment in the petroleum exploration and production arena. Some success has been achieved, forestalling the notion that dwindling energy sources may leave Tunisia in a position of being a net energy importer by 1992. New hydrocarbon discoveries could be a welcome change to this economic situation.

Significant changes in Tunisia's trade position may occur with the integration of the EC into a single market in 1992. Further economic overhaul, which included limiting state spending and Government subsidies, was expected. A substantial rise in food imports due to lingering drought conditions and increased public-sector spending, coupled with continued political unrest, could tip economic scales unfavorably.

<sup>1</sup>Where necessary, values have been converted from Tunisian dinars (D) to U.S. dollars at a rate of D0.878=US\$1.00.

<sup>2</sup>W. C. Davies, Abderrazak Bel Haiza. Sweeter E&P Terms, Cretaceous Abiod Chalk Oil Play Lead to Busier Exploration in Tunisia., Oil and Gas J., Dec. 10, 1990, pp. 50-53.

### OTHER SOURCES OF INFORMATION

Direction des Mines et de la Geologie  
Ministere de l'Economie Nationale  
195 Rue de la Kasbah  
Tunis, Tunisia

Ministere de l'industrie, des Mines et de l'Energie  
195 Rue de la Kasbah  
Tunis, Tunisia

Service Geologique de Tunisie  
95 Avenue Mohamed V  
Tunis, Tunisia

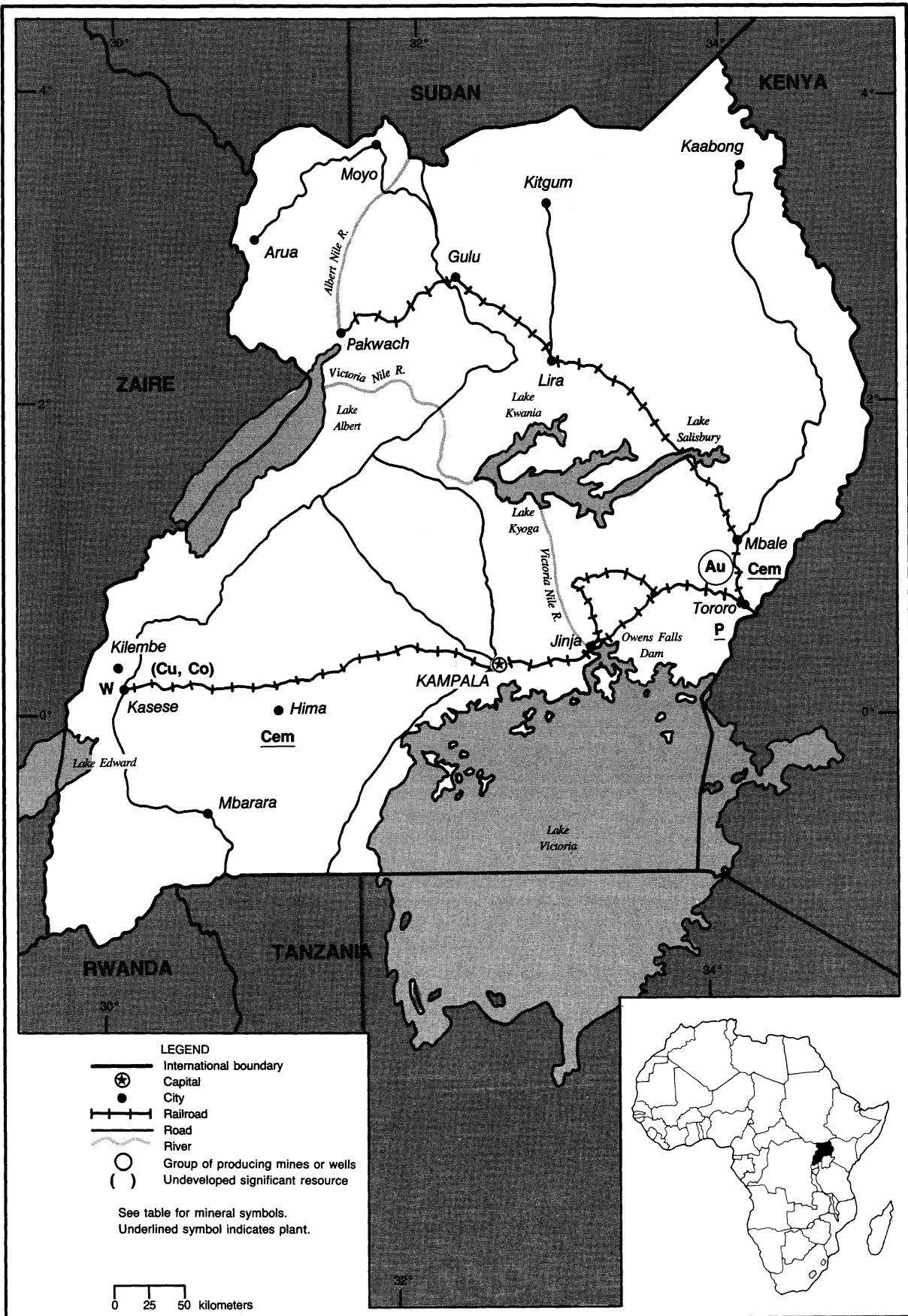
Compagnie des Phosphate de Gafsa  
GAFSA  
Cit  Bayache, Tunisia



# UGANDA

AREA 236,040 km<sup>2</sup>

POPULATION 17.96 million



# THE MINERAL INDUSTRY OF UGANDA

By David Izon

**T**he mineral industry contributed very little to the country's economy, accounting for only 0.03% of the GDP in 1990. Uganda's economy depended mainly on agriculture, which accounted for about 67% of the GDP of about \$3.4 billion in 1990. The leading sectors remained the same as those in the previous year, with agriculture, construction, and manufacturing dominating the economy. Uganda earned 97% of its foreign exchange from coffee sales, which declined in price in 1990.

Efforts to revive the mineral sector were successful as agreements were signed between the Government and several Western countries—Bureau de Recherches Géologiques et Minières of France and Barclay Metals of the United Kingdom on cobalt from the Kilembe Copper Mines; North Korea on a copper refinery and smelter; the Federal Republic of Germany on rehabilitation of the infrastructure; and Belgium's Petrofina on petroleum exploration and development. North Korea recently provided financial and technical assistance to upgrade a workshop at Kilembe, built to manufacture spare parts, and agreed in early 1991 to set up a concentrator, smelter, and refinery for the copper mines when the mines are rehabilitated.

The Government's implementation of the Special Import Program helped to slow down the monetary expansion within the economy, which in turn helped to reduce the inflation rate to 25% in late 1990. The Government's major policies focused on rehabilitation of its infrastructure and revitalization of the mining industry. The mining code was the Mining Act of 1970 but is currently under review. The Ugandan Constitution gave all minerals and mineral ores found in the country to the state. A new investment code was enacted in November 1990 that provided incentives to attract local and foreign investment. A re-

vision of regulations governing business operations in early 1991 also offered attractive tax incentives to new investors.

The value of total exports for 1990 was \$208 million, and imports amounted to \$618 million, resulting in a deficit of \$410 million. Uganda's major export products, in order of importance, were coffee, salt, sugar, tea, and tin. 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 clothes mainly from the Federal Republic of Germany, the United Kingdom, and the United States. Petroleum products were imported from neighboring Kenya.

Mineral production was minimal due to the lack of financing for the repair of old equipment and reconstruction or rehabilitation of degenerated mining facilities. Small-scale steel production is done at Jinja by Alam Steel Rolling Mills Ltd., a family-run company. Output from this mill in 1990 was reported at about 5,000 mt/a of rebars, round bars, angles, and sections. At full capacity, the mill is expected to produce 24,000 mt/a, mainly from scrap, and about 3,000 tons of billets imported from Zimbabwe. A pilot program to establish a demonstration direct reduction plant with a capacity of 30,000 mt/a at Muko was being sponsored by the United Nations Industrial Development Organization.

TABLE 1  
UGANDA: PRODUCTION OF MINERAL COMMODITIES

(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>                        | 1986   | 1987   | 1988   | 1989 <sup>p</sup> | 1990 <sup>e</sup> |
|---|--------|--------|--------|-------------------|-------------------|
| Cement, hydraulic                             | 15,000 | 15,908 | 14,244 | 13,755            | 14,000            |
| Lime, hydrated and quick <sup>e</sup>         | 500    | 500    | 500    | 500               | 500               |
| Phosphate minerals: Apatite <sup>e</sup>      | 100    | 100    | 100    | 100               | 100               |
| Salt, evaporated <sup>e</sup>                 | 5,000  | 5,000  | 5,000  | 5,000             | 5,000             |
| Tin, mine output, Sn content <sup>e</sup>     | 18     | 10     | 10     | 10                | 10                |
| Tungsten, mine output, W content <sup>e</sup> | 4      | 4      | 4      | 4                 | 4                 |

<sup>e</sup>Estimated. <sup>p</sup>Preliminary.

<sup>1</sup>Includes data available through Dec. 17, 1991.

<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.

There were no officially reported reserve figures for minerals, but the outlook was encouraging. The country's continued efforts to rehabilitate its copper mines and infrastructure will lead to growth of the mineral industry and may help stabilize the economy. Also, implementation of the African Development Bank's \$127 million phosphate mine and fertilizer plant project

scheduled to begin in September 1991 will enhance production of food crops, which will boost exports. Utilization of known mineral resources of copper, gold, iron, phosphate, salt, and tin would improve the country's economic outlook.

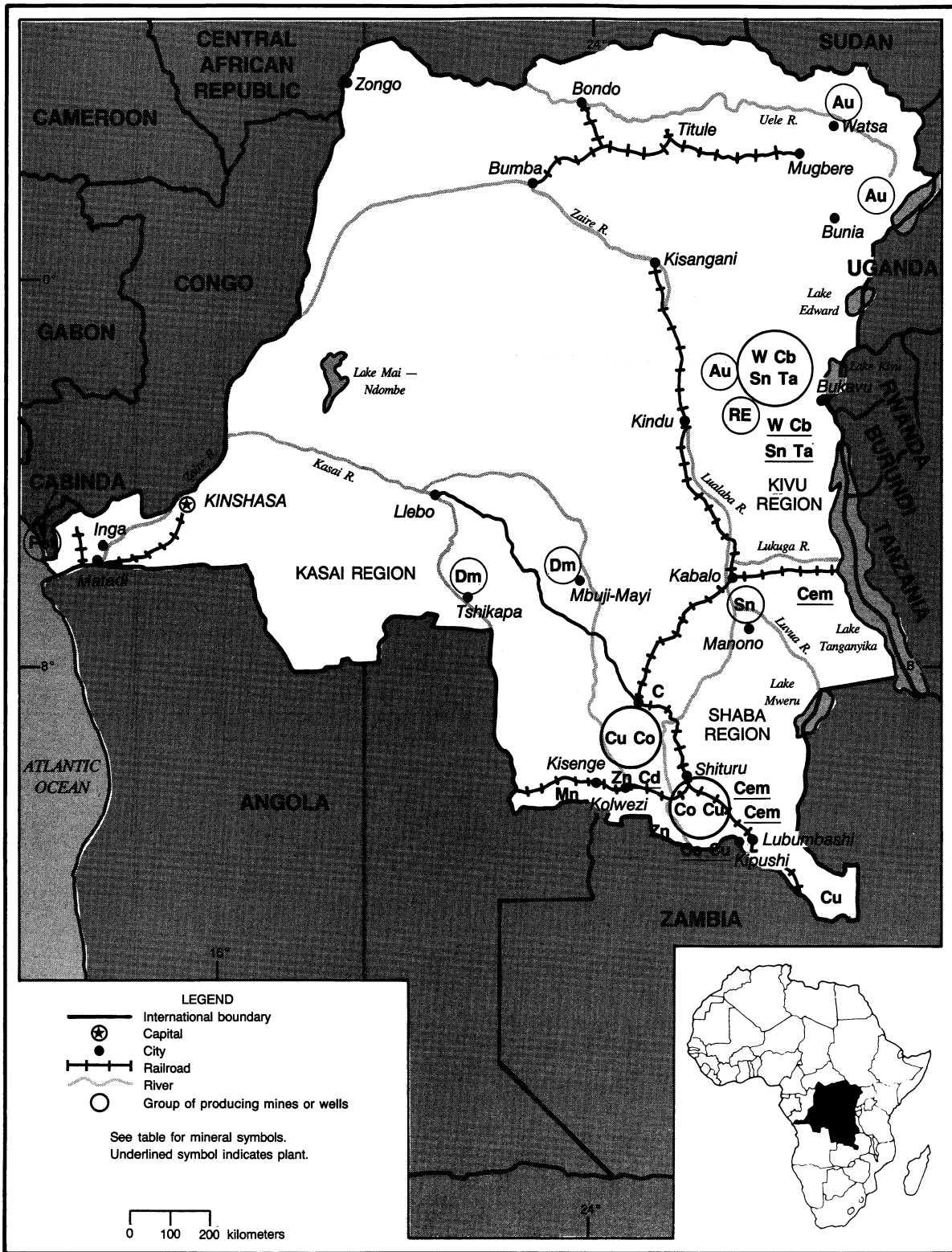
<sup>1</sup>Where necessary, values have been converted from Ugandan shillings (USH) to U.S. dollars at USH553.00=US\$1.00 in 1990.



