

THE MINERAL INDUSTRY OF SOUTH AFRICA

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Mining and downstream minerals processing remained keystones of the economy of the Republic of South Africa in 1998. With a population of 43.4 million, South Africa had a gross domestic product (GDP) per capita of \$6,800¹ based on purchasing power parity estimates for 1998. Of total exports of all goods valued at \$30.9 billion, gold exports accounted for 14.1%, and other minerals and metals exports, for about an additional 28%. The minerals industry, including mining and minerals processing through semimanufactured products, accounted for more than 6% of the GDP and more than 500,000 jobs. Employment in the mining sector, however, declined to 464,900 in 1998 from 603,700 in 1994; 97% of the cutbacks were in the gold mines. The most important mineral commodities produced in South Africa, in terms of value, were gold, coal, platinum-group metals (PGM), ferroalloys (ferrochromium, ferromanganese, ferrosilicon, and ferrovandium), aluminum, steel, iron ore, diamond, vanadium, and copper. Additionally, significant output of metallic commodities included antimony, chromium, cobalt, lead, manganese, nickel, silver, titanium, uranium, zinc, and zirconium. Important output of industrial minerals included andalusite (aluminum silicate), aggregate and sand, asbestos, dimension stone, fluor spar, limestone and lime, phosphate rock, sulfur, and vermiculite. South Africa was a major producer and the world's third largest exporter of coal, and it was also the largest producer of synthetic liquid fuels and petrochemicals derived from coal. South Africa's well-developed railway and port infrastructure served the domestic minerals industry and those in neighboring countries. South Africa produced more than 62 different mineral commodities from about 695 mines and quarries, including about 61 coal mines and 54 diamond and 53 gold operations.

Government Policies and Programs

The Ministry of Mines and Energy's Department of Minerals and Energy (DME) is the primary Government entity responsible for the establishment and implementation of minerals and energy policy and for oversight of the country's mineral industry. Within the DME are the Mineral Development Branch, which is responsible for regional mineral development, minerals economics (Minerals Bureau), mine rehabilitation, and mining rights; the Energy Branch, which promotes the optimum utilization of energy resources; and the Mine, Health & Safety Inspectorate. A number of parastatal institutions were associated with DME, including the Atomic

Energy Corp.; the Council for Nuclear Safety; the Council for Geosciences (formerly the Geological Survey of South Africa); the Council for Mineral Technology (Mintek), the parastatal mineral-research organization; the National Electricity Regulator, the South African Diamond Board, and the CEF (Central Energy Fund) (Pty.) Ltd., through which the State's interest in the liquid fuel industry is owned, developed, and managed commercially.

The long-awaited Minerals and Mining Policy White Paper outlining a new minerals and mining policy for South Africa was released in October 1998 (Department of Minerals and Energy, 1998, A minerals and mining policy for South Africa, White Paper, accessed December 2, 1998, at URL <http://www.dme.gov.za/minerals/default.htm>); views of the White paper varied (Chamber of Mines of the South Africa, October 20, 1998, Mining and minerals policy in the new South Africa, National Policy Issues, accessed December 2, 1998, at URL <http://www.bullion.org.za/bulza/pgs/polindx.htm>). The White Paper focused on the freeing up of unexploited mineral rights long held by the major mining houses to provide more opportunities in the mining sector for black South African entrepreneurial groups and for foreign investment. This would be achieved through the Mineral Rights Tax, which would be written off by exploration expenditures, and exempt operating mines.

Subject to the adoption of a new minerals policy and implementing legislation by Parliament, the South African mineral industry operated under the Mining Titles Registration Act, 1967; the Central Energy Fund Act, 1977; the Petroleum Products Act, 1977; the Diamonds Act, 1986; the Electricity Act, 1987; the Mineral Technology Act, 1989; the Minerals Act, 1991; the Minerals Amendment Act, 1993; the Nuclear Energy Act, 1993; the Liquid Fuels and Oil Repeal Act, 