# ZAIRE

AREA 2,345,410 km<sup>2</sup>

POPULATION 34.3 million



# THE MINERAL INDUSTRY OF ZAIRE

By Michael M. Heydari

**T**he overall decline of Zaire's mining industry continued in 1990 as both production and sales volumes decreased owing to the poor performance of its three main sectors: copper, diamond, and tin. Petroleum production stabilized after falling since 1985. Cobalt metal production increased slightly owing to a drawdown of intermediate-grade cobalt hydroxide. Other byproducts such as cadmium, silver, and zinc declined.

The poor output performance of the mining industry—which is dominated by La Generale des Carrieres des Mines (Gecamines), the parastatal mining company—was due primarily to a lack of investment funds, aging equipment, insufficient maintenance, fuel shortages, and poor management. The pressure to increase production at any cost in the face of inadequate development and production planning resulted in a major cave-in at Gecamines' Kamoto underground mine in Kolwezi on September 11, 1990. This caused an 80% reduction in Kamoto's copper production. As a result, the total copper production for Zaire in 1990 dropped to 339,000 tons, its worst performance since 1968 and down significantly from the 1989 level of 450,000 tons. The drop in sales proceeds further weakened the company's cash-flow situation, thus affecting the Zairian economy as a whole.

In 1990, the mining industry accounted for about 25% of the GDP, estimated at \$5.34 billion (1980 prices),<sup>1</sup> and about three-quarters of total export revenues. Gecamines alone accounted for about 60% of total export revenues and almost 25% of Government revenues.

There was a critical shortage of foreign exchange in the country since the world price of exportable agricultural and mining products, with the exception of cobalt, declined in 1990. This problem was made more acute by the drop in production from Gecamines.

## GOVERNMENT POLICIES AND PROGRAMS

The Government has been under pressure from international donors and private banks

to privatize state-owned industries in spite of opposition from vested interests in these organizations. Major reform measures aimed at stabilizing the economy were announced by the Government. It is, however, questionable whether these measures will be implemented in an appropriate and timely manner to prevent further deterioration of the minerals and related transport sectors.

Gecamines' drop in production resulted in reduced contributions to the state, from a predicted \$58.5 million to only \$39 million. Oil companies, which suffered losses from nonpayment of their bills by the central treasury, only remitted \$11.5 million in taxes to the treasury against an anticipated \$17 million. At the same time, the Government abandoned an International Monetary Fund/World Bank-sponsored structural adjustment program and was unable to control Government spending.

These budgetary gaps resulted in a deficit of about \$125 million for 1990, which pushed the inflation rate to its highest level in 25 years. Inflation began the year at 91% and rose rapidly, culminating at 250%.

The Bank of Zaire could only provide the local banking market with \$15 million per month, equal to a one-third of the economy's needs. Foreign exchange earnings secured 57% of the country's imports as against 67% in 1989.

For 1990 overall, the combination of a decline in real GDP by an estimated 2% and a population growth of about 3% resulted in a further decline in per capita income and purchasing power. This, in turn, sparked riots in the capital, Kinshasa, and elsewhere.

## PRODUCTION

Gecamines faced multiple crises in production, transportation, and finance in 1990. Production from the Kolwezi region was less than one-half of last year's level, largely because of the Kamoto Mine cave-in. Kolwezi ore ordinarily accounts for 60% of the total Gecamines ore production. The cave-in-induced shortfall idled facilities throughout the enterprise, leading to

Gecamines' announcement that force majeure required it to default on 45% of its copper deliveries.

Efforts to make up for lost underground mine production from open pits were severely hampered by parts and fuel shortages owing to a lack of cash or credit. In addition, railroad car shortages and certain weather-related transportation problems diminished the quantity of both copper and zinc available to the market.

## TRADE

Sales of mineral commodities dropped by about 10% from a record high of \$1.8 billion in 1989 and consisted of the following major mineral commodities: copper, \$951 million; diamond, \$258 million; crude petroleum, \$180 million; cobalt, \$256 million; zinc, \$47 million; and gold \$45 million. U.S. exports to Zaire were \$138 million in 1990 and consisted mainly of mining and transport equipment, wheat, cotton, and used clothing. Imports by the United States from Zaire were \$317 million, consisting mainly of mineral commodities. Zaire's main trading partners were Belgium, France, the Federal Republic of Germany, Japan, the Republic of South Africa and the United States. Official trade statistics for Zaire are not available. Data included in tables 2 and 3 are partial data only and represent trade with Zaire as reported by the European Community and the United States.

## 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. Gecamines, the principal parastatal company, operated on its own fiscal regime. Its holdings included subsidiary companies that produced cement, coal, 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

TABLE 1  
**ZAIRE: PRODUCTION OF MINERAL COMMODITIES FOR 1990<sup>1</sup>**

(Metric tons unless otherwise specified)

| Commodity  | 1986                 | 1987                | 1988                | 1989 <sup>p</sup>   | 1990 <sup>e</sup>    |
|--|----------------------|---------------------|---------------------|---------------------|----------------------|
| <b>METALS</b>  |                      |                     |                     |                     |                      |
| Cadmium, smelter   | 364                  | 299                 | 281                 | 224                 | <sup>2</sup> 213     |
| Cobalt:  |                      |                     |                     |                     |                      |
| Concentrate, Co content  | 33,373               | 22,517              | <sup>e</sup> 25,400 | <sup>e</sup> 25,000 | 20,000               |
| Refined  | 14,518               | 11,871              | 10,026              | 9,311               | <sup>2</sup> 10,033  |
| Columbite-tantalite concentrate:   |                      |                     |                     |                     |                      |
| Gross weight kilograms   | <sup>e</sup> 50,000  | <sup>e</sup> 50,000 | 33,500              | 48,020              | 50,000               |
| Cb content <sup>e</sup> do.  | 13,000               | 13,000              | <sup>8</sup> 8,723  | <sup>2</sup> 12,485 | 13,000               |
| Ta content <sup>e</sup> do.  | 14,000               | 14,000              | <sup>9</sup> 9,394  | <sup>2</sup> 13,446 | 14,000               |
| Copper:  |                      |                     |                     |                     |                      |
| Concentrate, Cu content  | <sup>5</sup> 561,400 | 505,600             | 534,700             | 470,800             | 372,056              |
| Blister and leach cathodes   | 498,100              | 487,400             | 466,300             | 450,400             | 339,357              |
| Refined  | 218,000              | 210,100             | 202,500             | 181,910             | 201,300              |
| Gold kilograms   | 5,220                | 4,372               | 3,422               | 2,032               | <sup>4</sup> 4,236   |
| Monazite concentrate, gross weight   | 7                    | 97                  | 168                 | 175                 | <sup>2</sup> 124     |
| Silver kilograms   | 34,328               | 36,767              | <sup>7</sup> 74,000 | <sup>e</sup> 20,000 | 75,000               |
| Tin:   |                      |                     |                     |                     |                      |
| Mine output, Sn content  | 2,650                | 2,378               | 2,775               | 2,346               | <sup>2</sup> 2,221   |
| Smelter, primary   | 56                   | 90                  | 120                 | 100                 | 95                   |
| Tungsten, mine output, W content   | 27                   | 21                  | 20                  | 16                  | 14                   |
| Zinc:  |                      |                     |                     |                     |                      |
| Mine output, Zn content  | 126,700              | 134,000             | 142,700             | 121,000             | 85,000               |
| Concentrate, Zn content  | 81,286               | 74,700              | 75,700              | 72,800              | 50,000               |
| Metal, primary, electrolytic   | 63,928               | 54,878              | 61,086              | 54,041              | <sup>2</sup> 38,203  |
| <b>INDUSTRIAL MINERALS</b>   |                      |                     |                     |                     |                      |
| Cement, hydraulic  | 444,700              | 491,600             | 495,000             | 460,000             | <sup>2</sup> 460,581 |
| Diamond:   |                      |                     |                     |                     |                      |
| Gem thousand carats  | 4,661                | 3,885               | <sup>2</sup> 2,724  | <sup>2</sup> 2,663  | 2,914                |
| Industrial <sup>e</sup> do.  | 18,643               | 15,540              | <sup>1</sup> 15,439 | <sup>1</sup> 15,092 | 16,513               |
| Total do.  | 23,304               | 19,425              | 18,163              | 17,755              | <sup>2</sup> 19,427  |
| Lime   | 136,400              | 98,500              | 100,300             | 100,200             | 100,000              |
| Stone, crushed thousand tons   | 432                  | 418                 | <sup>4</sup> 400    | <sup>4</sup> 400    | 400                  |
| Sulfur:  |                      |                     |                     |                     |                      |
| Byproduct of metallurgy, S content of sulfuric acid from sphalerite <sup>e</sup> | 38,500               | 34,500              | 35,000              | 34,500              | 34,000               |
| Sulfuric acid, gross weight <sup>3</sup>   | 146,400              | 140,300             | 140,000             | 140,000             | 140,000              |
| <b>MINERAL FUELS AND RELATED MATERIALS</b>                                       |                      |                     |                     |                     |                      |
| Coal, bituminous thousand tons   | 119                  | 122                 | 112                 | <sup>1</sup> 128    | 120                  |
| Petroleum:   |                      |                     |                     |                     |                      |
| Crude thousand 42-gallon barrels   | 11,857               | 11,418              | 10,728              | 10,119              | <sup>2</sup> 10,597  |
| Refinery products:   |                      |                     |                     |                     |                      |
| Gasoline do.   | 60                   | 336                 | 399                 | 578                 | <sup>2</sup> 580     |
| Kerosene and jet fuel do.  | 40                   | <sup>2</sup> 256    | 508                 | 613                 | <sup>2</sup> 600     |
| Distillate fuel oil do.  | 179                  | 520                 | 833                 | 1,027               | <sup>2</sup> 1,100   |
| Residual fuel oil do.  | 124                  | 339                 | 398                 | 867                 | <sup>2</sup> 900     |
| Refinery fuel and losses do.   | 39                   | 72                  | 95                  | 114                 | 120                  |
| Total do.  | 442                  | <sup>1</sup> 1,523  | 2,233               | 3,199               | 3,300                |

<sup>e</sup>Estimated. <sup>p</sup>Preliminary. <sup>r</sup>Revised.

<sup>1</sup>Table includes data available through Aug. 14, 1991.

<sup>2</sup>Reported figure.

<sup>3</sup>Includes acid produced from imported sulfur.

TABLE 2

ZAIRE: APPARENT EXPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity   | 1988    | 1989 <sup>p</sup>  | Destinations, 1989 |   |
|---|---------|--------------------|--------------------|---|
|   |         |                    | United States      | Other (principal)   |
| <b>METALS</b>   |         |                    |                    |   |
| Aluminum: Metal including alloys:   |         |                    |                    |   |
| Scrap   | —       | 19                 | —                  | All to West Germany.  |
| Unwrought   | —       | 100                | —                  | All to Italy.   |
| Antimony: Ore and concentrate value, thousands                                | —       | \$1                | —                  |   |
| Cadmium: Metal including alloys, all forms                                    | 239     | 250                | —                  | United Kingdom 105; France 67.                                      |
| Cobalt:   |         |                    |                    |   |
| Ore and concentrate   | 100     | 3                  | 3                  |   |
| Oxides and hydroxides   | 15      | 51                 | 51                 |   |
| Metal including alloys, all forms   | 7,844   | 3,030              | 1,115              | Japan 1,613.  |
| Columbium and tantalum:   |         |                    |                    |   |
| Ore and concentrate   | —       | 51                 | 51                 |   |
| Ash and residue containing columbium and tantalum                             | 62      | —                  |                    |   |
| Metal including alloys, all forms tantalum                                    | 24      | —                  |                    |   |
| Copper:   |         |                    |                    |   |
| Ore and concentrate   | 46,784  | 1                  | —                  | All to France.  |
| Matte and speiss including cement copper                                      | 6,007   | 1,947              | —                  | West Germany 1,235; United Kingdom 423.                             |
| Ash and residue containing copper   | 39      | —                  |                    |   |
| Metal including alloys:   |         |                    |                    |   |
| Scrap   | 312     | 6,160              | —                  | Belgium-Luxembourg 2,259; United Kingdom 2,023; West Germany 1,677. |
| Unwrought   | 217,242 | 177,137            | 17,378             | Belgium-Luxembourg 70,685; West Germany 51,041.                     |
| Semimanufactures  | 60      | —                  |                    |   |
| Gold: Metal including alloys, unwrought and partly wrought kilograms          | 1,258   | <sup>3</sup> 1,185 | NA                 | Belgium-Luxembourg 1,039; United Kingdom 139.                       |
| Iron and steel: Metal, scrap  | —       | 4,124              | —                  | Italy 4,084; Austria 40.  |
| Lithium: Ore and concentrate  | 36      | —                  |                    |   |
| Molybdenum: Ore and concentrate   | 3       | —                  |                    |   |
| Nickel: Oxides and hydroxides   | —       | 20                 | —                  | All to Italy.   |
| Silver: Metal including alloys, unwrought and partly wrought value, thousands | —       | \$68               | \$61               | West Germany \$7.   |
| Tin:  |         |                    |                    |   |
| Ore and concentrate   | 1,843   | NA                 |                    |   |
| Ash and residue containing tin  | 15      | —                  |                    |   |
| Metal including alloys, unwrought   | 25      | —                  |                    |   |
| Titanium: Ore and concentrate   | —       | 30                 | —                  | All to West Germany.  |
| Tungsten: Ore and concentrate   | 52      | 19                 | —                  | Do.   |
| Uranium and thorium: Ore and concentrate                                      | —       | 87                 | —                  | All to France.  |
| Zinc:   |         |                    |                    |   |
| Ore and concentrate   | 598     | 1,949              | —                  | Netherlands 1,458; Spain 491.                                       |
| Metal including alloys:   |         |                    |                    |   |
| Scrap   | 2       | —                  |                    |   |
| Unwrought   | 29,946  | 16,299             | 13,155             | West Germany 817; Republic of Korea 718.                            |
| Other:  |         |                    |                    |   |
| Ores and concentrates   | —       | 69                 | —                  | Japan 68; Italy 1.  |
| Ashes and residues  | —       | <sup>4</sup> 381   | NA                 | Belgium-Luxembourg 228; West Germany 140.                           |

See footnotes at end of table.

TABLE 2  
**ZAIRE: APPARENT EXPORTS OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

| Commodity   | 1988             | 1989 <sup>p</sup> | Destinations, 1989 |  |
|---|------------------|-------------------|--------------------|--|
|   |                  |                   | United States      | Other (principal)                        |
| <b>METALS—Continued</b>   |                  |                   |                    |  |
| Base metals including alloys, all forms   | 57               | —                 |                    |  |
| <b>INDUSTRIAL MINERALS</b>  |                  |                   |                    |  |
| Abrasives, n.e.s.: Dust and powder of precious and semiprecious stones including diamond value, thousands | ( <sup>q</sup> ) | \$1,835           | \$1,105            | Japan \$730.                             |
| Asbestos, crude   | —                | 257               | —                  | All to West Germany.                     |
| Barite and witherite  | —                | 3                 | —                  | Do.                                      |
| <b>Diamond, natural:</b>  |                  |                   |                    |  |
| Gem, not set or strung value, thousands   | \$332,001        | \$66,739          | \$62,607           | Belgium-Luxembourg \$3,586; Japan \$238. |
| Industrial stones do.   | \$281,512        | \$14,525          | \$12,076           | Japan \$1,455.                           |
| Dust and powder carats  | 21,000           | 44,300            | —                  | Spain 36,000; France 8,300.              |
| <b>Precious and semiprecious stones other than diamond:</b>   |                  |                   |                    |  |
| Natural value, thousands  | \$1,393          | \$2,011           | \$1,658            | Hong Kong \$165; West Germany \$122.     |
| Synthetic do.   | \$15             | \$120             | \$8                | France \$110.                            |
| Stone, sand and gravel: Dimension stone, crude and partly worked  | 11               | —                 |                    |  |
| <b>MINERAL FUELS AND RELATED MATERIALS</b>  |                  |                   |                    |  |
| <b>Petroleum:</b>   |                  |                   |                    |  |
| Crude thousand 42-gallon barrels  | 11,754           | 309               | NA                 | All to Spain.                            |
| Refinery products: Residual fuel oil do.  | 144              | 83                | 83                 |  |

<sup>p</sup>Preliminary. NA Not available.

<sup>1</sup>Table prepared by Virginia A. Woodson. 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 exports. These data have been compiled from trade statistics of individual trading partners unless otherwise specified.

<sup>2</sup>May include niobium and vanadium.

<sup>3</sup>Excludes unreported quantity valued at \$13,545,000 imported by the United States.

<sup>4</sup>Excludes unreported quantity valued at \$298,000 imported by the United States.

<sup>5</sup>Unreported value for 528 metric tons.

TABLE 3  
**ZAIRE: APPARENT IMPORTS OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

| Commodity  | 1988 | 1989 <sup>p</sup> | Destinations, 1989 |                                      |
|--|------|-------------------|--------------------|--------------------------------------|
|  |      |                   | United States      | Other (principal)                    |
| <b>METALS</b>                                      |      |                   |                    |                                      |
| Alkali and alkaline-earth metals                   | 10   | —                 |                    |                                      |
| <b>Aluminum:</b>                                   |      |                   |                    |                                      |
| Oxides and hydroxides                              | —    | 259               | —                  | West Germany 200; United Kingdom 58. |
| <b>Metal including alloys:</b>                     |      |                   |                    |                                      |
| Unwrought  | 1    | —                 |                    |                                      |
| Semimanufactures                                   | 523  | 247               | —                  | Belgium-Luxembourg 240; China 7.     |
| Unspecified  | 10   | —                 |                    |                                      |
| Cadmium: Metal including alloys, all forms         | —    | 28                | 28                 |                                      |
| <b>Chromium:</b>                                   |      |                   |                    |                                      |
| Oxides and hydroxides kilograms                    | 500  | —                 |                    |                                      |
| Metal including alloys, all forms value, thousands | \$3  | \$8               | —                  | 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  | 1988             | 1989 <sup>a</sup> | Sources, 1989 |  |
|--|------------------|-------------------|---------------|--|
|  |                  |                   | United States | Other (principal)                              |
| <b>METALS—Continued</b>  |                  |                   |               |  |
| Cobalt: Metal including alloys, all forms kilograms                  | 199              | —                 |               |  |
| Copper: Metal including alloys:                                      |                  |                   |               |  |
| Scrap  | 1                | —                 |               |  |
| Unwrought  | —                | 2                 | —             | All from Belgium-Luxembourg.                   |
| Semimanufactures   | 79               | 36                | —             | Belgium-Luxembourg 35; China 1.                |
| Gold: Metal including alloys, unwrought and partly wrought kilograms | 4                | ( <sup>2</sup> )  | —             | All from Belgium-Luxembourg.                   |
| Iron and steel:  |                  |                   |               |  |
| Metal:   |                  |                   |               |  |
| Scrap  | —                | 6                 | —             | Do.  |
| Pig iron, cast iron, related materials                               | 2                | 27                | —             | All from Netherlands.                          |
| Ferroalloys: Ferrosilicochromium                                     | —                | 140               | —             | All from West Germany.                         |
| Steel, primary forms   | 15               | 19                | —             | All from Belgium-Luxembourg.                   |
| Semimanufactures:  |                  |                   |               |  |
| Bars, rods, angles, shapes, sections                                 | 8,800            |                   |               |  |
| Universals, plates, sheets   | 1,303            |                   |               |  |
| Rails and accessories  | 4,606            | 47,022            | 295           | Belgium-Luxembourg 11,297; West Germany 8,838, |
| Wire   | 661              |                   |               | France 7,720.                                  |
| Tubes, pipes, fittings   | 4,383            |                   |               |  |
| Castings and forgings, rough   | 35               |                   |               |  |
| Lead:  |                  |                   |               |  |
| Oxides   | —                | 148               | —             | Italy 141; West Germany 6.                     |
| Metal including alloys:  |                  |                   |               |  |
| Unwrought  | 270              | 82                | —             | All from Belgium-Luxembourg.                   |
| Semimanufactures   | 7                | 32                | —             | Do.  |
| Nickel: Metal including alloys:                                      |                  |                   |               |  |
| Unwrought  | 6                | 3                 | —             | All from Belgium-Luxembourg.                   |
| Semimanufactures   | 1                | —                 |               |  |
| Platinum-group metals:   |                  |                   |               |  |
| Waste and sweepings value, thousands                                 | —                | \$116             | —             | All from Belgium-Luxembourg.                   |
| Metals including alloys, unwrought and partly wrought kilograms      | 130              | —                 |               |  |
| Silver: Metal including alloys, unwrought and partly wrought do.     | NA               | 1,463             | —             | All from Belgium-Luxembourg.                   |
| Tin: Metal including alloys:   |                  |                   |               |  |
| Unwrought  | —                | 1                 | —             | Do.  |
| Semimanufactures value, thousands                                    | —                | \$2               | —             | Do.  |
| Titanium:  |                  |                   |               |  |
| Ore and concentrate  | 1                | —                 |               |  |
| Oxides   | 8                | 33                | —             | Belgium-Luxembourg 26; United Kingdom 3.       |
| Uranium and thorium: Oxides and other compounds kilograms            | 61               | —                 |               |  |
| Zinc:  |                  |                   |               |  |
| Oxides   | —                | 5                 | —             | France 2; Italy 2.                             |
| Metal including alloys: Semimanufactures                             | ( <sup>2</sup> ) | 10                | —             | All from Belgium-Luxembourg.                   |

See footnotes at end of table.

TABLE 3—Continued

ZAIRE: APPARENT IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity  | 1988             | 1989 <sup>a</sup> | Sources, 1989 |                                       |
|--|------------------|-------------------|---------------|---------------------------------------|
|  |                  |                   | United States | Other (principal)                     |
| METALS—Continued   |                  |                   |               |                                       |
| Other:   |                  |                   |               |                                       |
| Ashes and residues   | 10               | —                 | Do.           |                                       |
| Base metals including alloys, all forms                      | 392              | —                 |               |                                       |
| INDUSTRIAL MINERALS  |                  |                   |               |                                       |
| Abrasives, n.e.s.:   |                  |                   |               |                                       |
| Natural: Corundum, emery, pumice, etc.                       | 2                | 2                 | —             | All from Belgium-Luxembourg.          |
| Artificial: Silicon carbide                                  | —                | 1                 | —             | Do.                                   |
| Grinding and polishing wheels and stones                     | 23               | 84                | (?)           | Belgium-Luxembourg 44; Italy 32.      |
| Barite and witherite   | 24               | 200               | —             | Netherlands 150; Italy 42.            |
| Cement   | —                | 1,509             | —             | Belgium-Luxembourg 1,076; France 409. |
| Chalk  | —                | 24                | —             | All from Belgium-Luxembourg.          |
| Clays, crude:  |                  |                   |               |                                       |
| Bentonite  | 243              | 58                | —             | Japan 50; France 7.                   |
| Kaolin   | 27               | 16                | —             | Italy 8; Belgium-Luxembourg 7.        |
| Unspecified  | 44               | 76                | —             | All from United Kingdom.              |
| Diamond, natural:  |                  |                   |               |                                       |
| Gem, not set or strung                                       | value, thousands | \$3               | —             |                                       |
| Industrial stones  | carats           | 86                | 150           | —                                     |
| Diatomite and other infusorial earth                         |                  | 8                 | 262           | —                                     |
| Crude, n.e.s.  |                  | 1                 | 2             | —                                     |
| Manufactured:  |                  |                   |               |                                       |
| Ammonia  |                  | 56                | —             |                                       |
| Nitrogenous  |                  | 3,506             | 12,279        | —                                     |
| Phosphatic   |                  | 5                 | 9             | —                                     |
| Potassic   |                  | —                 | 1,781         | —                                     |
| Unspecified and mixed  |                  | 3,226             | 9,547         | NA                                    |
| Gypsum and plaster   |                  | 5,600             | 8,254         | —                                     |
| Lime   |                  | 1,627             | 734           | —                                     |
| Magnesium compounds:   |                  |                   |               |                                       |
| Magnesite, crude   |                  | —                 | 4             | —                                     |
| Oxides and hydroxides  |                  | —                 | 5             | —                                     |
| Other  |                  | —                 | 124           | —                                     |
| Mica:  |                  |                   |               |                                       |
| Crude including splittings and waste                         |                  | (?)               | —             |                                       |
| Worked including agglomerated splittings                     |                  |                   |               |                                       |
| value, thousands   |                  | \$3               | —             |                                       |
| Phosphates, crude  |                  | 10                | 189           | —                                     |
| Pigments, mineral: Iron oxides and hydroxides, processed     |                  | 2                 | 3             | —                                     |
| Precious and semiprecious stones other than diamond: Natural |                  | value, thousands  | \$2           | \$73                                  |
| Salt and brine   |                  | 78                | 156           | 6                                     |
| Sodium compounds, n.e.s.:                                    |                  |                   |               |                                       |
| Soda ash, manufactured                                       |                  | —                 | 254           | —                                     |
| Sulfate, manufactured  |                  | NA                | 41            | —                                     |
| Stone, sand and gravel:                                      |                  |                   |               |                                       |
| Dimension stone: Crude and partly worked                     |                  | —                 | 750           | —                                     |

See footnotes at end of table.

TABLE 3—Continued

ZAIRE: APPARENT IMPORTS OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

| Commodity  | 1988                       | 1989 <sup>a</sup> | Sources, 1989    |  |
|--|----------------------------|-------------------|------------------|--|
|  |                            |                   | United States    | Other (principal)                                      |
| <b>INDUSTRIAL MINERALS—Continued</b>             |                            |                   |                  |  |
| <b>Stone, sand and gravel:—Continued</b>         |                            |                   |                  |  |
| Gravel and crushed rock                          | —                          | 3                 | —                | All from Belgium-Luxembourg.                           |
| Sand other than metal-bearing                    | —                          | 24                | —                | Belgium-Luxembourg 12; Netherlands 11.                 |
| <b>Sulfur:</b>                                   |                            |                   |                  |  |
| Elemental: Crude including native and byproduct  | —                          | 184               | —                | West Germany 140; Belgium-Luxembourg 39.               |
| Dioxide  | —                          | 26                | —                | Belgium-Luxembourg 24.                                 |
| Sulfuric acid                                    | 144                        | 330               | —                | Netherlands 202; Belgium-Luxembourg 128.               |
| Talc, steatite, soapstone, pyrophyllite          | —                          | 676               | 80               | France 515; Belgium-Luxembourg 81.                     |
| Vermiculite                                      | —                          | 233               | —                | All from Italy.  |
| Other: crude                                     | —                          | 371               | 208              | Belgium-Luxembourg 163.                                |
| <b>MINERAL FUELS AND RELATED MATERIALS</b>       |                            |                   |                  |  |
| Asphalt and bitumen, natural                     | —                          | 2                 | 2                |  |
| Carbon black                                     | 415                        | 644               | 612              | Belgium-Luxembourg 16; West Germany 9.                 |
| Coal: Briquets of anthracite and bituminous coal | —                          | 11                | —                | All from Belgium-Luxembourg.                           |
| Coke and semicoke                                | 12                         | 3,501             | —                | Do.  |
| Peat including briquets and litter               | —                          | 19                | —                | Do.  |
| <b>Petroleum:</b>                                |                            |                   |                  |  |
| Crude  | thousand 42-gallon barrels | ( <sup>2</sup> )  | —                |  |
| <b>Refinery products:</b>                        |                            |                   |                  |  |
| Gasoline   | do.                        | —                 | 30               | Italy 19; France 10.                                   |
| Mineral jelly and wax                            | do.                        | 1                 | 8                | ( <sup>2</sup> ) West Germany 5; Belgium-Luxembourg 1. |
| Kerosene and jet fuel                            | do.                        | —                 | 178              | Spain 167; Netherlands 8.                              |
| Distillate fuel oil                              | do.                        | NA                | 116              | —  |
| Lubricants                                       | do.                        | 7                 | 220              | ( <sup>2</sup> ) All from Portugal.                    |
| Residual fuel oil                                | do.                        | —                 | 10               | Spain 70; Italy 64; United Kingdom 39.                 |
| Asphalt  | do.                        | 1                 | —                | Greece 9; Portugal 1.                                  |
| Bitumen and other residues                       | do.                        | 1                 | 6                | ( <sup>2</sup> ) Spain 4; Belgium-Luxembourg 1.        |
| Bituminous mixtures                              | do.                        | 2                 | ( <sup>2</sup> ) | ( <sup>2</sup> )                                       |

<sup>a</sup>Preliminary. NA Not available.<sup>1</sup>Table prepared by Virginia A. Woodson. 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.<sup>2</sup>Less than 1/2 unit.<sup>3</sup>Excludes unreported quantity valued at \$40,000 exported by the United States.

belong to the state. Prospecting and exploration, research, 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.

## COMMODITY REVIEW

**Metals.—Cobalt.**—Zaire remained the world's largest producer of cobalt. During 1990, Gecamines made a decision to stress cobalt production by reprocessing previously stockpiled cobalt hydrates. This re-

sulted in an improvement in production to 10,033 tons from 9,311 tons in 1989, although it was much lower than the company's earlier forecast of about 13,000 tons. Gecamine's sale prices rose from an average of \$7.20 per pound in 1989 to the \$13.5 to \$14.5 range in 1990.

Zaire has managed to keep a relative hold on the world cobalt price through its system of stockpiling in Antwerp and releasing measured amounts onto the market. A sharp price increase would be detrimental to the long-term prospects of the mineral as it may force industry to look at alternatives if the

source of cobalt was deemed too unstable.

**Copper.**—The country's main copper producer, Gecamines, produced 339,000 tons of copper in 1990, down from 425,000 tons in 1989. It sold 380,000 tons of copper by running down its inventories.

In September, a major cave-in occurred at Gecamines' Kamoto underground mine in Kolwezi. As a result, mine production, which averaged about 300,000 mt/month at a grade of 4.3 % copper and 0.3% cobalt, dropped to about 50,000 mt/month. Gecamines investigation officially blamed



TABLE 4

## ZAIRE: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

(Metric tons)

| Commodity | Major operating companies                    | Location of main facilities | Annual capacity           |
|-----------|--|-----------------------------|---------------------------|
| Cobalt    | Generale des Carrieres et des Mines du Zaire | Shituru                     | 9,000 metal as granules.  |
| Do.       | do.  | Lulu                        | 9,000 metal as flake.     |
| Copper    | Generale des Carrieres et des Mines du Zaire | Lubumbashi                  | 165,000 blister Cu.       |
| Do.       | do.  | Shituru                     | 250,000 refined Cu        |
| Diamond   | Societe Miniere de Bakwanga                  | Mbuji Mayi                  | 9.2.                      |
| Do.       | Artisanal miners                             | Tshikapa                    | 15.                       |
| Tin       | Societe Miniere et Industrielle de Kivu      | Kindu, Kalima               | 3,000 Sn in concentrate.  |
| Zinc      | Generale des Carrieres et des Mines du Zaire | Kipushi                     | 85,000 Zn in concentrate. |
| Do.       | Do.  | Kolwezi                     | 75,000 refined Zn.        |

the incident on a coincidence of downward and upward earth movements converging on the main gallery of the mine that collapsed, and company officials insisted that there was no evidence of human or technical error causing the accident. Despite the official claims, the cause of the cave-in was reportedly attributed to faulty mine design and cutting corners in the already unstable design to maximize production as the company had fallen behind in its plans to backfill empty chambers.

Gecamines signed an agreement with a French conglomerate for a 5-year co-operation program to develop copper deposits about 200 km from Lubumbashi in southern Zaire. The copper-cobalt deposits at Tenke Fungurume form part of the copper belt that stretches between Zambia and Zaire. They were evaluated in the early 1970's by Charter Consolidated, but in 1975-76, the company shelved initial plans to produce 130,000 mt/a of copper and 6,500 mt/a of cobalt. Reserves consist of 51 Mmt of ore.

**Gold.**—Total gold production amounted to 4,234 kg valued at about \$45 million. Kilomoto's production has fallen considerably over the years, from 8,000 kg in 1950 to 486 kg in 1990, largely owing to obsolete equipment. Sominki produced 480 kg of gold in 1990 primarily from two operations, the Mobale underground mine and the

Lugushwa alluvial operation. Gecamines' gold production, as a by-product of copper, was about 11 kg, down from 30 kg in 1989, reflecting the substantially lower copper production.

Compagnie Francaises de Mines (Coframines), part of the French group BRGM, in association with Mining International Development (France and Belgium) and the Republic of South Africa's Rand Mines Ltd., is to provide 32% of the capital for a new gold mining company, Kimin. The state-owned Office des Mines d'Or de Kilomoto (Okimo), which has 83,000 km<sup>2</sup> of gold mining concessions in Haut-Zaire Province, will own 51% of the company by contributing \$18 million. Other shareholders will be the Orgaman Group (10%) and the World Bank's International Finance Corp. (7%). Kimin will mine 2.5% of the concessions owned by Okimo over a period of 25 years, for an annual rent of \$2 million for the first four years and \$4 million thereafter. With an initial investment of \$162 million, Kimin expects to produce 0.49 tons of gold in the first year, increasing to 1.94 tons the following year, and leveling off at 8.55 tons after the fifth year.

**Tin.**—In 1990, Sominki produced an average of 200 tons of tin per month. The company employed about 10,000 employees. Profits generated from its other operations were used to cover losses resulting

from production costs of \$10,000 per ton in the face of a market price equivalent to about \$6,000 per ton.

**Zinc.**—Output was a byproduct of Gecamines' Kipushi Mine west of Lubumbashi. The zinc-bearing ore undergoes initial concentration on-site and is then sent to Likasi for roasting and recovery of sulfur, and then on to Kolwezi for final processing. Transport and fuel problems considerably hindered zinc production. Electrolytic metal production fell from 54,041 tons in 1989 to about 38,203 tons in 1990.

Gecamines is considering final processing of zinc on site at the Kipushi Mine. This would eliminate transport bottlenecks created by difficult road conditions and an inefficient railroad system, likely resulting in higher zinc production. It is not clear whether funding can be arranged for this project.

**Industrial Minerals.**—The Société Minière de Bakwanga (MIBA) remained the major diamond producer in Zaire. The company's 1990 production reached an 11-year high of 9,556,436 carats from a total excavation of 8.56 Mm<sup>3</sup>. The overall grade of the deposits mined during the year was 5.02 carats/m<sup>3</sup>, a significant increase from the previous year level of 4.59 carats/m<sup>3</sup>.

Artisanal workers have historically accounted for the largest portion of diamond production in Zaire. Production by artisanal workers, scattered throughout the diamond regions of Tshikapa and Mbuji Mayi, totaled 9.8 million carats. The ratio of gem to industrial diamond recovered by artisanal workers is higher than for MIBA, but their level of recovery is lower.

Total country diamond exports amounted to 19.43 million carats. The average price realized was \$13.26 per carat, down from 1989's \$14.25 per carat, reflecting the nongem quality of the bulk of Zaire's diamond production.

### Mineral Fuels

After several years of uninterrupted decline, oil production leveled off in 1990. Yield was higher than expected due to better performance of wells that continued to produce at full capacity. However, no new drilling activities were undertaken by Zaire Gulf Oil Co. (ZAGOC), the leading oil producer.

### Reserves

Zaire's major mineral reserves are considered sufficient for many years of pro-

duction. As the higher grade materials are depleted, higher tonnages of ore will need to be mined. 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.

TABLE 5

**ZAIRE: RESERVES OF MAJOR MINERAL COMMODITIES FOR 1990**

(Thousand tons unless otherwise specified)

| Commodity                    | Reserve |
|------------------------------|---------|
| Cobalt                       | 2,949   |
| Copper                       | 45,671  |
| Gold kilograms               | 85,986  |
| Manganese, manganese dioxide | 13,000  |
| Tin, cassiterite             | 2654    |

<sup>1</sup>Reserves of carbonate ore were reported to be several million tons.  
<sup>2</sup>Includes 200,000 tons in Gecamines concession and 300,000 tons in Societe Zairetain's concession.

**INFRASTRUCTURE**

Zaire is a landlocked country except for a small coastal area on the Atlantic Ocean where the Port of Matadi is located, with a capacity of about 2 Mmt/a. Zaire 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. Engine 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 shipped on the Voie Nationale, the only transport route entirely within Zaire, as well as other routes to Dar es Salaam in Tanzania and to ports in the Republic of South Africa. On present export routes, it takes 45 days to get copper seaborne, either via Zambia and Zimbabwe or eastward along the Tazara railway, operated by both Zambia and Tanzania. The third rail route, the Voie Nationale, is a 2,500-km tortuous and costly journey. Trains head northwest and carry about 50% of production as far as Ilebo, where they are offloaded, and the cargo is then transported on the Kasai River, a tributary of the Zaire River, to Kinshasa. At Kinshasa, cargo is reloaded to railcars and shipped to Matadi for transfer to oceangoing vessels. An increasing 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. Gecamines is also dependent upon imported coke and petroleum refinery products for its mine and metallurgical operations.

**OUTLOOK**

Zaire will remain a supplier of cobalt, copper, and diamond. However, the inability to meet goals for improvement of internal transport, mining, and processing of copper and cobalt ore may lead to a continued decline in output of the country's most important company, Gecamines. Zaire's future copper output trends will depend on the availability of financing. It is, however, unclear whether Zaire's creditors will agree to extend the terms of existing loans and grant new lines of credit if the political situation remains unstable. In the New World Order, Zaire has to compete for scarce investment funds with such newcomers as the Eastern European countries and other emerging democracies in Latin America, Asia, and Africa.

<sup>1</sup>Where necessary, values have been converted from zaires (Z) to U.S. dollars at the rate of Z2,000=US\$1.00 for 1990.

**OTHER SOURCES OF INFORMATION**

**Agency**

Department of National Economy and Industry  
 Kinshasa, Zaire

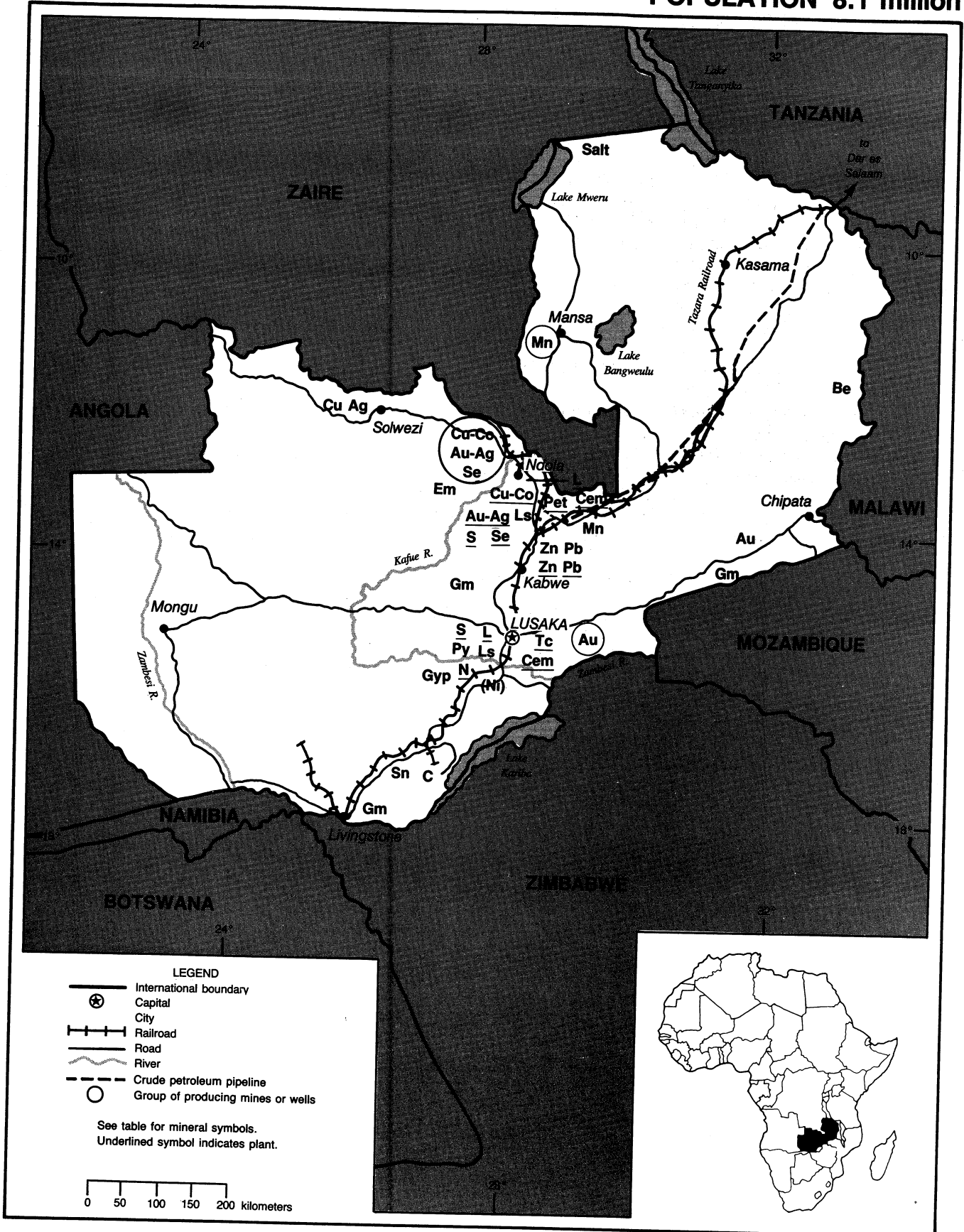
**Publications**

Conjoncture Economique. Republic du Zaire. Dec. 1989, 629 pp.  
 Zaire: Minerals Perspective.  
 BuMines Mineral Perspectives, 1985, 36 pp.

# ZAMBIA

AREA 752,610 km<sup>2</sup>

POPULATION 8.1 million



# THE MINERAL INDUSTRY OF ZAMBIA

By Lloyd E. Antonides

**C**opper production remained the foundation of Zambia's economy and made the country the world's fourth largest producer of copper and second of cobalt, its associated product. Although copper and other mineral commodity production contributed less than 10% to the GDP and employed only about 15% of the work force, it earned more than 90% of foreign exchange. In comparison, agriculture accounted for 20% of GDP and manufacturing, 25%. The potential for growth of the industry was indicated by the many mineral deposits that were known to occur but as yet were inadequately explored and defined.

Because of such dependency on one commodity, the country's economy was in

difficulty when copper prices fell about 60% in the mid-1970's. The rise of copper prices in the 1980's only partially mitigated the effect of the resulting debt and economic disruption. Although the inflation rate for consumer prices was substantially reduced in 1990, it remained more than 100%.

## GOVERNMENT POLICIES AND PROGRAMS

A multiparty system took root in 1990, and a free market economy was being developed. The Government took major steps to liberalize the economy as part of an economic restructuring program monitored by the International Monetary Fund (IMF). It was considered one of the most rigorous

structural adjustment plans the IMF ever tried. Price controls were removed except for a phaseout on maize and liberalization of agricultural producer prices. Most imports were freely obtainable.

The system of exchange rates and distribution of foreign exchange was being revised or abandoned. The Government announced its intention to sell 49% of its share in all parastatals and was studying outright sale of some. In addition, the investment and mining codes were being revised to attract foreign investment.

## PRODUCTION

No significant changes in production of minerals were reported during 1990.

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

(Metric tons unless otherwise specified)

| Commodity <sup>2</sup>       | 1986      | 1987      | 1988      | 1989 <sup>p</sup> | 1990 <sup>e</sup> |
|------------------------------|-----------|-----------|-----------|-------------------|-------------------|
| <b>METALS<sup>3</sup></b>    |           |           |           |                   |                   |
| Beryllium:Beryl kilograms    | 723       | 1,131     | 1,343     | 880               | *1,000            |
| <b>Cobalt:<sup>4</sup></b>   |           |           |           |                   |                   |
| Mine output:                 |           |           |           |                   |                   |
| Ore milled: <sup>5</sup>     |           |           |           |                   |                   |
| Gross weight thousand tons   | 6,864     | 7,015     | 6,634     | 6,596             | 6,505             |
| Co content                   | 8,656     | 11,198    | 10,687    | 10,590            | 10,870            |
| Concentrate:                 |           |           |           |                   |                   |
| Gross weight                 | 294,569   | 295,285   | 268,662   | 274,989           | 258,698           |
| Co content                   | 5,869     | 7,365     | 7,090     | 7,255             | 7,086             |
| <b>Metal:</b>                |           |           |           |                   |                   |
| Materials treated:           |           |           |           |                   |                   |
| Gross weight                 | 281,189   | 286,024   | 313,897   | 299,811           | 261,608           |
| Co content                   | 5,743     | 7,261     | 7,519     | 7,075             | 6,666             |
| Refined electrolytic cathode | 4,160     | 4,694     | 4,871     | 4,447             | 4,674             |
| <b>Copper:<sup>4</sup></b>   |           |           |           |                   |                   |
| Mine output: <sup>6</sup>    |           |           |           |                   |                   |
| Ore milled:                  |           |           |           |                   |                   |
| Gross weight thousand tons   | 26,010    | 24,419    | 24,040    | 23,640            | 22,952            |
| Cu content                   | 537,261   | 507,446   | 540,701   | 538,115           | 519,400           |
| Concentrate:                 |           |           |           |                   |                   |
| Gross weight                 | 1,682,355 | 1,642,907 | 1,507,632 | 1,487,749         | 1,343,642         |
| Cu content                   | 423,397   | 403,450   | 394,122   | 419,080           | 400,221           |

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>   | 1986              | 1987     | 1988     | 1989 <sup>p</sup> | 1990 <sup>e</sup> |
|--|-------------------|----------|----------|-------------------|-------------------|
| <b>METALS<sup>3</sup>—Continued</b>                            |                   |          |          |                   |                   |
| <b>Metal:</b>  |                   |          |          |                   |                   |
| <b>Electrowon:</b>   |                   |          |          |                   |                   |
| From tailings leachate <sup>7</sup>                            | 90,598            | 98,306   | 97,690   | 78,716            | 67,774            |
| From copper concentrate leachate                               | 22,654            | 18,940   | 20,041   | 16,857            | 12,418            |
| From cobalt concentrate leachate                               | 26,556            | 27,228   | 29,986   | 25,233            | 24,379            |
| Total electrowon   | 139,808           | 144,474  | 147,717  | 120,806           | 104,571           |
| Smelter output, blister/anode <sup>8</sup>                     | 349,469           | 347,909  | 308,928  | 345,486           | 316,277           |
| <b>Refined:</b>  |                   |          |          |                   |                   |
| Electrorefined <sup>9</sup>                                    | 352,150           | 347,342  | 311,983  | 342,735           | 334,878           |
| Shapes <sup>10</sup>   | 94,376            | 79,281   | 85,728   | 75,383            | 50,546            |
| Subtotal   | 446,526           | 426,623  | 397,711  | 418,118           | 385,424           |
| Electrowon <sup>11</sup>                                       | 51,068            | 69,638   | 51,848   | 45,444            | 52,660            |
| Total refined grade  | 497,594           | 496,261  | 449,559  | 463,562           | 438,084           |
| <b>Lead:<sup>4</sup></b>                                       |                   |          |          |                   |                   |
| Mine output, Pb content of ore milled                          | 12,201            | 12,510   | 12,118   | 8,807             | 9,638             |
| Metal, refined, gross weight <sup>13</sup>                     | 6,793             | 7,554    | 6,345    | 3,653             | 3,670             |
| Manganese concentrate (≈48% Mn), gross weight                  | 554               | —        | 502      | 351               | 712               |
| Selenium: metal, refined, gross weight <sup>14</sup> kilograms | 22,150            | 26,819   | 24,083   | 20,861            | 21,692            |
| Silver <sup>12</sup> do.                                       | 26,397            | 27,843   | 24,093   | 19,719            | 17,031            |
| Tin concentrate (≈70% Sn), gross weight                        | 3                 | 24       | 2        | 2                 | 2                 |
| <b>Zinc:<sup>4</sup></b>                                       |                   |          |          |                   |                   |
| Mine output, Zn content of ore milled                          | 26,964            | 30,287   | 25,169   | 22,853            | 32,074            |
| Metal, refined, gross weight                                   | 22,112            | 20,899   | 18,343   | 12,351            | 9,717             |
| <b>INDUSTRIAL MINERALS</b>                                     |                   |          |          |                   |                   |
| Cement, hydraulic  | 333,716           | 374,982  | 404,600  | 385,937           | 375,000           |
| <b>Clay:</b>   |                   |          |          |                   |                   |
| Brick <sup>15</sup>  | 4,627             | 6,606    | ≈5,000   | 5,126             | ≈3,732            |
| Building, not further specified                                | 4,095             | 3,096    | ≈2,000   | ≈2,000            | 2,000             |
| China  | 515               | 315      | 367      | ≈350              | 350               |
| Feldspar   | 214               | 45       | 120      | 20                | ≈60               |
| <b>Gem stones:</b>   |                   |          |          |                   |                   |
| Amethyst kilograms   | 6,991             | 3,757    | 4,701    | 6,275             | ≈18,130           |
| Aquamarine do.   | ( <sup>16</sup> ) | 63       | 56       | 89                | ≈166              |
| Emerald do.  | 413               | 992      | 1,039    | 334               | ≈619              |
| Lime, hydrated, and quicklime thousand tons                    | 243               | 235      | 239      | 320               | 300               |
| Nitrogen: N content of ammonia                                 | 24,700            | 33,330   | 16,200   | ≈11,700           | 6,200             |
| Sand and gravel, construction thousand tons                    | 129               | 150      | 200      | 226               | 1,000             |
| <b>Stone:</b>  |                   |          |          |                   |                   |
| Limestone, construction aggregate do.                          | 705               | 720      | 999      | 775               | ≈772              |
| Phyllite do.   | 19                | 22       | 25       | 22                | ≈23               |
| Building, not further specified do.                            | 134               | 130      | 1,536    | 933               | 50                |
| <b>Sulfur:<sup>4</sup></b>                                     |                   |          |          |                   |                   |
| <b>Pyrite concentrate:</b>                                     |                   |          |          |                   |                   |
| Gross weight (≈42% S)  | 40,590            | 56,122   | 74,952   | 70,828            | ≈72,060           |
| S content <sup>e</sup>   | 17,000            | 23,600   | 31,500   | 29,700            | 30,300            |
| <b>In sulfuric acid:<sup>e</sup> <sup>17</sup></b>             |                   |          |          |                   |                   |
| From pyrite roaster gas, S content                             | 17,000            | 23,000   | 31,000   | 29,000            | 30,000            |
| From smelter gas, S content                                    | ≈87,000           | ≈86,000  | ≈75,000  | 73,000            | 70,000            |
| Total, S content   | ≈104,000          | ≈109,000 | ≈106,000 | 102,000           | 100,000           |

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>                             | 1986  | 1987  | 1988  | 1989 <sup>b</sup> | 1990 <sup>c</sup> |
|--|-------|-------|-------|-------------------|-------------------|
| <b>INDUSTRIAL MINERALS—Continued</b>               |       |       |       |                   |                   |
| Talc   | 266   | 258   | 73    | 114               | <sup>3</sup> 160  |
| <b>MINERAL FUELS AND RELATED MATERIALS</b>         |       |       |       |                   |                   |
| Coal, bituminous<br>thousand tons                  | 557   | 463   | 524   | 395               | <sup>3</sup> 382  |
| Petroleum, refinery products:                      |       |       |       |                   |                   |
| Liquefied petroleum gas—thousand 42-gallon barrels | 60    | 77    | 84    | 43                | 40                |
| Motor gasoline do.                                 | 916   | 972   | 1,149 | 1,237             | 1,230             |
| Jet fuel do.                                       | 361   | 416   | 520   | <sup>4</sup> 540  | 530               |
| Kerosene do.                                       | 239   | 253   | 318   | <sup>4</sup> 323  | 320               |
| Distillate fuel oil do.                            | 2,078 | 2,041 | 2,149 | 2,071             | 2,070             |
| Residual fuel oil do.                              | 624   | 615   | 564   | 623               | 620               |
| Other do.  | 418   | 407   | 466   | 431               | 430               |
| Total, including refinery fuel and losses do.      | 4,696 | 4,781 | 5,250 | 5,268             | 5,240             |

<sup>4</sup>Estimated. <sup>b</sup>Preliminary. <sup>c</sup>Revised.<sup>1</sup>Table includes data available through Dec. 1, 1991.<sup>2</sup>In addition to commodities listed, fluospar production was reported in 1989 (99 metric tons) and 1990 (35 metric tons); also, minor quantities of crude construction materials (clays, sand and gravel, stone, et al.) presumably were produced, but information is inadequate to reliably estimate output.<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.<sup>7</sup>Apparently included metal recovered from ores toll processed by ZCCM for another company in 1986 (501 tons) and 1987 (106 tons).<sup>8</sup>Included the following quantity of blister anodes produced on toll from Zairean concentrates, in metric tons: 1986—26,897; 1987—29,205; 1988—24,812; 1989—15,303; and 1990—16,182.<sup>9</sup>Included the following quantity of electrolytic cathodes (presumably refined-grade) produced on toll from blister smelted from Zairean concentrates, in metric tons: 1986—26,111; 1987—28,886; 1988—28,886; 1989—15,094; and 1990—16,494.<sup>10</sup>Reported as "finished production, refined shapes" (wirebar and billets), presumably 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>11</sup>Reported as "finished production, leach cathodes," which apparently were a portion of the total electrowon cathodes that were not further refined (presumably meeting specifications for refined-grade). Also included are electrowon cathodes produced on toll by ZCCM for another Zambian company and not further refined in 1986 (501 tons) and 1987 (106 tons).<sup>12</sup>Mostly from copper and cobalt refinery mud-slimes.<sup>13</sup>For practical purposes, outputs of crude (smelted) and refined metal were regarded as equal.<sup>14</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>15</sup>Weight of finished brick.<sup>16</sup>Less than 1/2 unit.<sup>17</sup>Additional acid is produced by burning imported sulfur, starting Nov. 1988, but information is inadequate for reliably estimating output.**TRADE**

Cobalt, copper, lead and zinc were usually considered the major mineral exports in order of importance. However, smuggled gem stones were reported to be very significant. Japan was the leading destination for official exports in recent years.

Crude oil was by far the major import. The Republic of South Africa and the Arabian Gulf States were the principal sources of imports.

The United States was not a significant trading partner.

**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 major commercial and industrial ventures. Zambia Consolidated Copper Mines Ltd. (ZCCM) was the principal entity in the minerals field. Leading officials of the new Government have given indications that the privatization program extends to all parastatals. Proposed new investment and mining acts were expected to result in formation of new private companies.

**COMMODITY REVIEW****Metals**

**Cobalt.**—Although there was no major change in the international supply-demand situation during the year, price matters dominated the cobalt news. At midyear,

traders became concerned over the growth in demand versus the disruption of the Zairean supply due to civil unrest and of the Zambian supply due to effects of the Gulf crisis on oil imports. Prices did rise, including the producer price set jointly by Zaire and Zambia. In 1990, Zaire and Zambia, respectively, produced about 10,000 tons and 5,000 tons of a Western World total of about 20,000 tons, compared with consumption of 22,000 tons. The producer price was \$8.40 from January 1990 until it was raised to \$11 in January 1991. Cobalt was produced as a coproduct of copper production.

**Copper.**—ZCCM, in its annual report for the year ending March 31, 1991, indicated external investment would probably soon be needed for facilities to maintain operations at the same level. Copper ore reserves

on ZCCM property were apparently considered sufficient for at least 15 years, although data shown suggested even more, a total of almost 400 Mmt averaging slightly more than 3% and mineral resources totaling more than 1,200 Mmt at 2.4%. As for the previous 3 years, the company made a net profit after tax. It was \$179 million<sup>1</sup> and, as usual, a substantial increase over the previous year, although much of it was due to currency exchange rate changes.

The African Development Bank approved a \$64 million loan to ZCCM at midyear. It was toward a 4-year, \$175 million rehabilitation program. The program covered work at the Nkana smelter including installing a Teniente Modified Converter and renovating the acid plant, replacing small flotation cells at the Nchanga concentrator with modern large cells, and improving other facilities as well as employee training. Additional financial assistance was also being sought for the program, parts of which apparently began several years earlier.

Opening a new surface mine on a 9-Mmt, 4.4% copper deposit under old tailings west of the Nchanga workings also started. A new dam was to be made to hold the tailings.

The first portion of an initial shipment of 1,500 tons of Zambian copper arrived at Walvis Bay on the South Atlantic Ocean in mid-September. It was planned to ship 5,000 mt/month using trucks to Grootfontein in Namibia and then rail to the port.

Early in 1991, ZCCM announced a 6-month shutdown starting in May 1991 of the 200,000-mt/a Mufulira smelter. The electric furnace is to be rebuilt. Deliveries of copper are not expected to be affected, according to the company.

### Industrial Minerals

**Gem stones.**—The mining, processing, and marketing of gem stones were identified by the World Bank and other study groups as having a very attractive potential for foreign investment. Some investigators even considered gem stones to be next to copper as the most important mineral product to the Zambian economy. One estimated that emeralds accounted for 80% of total value of Zambian gem stone production and more than 20% of the world supply. An estimated 95% of emeralds produced was being smuggled out of Zambia. Amethyst, aquamarine, garnet, and tourmaline were also mined.

Of 30 to 40 registered gem stone 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.

Aid donors pressured the Government into reforming policies on production and marketing. Miners became entitled to retain 50% of foreign exchange earnings, and a gem stone board run by miners was to be set up. Presumably, the board would oversee a national gem stone marketing company that would be established to auction production.

**Talc.**—A company formed in 1989, called Talc Zambia, was to have been awarded supply contracts by buyers in Zimbabwe, Tanzania, and the Republic of South Africa. The deposits to be mined were identified as being near Ndola and possibly was the world's largest.

### Mineral Fuels

**Coal.**—The Government reportedly approved proceeding with the second phase of the rehabilitation of the Maamba Collieries Ltd. strip mine in southern Zambia. However, early in 1991, the Government was seeking financing for a study of the longer term viability of the mine before committing major funds. The company is an unprofitable parastatal that was considered well-managed but needing foreign exchange and improved productivity.

**Petroleum.**—Mobil Oil Corp. announced in March 1991 that ground seismic surveys would be made on both the Zambian and Zimbabwean sides of the Zambezi River valley. 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. A drilling decision was not expected until late 1992 at the earliest.

The Italian-managed state-owned Indeni oil refinery in Ndola was to be shut down in late August because no crude was available. The pipeline from Dar es Salaam was not operating. The Gulf crisis was claimed as the cause of the supply stoppage, and rationing was being considered.

### Reserves

Copper ore reserves of ZCCM are ample for at least 15 years of continued full-scale operation according to ZCCM officials. Additional known resources of ZCCM are huge, and there were other known copper

deposits as well. Cobalt reserves that are associated with the copper ore are substantial.

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. Nickel resources were being defined by an unidentified private company.

A large variety of other metallic minerals deposits were also known but needed further exploration. Most work has been done on iron, tin, and molybdenum.

Industrial mineral resources that were being studied or exploited included the following: fluorspar, gemstones, limestone for cement and lime, marble, and talc. Phosphate resources were considered to have some potential.

Mineral fuel resources consisting of bituminous coal are known.

## INFRASTRUCTURE

A fairly extensive road and railway network existed within the country and externally for access to ocean and lake ports for international trade. However, political unrest prevented use of some external links. Lack of maintenance on internal routes was of concern, and donor aid programs were helping to improve the situation.

Electric power supply was adequate, furnished by about 70% from hydroelectric, 20% from oil, and 10% from coal plants. Expansion of hydro sources was planned.

## OUTLOOK

For the near term economic difficulties can be expected to continue. But the longer term looks bright with the new open political environment and market-oriented Government, and reasonable personnel and financial assistance from international and bilateral sources. Agricultural and mineral resources should remain the basis for a balanced economy. And with political stability and the new investment and mining policies, the international mining community can be expected to recognize opportunities.

<sup>1</sup>Where necessary, values have been converted from Zambia kwachas (K) to U.S. dollars at the rate of K28.99=U.S.\$1.00 for 1990 values and K12.90=U.S.\$1.00 for 1989 values. These were the official year averages quoted by the Bank of Zambia, which quoted rates for end of 1989 at 21.64, 1990 at 42.74, and June 1991 at 65.36.

**OTHER SOURCES OF INFORMATION**

Ministry of Mines  
P.O. Box 31969  
Lusaka, Zambia  
Telephone: 227-653

Mines Development Department  
P.O.Box 31969  
Lusaka, Zambia  
Telephone: 227-653

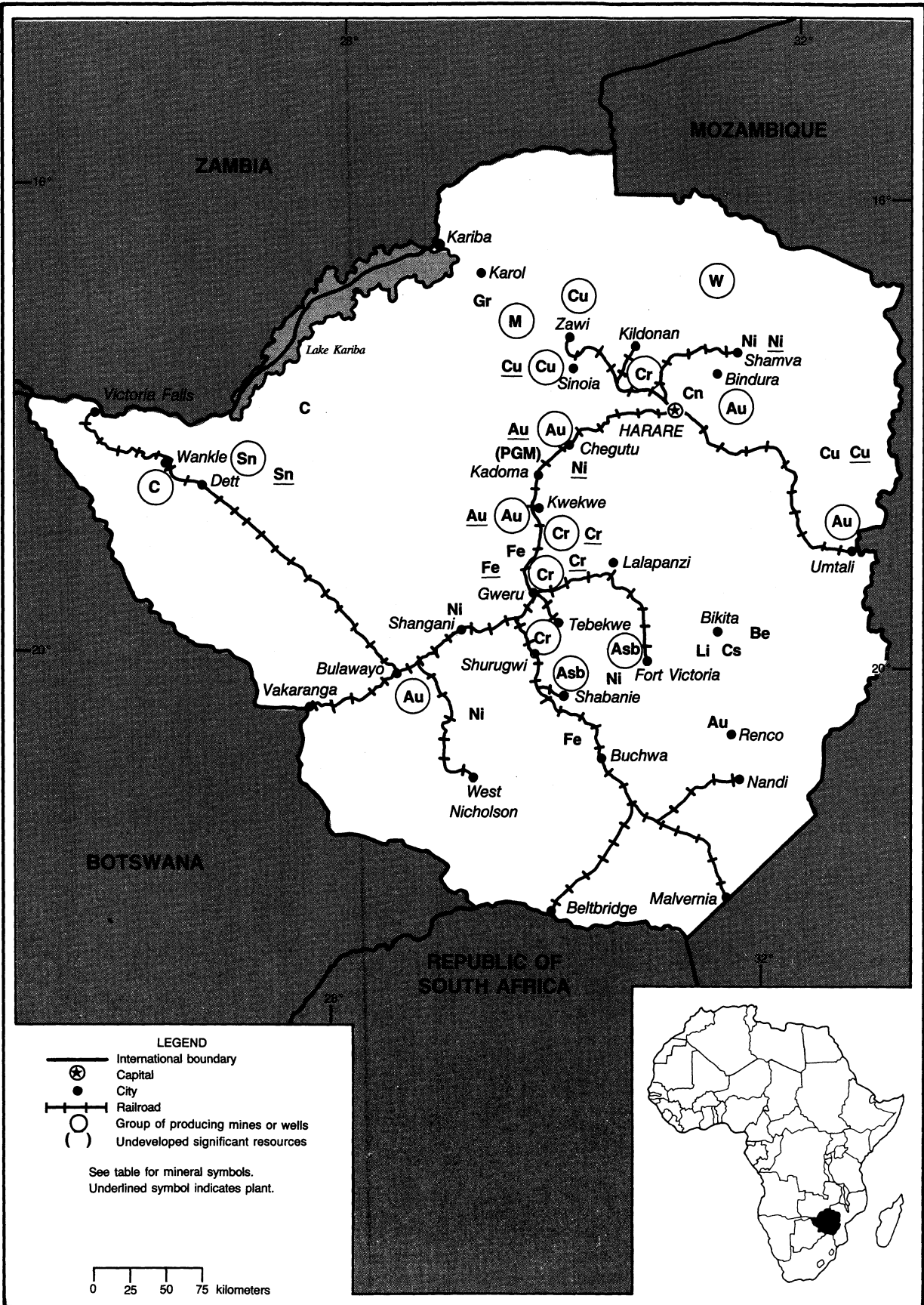
Geological Survey Department  
P.O.Box 50135  
Lusaka, Zambia  
Telephone: 250-174



# ZIMBABWE

AREA 390,580 km<sup>2</sup>

POPULATION 10.7 million



# THE MINERAL INDUSTRY OF ZIMBABWE

By David Izon

**Z**imbabwe is among the major world suppliers of ferrochrome, chrysotile asbestos, and lithium minerals. More than one-half of the world's known reserves of high-grade chromium ore is found in Zimbabwe. It was also a moderate supplier of copper, gold, nickel, and tin. The most important minerals, in order of economic value, were gold, asbestos, nickel, coal, copper, chromite, tin, and silver. The mining sector contributed a small proportion to the GDP in 1990, but it played a vital role in Zimbabwe's economy mainly because of its enormous foreign exchange earning capacity. The mining industry accounted for about 7% of GDP and about 42% of the country's foreign exchange earnings. The mining industry was inhibited by a chronic shortage of foreign exchange, by transport problems, and by high inflation. Investment incentives were announced to stimulate more imports, give industry more foreign exchange, and allow foreign investors to repatriate a higher percentage of their profits.

## GOVERNMENT POLICIES AND PROGRAMS

The Government established policies and programs to ensure continued modest growth in the mining sector. An economic reform scheme was adopted that aimed at increasing exports and foreign investment. These included trade liberalization measures that were intended to alleviate some of the foreign exchange constraints on the mining industry. Under the new investment code, companies that exported more than 75% of their production were allotted unlimited foreign exchange. Also, import restrictions on equipment for the manufacturing industry were lifted. The Government established an investment center to process applications and approve proposals involving investments of up to \$2.2 million.<sup>1</sup> Larger projects were referred to the minister of finance who made decisions after consultation with appropriate sectoral ministers. The center was also responsible for investment promotion and monitoring of project implementation.

The new mining law required that prospectors must be citizens of Zimbabwe or

employ local agents. Also, mining industries were allowed to retain 5% of their export earnings for the purchase of imported raw materials and capital goods. Allocations of foreign exchange for the mining and agricultural sectors were to be made every 6 months.

Major projects planned for implementation were the development of the country's extensive chromium and platinum reserves, rehabilitation and expansion of Zimbabwe Iron and Steel Co. (ZISCO) to cost \$100 million, and construction of a \$200 million, 900-mt/d fertilizer plant. Another significant project under consideration included construction of an \$800 million 1,600 MW hydroelectric facility. It is to be located at Batoka Gorge on the Zambezi River 50 km downstream from Victoria Falls.

The country's transportation problems were being studied by the World Bank and the Government. Plans to improve the transport system were underway with an allocation of \$178 million. Most of the money was used for the National Railways of Zimbabwe (NRZ) traffic development program. This involved building roads and bridges and performing immediate improvements at the railroad tracks. The Government planned to allocate \$451 million to the transport sector over the next 5 years.

## PRODUCTION

In general, mineral production grew by about 4.5% in 1990, down from 7% in 1989. The decline in production was partly due to large increases in energy and transport prices owing to the Persian Gulf crisis. This caused chronic shortage of foreign exchange needed for purchase of raw materials and industrial equipment. The most important minerals produced, in terms of value, were asbestos, copper, ferrochrome, gold, and nickel. Gold had the highest value, accounting for 31% of mineral export earnings. In terms of volume, there was a slight increase in production of coal, chromite, gold, and iron ore. Most of the country's mineral industries were export orientated and thus were exposed to world market fluctuations.

## TRADE

The main export commodities, in order of importance, were tobacco, gold, ferroalloys, cotton, nickel, asbestos, iron and steel, coffee, sugar, and copper. Zimbabwe's trade balance in 1990 amounted to a surplus of \$355 million. Zimbabwe's leading trade partners were the Federal Republic of 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 ferrochrome, pig iron, steel, and coke. Total mineral export earnings in 1990 amounted to about \$640 million. Gold was the leading mineral export, with a value of \$200 million, followed by ferrochrome valued at \$190 million, nickel at \$94 million, and asbestos at \$58 million. This accounted for about 42% of total export earnings. Principal mineral exports to the United States were ferrochrome and nickel. There was a decrease of 16.4% in sales of ferroalloys, about an 8% decrease in nickel sales, and a decrease of 1.4% of copper and its byproducts. Increase in sales reported for asbestos, iron and steel, gem stones, and graphite were not enough to offset the losses.

Major import commodities were machinery and transport equipment, chemicals, farm equipment, petroleum products, and computers. Principal imports from the United States were aircraft, computers, farm equipment, synthetic fibers, and packaging materials.

## STRUCTURE OF THE MINERAL INDUSTRY

Mining in Zimbabwe was carried on by about 13 major companies and their subsidiaries. They were in many cases privately owned but subsidiaries of international mining companies. The mines belonging to these companies produced 85% of the country's mineral output. The rest of the production was from approximately 500 small mines. These small mines were operated by small works having 10 to 200 em-

ployees. They were mostly engaged in gold mining, but a few of them produced other minerals such as tungsten, tantalite, tin, and semiprecious stones.

Most of the minerals produced in Zimbabwe were processed before being exported through the Minerals Marketing Corp. of Zimbabwe. Refractory minerals containing

gold were treated at the state owned and operated roasting plant. The mining industry employed approximately 56,000 workers, about 5% of the national labor force. The mining industry accounted for 50% of rail tonnage, and its annual electricity consumption amounted to one-third of the total electricity consumed in the country. A large share

of the locally manufactured goods and industry's output, such as chemicals, explosives, coal, and liquid fuels were consumed by the mining industry.

Oil and gas prospecting was conducted around the Zambezi valley by joint-venture agreements with foreign partners in equity sharing arrangements.

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

(Metric tons unless otherwise specified)

| Commodity   | 1986           | 1987           | 198 8          | 1989 <sup>p</sup> | 1990 <sup>p</sup> |
|---|----------------|----------------|----------------|-------------------|-------------------|
| <b>METALS</b>   |                |                |                |                   |                   |
| Aluminum: Bauxite, gross weight                       | 24,284         | —              | —              | —                 | —                 |
| Antimony, mine output, concentrate, Sb content        | 175            | 153            | 165            | 210               | 101               |
| Beryllium: Beryl concentrate, gross weight            | 103            | 83             | 33             | 46                | 28                |
| Chromium: Chromite, gross weight                      | 533,105        | 570,298        | 561,477        | 627,424           | 643,098           |
| Cobalt: <sup>2</sup>                                  |                |                |                |                   |                   |
| Mine output, Co content <sup>e</sup>                  | 48             | 88             | 104            | 90                | 102               |
| Metal   | 76             | 110            | 126            | 112               | 127               |
| Columbium and tantalum: Tantalite concentrate:        |                |                |                |                   |                   |
| Gross weight kilograms                                | 33,000         | 37,000         | 66,000         | 32,000            | 35,000            |
| Cb content <sup>e</sup> do.                           | 5,000          | 2,600          | 9,900          | 4,800             | 5,200             |
| Ta content <sup>e</sup> do.                           | 11,600         | 6,100          | 23,100         | 11,200            | 12,200            |
| Copper:   |                |                |                |                   |                   |
| Mine output, concentrate, Cu content <sup>e</sup>     | 21,390         | 19,800         | 16,900         | 16,400            | 14,698            |
| Metal:  |                |                |                |                   |                   |
| Smelter output, blister/anode, primary <sup>e,3</sup> | 20,500         | 19,000         | 16,300         | 15,800            | 14,100            |
| Refinery output, refined/cathode, primary             | 20,423         | 18,819         | 16,116         | 15,659            | 14,080            |
| Gold kilograms  | 14,853         | 14,710         | 14,191         | 16,003            | 16,900            |
| Iron and steel:                                       |                |                |                |                   |                   |
| Mine output, iron ore:                                |                |                |                |                   |                   |
| Gross weight thousand tons                            | 1,110          | 1,328          | 1,020          | 1,143             | 1,259             |
| Fe content <sup>e</sup> do.                           | 670            | 824            | 632            | 686               | 730               |
| Metal:  |                |                |                |                   |                   |
| Pig iron <sup>e</sup> do.                             | 644            | 575            | 600            | 520               | 521               |
| Steel, crude do.                                      | 490            | 515            | 500            | 650               | 580               |
| Ferroalloys:  |                |                |                |                   |                   |
| Ferrochromium   | 155,000        | 212,300        | 224,000        | 173,000           | 222,102           |
| Ferrochromium-silicon                                 | 50,000         | 21,192         | 29,000         | 25,000            | 16,612            |
| Ferromanganese  | 2,000          | —              | 2,000          | —                 | —                 |
| Total   | <u>207,000</u> | <u>233,492</u> | <u>255,000</u> | <u>198,000</u>    | <u>238,714</u>    |
| Nickel:   |                |                |                |                   |                   |
| Mine output, concentrate, Ni content <sup>e</sup>     | 10,370         | 12,320         | 13,500         | 13,600            | 13,490            |
| Refinery output, refined metal <sup>4</sup>           | 9,730          | 10,394         | 11,490         | 11,633            | 11,426            |
| Platinum-group metals:                                |                |                |                |                   |                   |
| Palladium kilograms                                   | 35             | 29             | 46             | 43                | 31                |
| Platinum do.  | 26             | 18             | 28             | 25                | 21                |
| Total do.   | <u>61</u>      | <u>47</u>      | <u>74</u>      | <u>68</u>         | <u>52</u>         |
| Silver do.  | 26,150         | 25,351         | 21,953         | 22,305            | 21,221            |

See footnotes at end of table.

TABLE 1—Continued

**ZIMBABWE: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>**

(Metric tons unless otherwise specified)

| Commodity   | 1986     | 1987    | 1988    | 1989 <sup>P</sup> | 1990 <sup>P</sup> |
|---|----------|---------|---------|-------------------|-------------------|
| <b>METALS:—Continued</b>  |          |         |         |                   |                   |
| <b>Tin:</b>   |          |         |         |                   |                   |
| Mine output, Sn content <sup>e</sup>                            | 1,470    | 1,410   | 1,140   | *1,130            | *1,117            |
| Smelter output, metal   | 1,079    | 1,038   | 855     | 848               | 838               |
| <b>Tungsten, concentrate:</b>                                   |          |         |         |                   |                   |
| Gross weight  | 2        | 1       | 1       | ( <sup>g</sup> )  | ( <sup>g</sup> )  |
| W content <sup>e</sup>  | 1        | 1       | 1       | 1                 | 1                 |
| <b>INDUSTRIAL MINERALS</b>                                      |          |         |         |                   |                   |
| Asbestos  | 163,989  | 193,925 | 186,581 | 187,006           | 160,861           |
| Barite  | 298      | 191     | 3,400   | 1,900             | 320               |
| Cement, hydraulic   | *750,000 | 810,712 | 775,736 | 719,469           | 700,000           |
| <b>Clays:</b>   |          |         |         |                   |                   |
| Bentonite (montmorillonite)                                     | 71,987   | 116,802 | 113,157 | 104,865           | 99,854            |
| Fire clay   | 12,591   | 16,022  | 16,171  | 19,100            | 19,914            |
| Kaolin  | 901      | 780     | 95      | 17                | —                 |
| Feldspar  | 2,026    | 2,962   | 3,730   | 2,697             | 2,197             |
| <b>Gem stones, precious and semiprecious: Emerald kilograms</b> | 59       | 1,979   | 6,380   | 6,300             | 13,010            |
| Graphite  | 15,000   | 13,530  | 11,441  | 18,147            | 16,383            |
| Kyanite   | 1,851    | —       | 1,795   | 1,869             | 160               |
| Lithium minerals, gross weight                                  | 32,760   | 14,959  | 15,073  | 20,647            | 19,053            |
| Magnesium compounds: Magnesite                                  | 22,649   | 28,991  | 30,121  | 33,423            | 32,639            |
| Mica  | 1,340    | 800     | 1,797   | 1,471             | 1,301             |
| Nitrogen: N content of ammonia                                  | 49,100   | 53,300  | 64,400  | *61,500           | 62,500            |
| <b>Phosphate rock, marketable concentrate</b>                   |          |         |         |                   |                   |
| thousand tons   | 136      | 155     | 125     | 134               | 148               |
| Pigments, iron oxide  | 207      | *200    | 363     | 287               | 416               |
| Quartz <sup>6</sup>   | 145      | 41      | 55      | 62                | 63                |
| thousand tons   |          |         |         |                   |                   |
| Stone: Limestone  | 1,407    | 1,537   | 1,408   | 1,370             | 1,252             |
| do.   |          |         |         |                   |                   |
| <b>Sulfur</b>   |          |         |         |                   |                   |
| <b>Pyrite:</b>  |          |         |         |                   |                   |
| Gross weight  | 62,506   | 46,606  | 39,659  | 47,561            | 66,571            |
| S content <sup>e</sup>  | 25,000   | 20,500  | 17,500  | 20,900            | 29,300            |
| Byproduct acid, metallurgical and coal process gas <sup>e</sup> | 5,000    | 5,000   | 5,000   | 5,000             | 5,000             |
| Total   | 30,000   | 25,500  | 22,500  | 25,900            | 34,300            |
| Talc  | 797      | 516     | 976     | 1,513             | 1,787             |
| <b>MINERAL FUELS AND RELATED MATERIALS</b>                      |          |         |         |                   |                   |
| Coal, bituminous  | 4,047    | 4,848   | 4,900   | 5,111             | 5,505             |
| thousand tons   |          |         |         |                   |                   |
| Coke, metallurgical <sup>e7</sup>                               | 200      | *592    | 600     | 600               | 565               |
| do.   |          |         |         |                   |                   |

<sup>e</sup>Estimated. <sup>P</sup>Preliminary.<sup>1</sup>Table includes data available through Jan. 15, 1992.<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. for 1986 ending Aug. 31; additional output by the Redcliff plant of Zisco Ltd. may total 250,000 metric tons per year of metallurgical coke and coke breeze.

TABLE 2

## ZIMBABWE: STRUCTURE OF THE MINERAL INDUSTRY FOR 1990

(Thousand metric tons unless otherwise specified)

| Major commodity | Major operating companies                   | Location of main facilities    | Annual capacity       |
|-----------------|---|--------------------------------|-----------------------|
| Asbestos        | Shabanie and Mashaba Mines (Pvt.) Ltd.      | Shabanie                       | 300.                  |
| Chromite        | Zimbabwe Mining and Smelting Co. (Pvt) Ltd. | Kwekwe                         | 1,000.                |
| Do.             | Zimbabwe Alloys Ltd.                        | Gweru                          |                       |
| Coal            | Wankie Colliery Co. Ltd.                    | Wankie                         | 1,000.                |
| Cobalt          | Bindura Nickel Corp.                        | Shangani, Samva                | 0.2.                  |
| Copper          | Mhangura Copper Mines (MCM)                 | Sinoia                         | 30.                   |
| Gold kilograms  | Cluff Minerals Zimbabwe Ltd.                | Bindura                        | 2,500.                |
| Do.             | Rio Tinto Mining (Zimbabwe) Ltd.            | Renco                          | 1,000.                |
| Iron and steel  | Zimbabwe Iron and Steel Co.                 | Redcliff, near Gweru<br>Buchwa | 1,000.<br>crude steel |
| Nickel          | Bindura Nickel Corp.                        | Bindura                        | 13.                   |
| Do.             | Empress Nickel Refinery Ltd.                | Eiffel Flats<br>near Chegutu   | 10.                   |
| Tin             | Kamativi Tin Mines Ltd.                     | Near Dett                      | 1,000.                |

## COMMODITY REVIEW

## Metals

**Gold.**—Gold production increased primarily owing to Cluff Resources' Freda-Rebecca Project in Bindura, which produced about 2,120 kg in 1990. Cluff Resources announced plans to increase annual production to 2,500 kg by 1992. The expansion project is being financed partly by raising \$16 million in bonds on the Zimbabwe Stock Exchange. The total amount of gold produced in 1990 was 16,900 kg. About 1,400 artisanal miners produced 1,690 kg. The increased production in 1990 was mainly due to improvements made at the Dalny Mine of the Falcon Mines Group. Illegal gold panning activities were common. The advent of heap leaching has resulted in many established and small mines re-treating their waste to reclaim the residual gold. The process is creating environmental concerns for the Government. The established companies rarely have problems in the use of cyanide and lime, but the small-scale miners lack the experience and resources to abide by the strict Government regulations.

The Reserve Bank of Zimbabwe is responsible for the purchase of all gold in the country. It also sets the floor price to producers to create incentives for investment in this sector.

**Nickel.**—Bindura Nickel Corp. was a major producer of nickel in the country. In

1990, Bindura's four mines at Trojan, Shangani, Madziwa, and Epoch milled a total of more than 12,500 tons of nickel in concentrates. Two shafts were completed in 1990 on the subvertical shaft-deepening project at the Trojan Mine. A major breakdown of one of the primary mills at the Shangani Mine affected production, keeping it at about the 1989 level. The mine experienced some development and production problems owing to poor ground conditions. The Epoch and Madziwa Mines suffered some reduction in head grade because mine development problems prevented production from better grade stope blocks. The Empress Nickel Refinery produced nickel cathode for BCL Ltd. in Botswana, for whom it was toll refining matte.

**Platinum Group-Metals.**—The Great Dyke was explored by a consortium of companies for its copper, nickel, and platinum potential. Four major projects were being considered for development: the joint venture of Delta and BHP-Utah's Hartley project; Union Carbide's Mimosa Mine; the consortium of Anglo American, Rio Tinto, and Plateau's Zinca Mine Project; and Anglo American's Unki Project. It is anticipated that 2 of these projects could be developed within two years. The most promising of the four projects are the Mimosa Mine near Zvishavane and the Hartley. At the Mimosa Mine, it is estimated that overall recovery rate would be 94% using safe, economic

mining methods. Output was planned at 2,123 kg/a. The initial phase of the project, scheduled to start in 1995, required an investment of \$140 million from the shareholders. In late 1990, Union Carbide Zimbabwe announced a plan to invest \$500 million in the project over 5 years to be absorbed by its ferrochrome sector. The final phase was scheduled to begin in 1998.

Delta Gold (Pty.) Ltd. of Australia and BHP Minerals of Utah formed a joint venture to develop a platinum operation near Chegutu on the Hartley complex of the Great Dyke. Initial studies showed that it was feasible for 2 Mmt of ore to be mined, producing about 3,000 kg/a of platinum. BHP completed a first stage of drilling program ahead of schedule in 1990 and started the second stage of underground drilling for a revised feasibility study to be completed in October 1992. On completion, Hartley would be the largest underground platinum mine outside the Republic of South Africa. It is estimated that the Hartley complex would produce 3% of world supply of platinum and contribute 7% of Zimbabwe's total export earnings as well as employ 2,000 people. The estimated cost of the project was about \$250 million.

## Industrial Minerals

In an attempt to encourage a production increase, the Government removed price controls on cement. The Government also placed cement and cement raw materials on the Open General Import Licensing sys-

tem to allow the country's two cement companies to import cement to meet the shortfall in local production. Cement shortages delayed some major construction projects during the year. The \$80 million expansion project of United Portland Cement Co.'s plant, which was planned to raise annual production to 750,000 mt/a, was delayed. A \$14 million refurbishment project for Circle Cement's plant was awaiting approval by the Zimbabwe Investment Center. Commissioning of the projects may raise annual production to about 1.2 Mmt.

### Reserves

Officially reported reserve figures were not available. However, some data have been reported by the Zimbabwe Chamber of Mines Journal, regarding resources. Reserves of chromite in the Great Dyke have been reported at 448 Mmt. Coal reserves were estimated at more than 30 billion tons, copper ore at about 13 Mmt, lithium ore at about 6 Mmt, nickel ore at about 23 Mmt, and PGM ore at the Hartley complex at about 37 Mmt.

## INFRASTRUCTURE

The National Railways of Zimbabwe (NRZ), one of the largest in Africa, consists of 4,304 km of total railroad. The system was operated by the Government along with its Motor Transport Service. All major cities and industrial centers are along the rail network that serves most of the country. Most of the bulk imports and exports are moved by rail to the international markets, making it the backbone for agricultural and industrial development. The existing road system is not capable of carrying large tonnages for long distances in competition with the railroad at the cheaper prices as could the railways. Zimbabwe is landlocked. Trade is via Botswana, Mozambique, and the Republic of South Africa.

## OUTLOOK

Nonfuel minerals such as asbestos, chromite, gold, and nickel will remain the mainstays of the economy for the immedi-

ate future. The recovery in mine production is expected to continue in the 1990's, with increases mainly in the production of coal, gold, and the PGM. The new investment regulations should encourage further foreign participation and increase output. Limitations of foreign exchange availability, which had delayed the import of spare parts and new equipment, may not continue for long. The construction of a new dam to provide electricity and an efficient transport system in the second 5 year development plan are expected to address the needs of the mining, energy, and transport sectors.

<sup>1</sup>Where necessary, values have been converted from Zimbabwe dollars (ZD) to U.S. dollars at ZD2.40=US\$1.00 for 1990.

## OTHER SOURCES OF INFORMATION

Chamber of Mines Journal  
P.O. Box 2677  
Harare, Zimbabwe  
Mining in Zimbabwe  
P.O.Box 1683  
Harare, Zimbabwe

## MAP SYMBOLS

| Commodity           | Symbol      | Commodity                   | Symbol      | Commodity                     | Symbol                 |
|---------------------|-------------|-----------------------------|-------------|-------------------------------|------------------------|
| Alunite             | Alu         | Gypsum                      | Gyp         | Rare earths                   | RE                     |
| Alumina             | <u>Al</u>   | Indium                      | In          | Rhenium                       | Re                     |
| Aluminum            | <u>AL</u>   | Iron and steel              | <u>Fe</u>   | Salt                          | Salt                   |
| Andalusite          | And         | Iron ore                    | Fe          | Sand and gravel               | Sd/Gvl                 |
| Antimony            | Sb          | Jade                        | J           | Sandstone                     | Ss                     |
| Arsenic             | As          | Kaolin                      | Kao         | Selenium                      | Se                     |
| Asbestos            | Asb         | Kyanite                     | Ky          | Sepiolite, meerschaum         | Sep                    |
| Asphalt             | Asp         | Lapis lazuli                | Laz         | Serpentine                    | Serp                   |
| Barite              | Ba          | Lead                        | Pb          | Shale                         | Sh                     |
| Bauxite             | Bx          | Lignite                     | Lig         | Silicon                       | <u>Si</u>              |
| Bentonite           | Bent        | Lime                        | <u>Lime</u> | Sillimanite                   | Slm                    |
| Beryllium           | Be          | Limestone                   | Ls          | Silver                        | Ag                     |
| Bismuth             | Bi          | Liquefied natural gas       | <u>LNG</u>  | Soapstone                     | So                     |
| Bitumen (natural)   | Bit         | Liquefied petroleum gas     | <u>LPG</u>  | Soda ash, trona               | NaAsh                  |
| Boron               | B           | Lithium                     | Li          | Sodium sulfate                | NaSO <sub>4</sub>      |
| Bromine             | Br          | Magnesite                   | Mag         | Stone                         | St                     |
| Cadmium             | Cd          | Magnesium                   | <u>Mg</u>   | Strontium                     | Sr                     |
| Calcium             | Ca          | Manganese                   | Mn          | Sulfur                        | S                      |
| Carbon black        | <u>CBl</u>  | Marble and alabaster        | Marb        | Talc                          | Tc                     |
| Cement              | <u>Cem</u>  | Marl                        | Ma          | Tantalum                      | Ta                     |
| Cesium              | Cs          | Mercury                     | Hg          | Tellurium                     | Te                     |
| Chromite            | Cr          | Mica                        | M           | Thorium                       | Th                     |
| Clays               | Clay        | Molybdenum                  | Mo          | Tin                           | Sn                     |
| Coal                | C           | Natural gas                 | NG          | Titanium (rutile or ilmenite) | Ti                     |
| Cobalt              | Co          | Natural gas liquids         | <u>NGL</u>  | Titanium dioxide (processed)  | <u>TiO<sub>2</sub></u> |
| Columbium (niobium) | Cb          | Nepheline syenite           | Neph        | Tungsten                      | W                      |
| Copper              | Cu          | Nickel                      | Ni          | Umber                         | Um                     |
| Corundum            | Cn          | Nitrates                    | Nit         | Uranium                       | U                      |
| Cryolite            | Cry         | Nitrogen (ammonia plants)   | N           | Vanadium                      | V                      |
| Diamond             | Dm          | Ochre                       | Oc          | Vermiculite                   | Vm                     |
| Diatomite           | Dia         | Oil sands                   | OSs         | Wollastonite                  | Wo                     |
| Dolomite            | Ds          | Oil shale                   | OSh         | Yttrium                       | Y                      |
| Emerald             | Em          | Olivine                     | Ol          | Zinc                          | Zn                     |
| Emery               | E           | Opal                        | Opal        | Zircon                        | Zr                     |
| Feldspar            | Feld        | Peat                        | Peat        |                               |                        |
| Ferroalloys         | <u>FA</u>   | Perlite                     | Per         |                               |                        |
| Ferrochrome         | <u>FeCr</u> | Petroleum, crude            | Pet         |                               |                        |
| Ferromanganese      | <u>FeMn</u> | Petroleum refinery products | <u>Pet</u>  |                               |                        |
| Ferronickel         | <u>FeNi</u> | Phosphate                   | P           |                               |                        |
| Ferrosilicon        | <u>FeSi</u> | Pig iron                    | <u>Pig</u>  |                               |                        |
| Fertilizer          | <u>Fz</u>   | Pigments, iron              | Pigm        |                               |                        |
| Fluorspar           | F           | Platinum-group metals       | PGM         |                               |                        |
| Gallium             | Ga          | Potash                      | K           |                               |                        |
| Garnet              | Gt          | Pozzolana                   | Pz          |                               |                        |
| Gem stones          | Gm          | Pumice                      | Pum         |                               |                        |
| Germanium           | Ge          | Pyrite                      | Py          |                               |                        |
| Gold                | Au          | Pyrophyllite                | Pyrp        |                               |                        |
| Graphite            | Gr          | Quartz or quartzite         | Qtz         |                               |                        |

## MAP LEGEND

Symbol = Mine, including beneficiation plants, well  
 Circled Symbol = Group of producing mines or wells  
 Underlined Symbol = Processing plant or oil refinery, including smelters and metal refineries  
 (Symbol) = Undeveloped significant resource





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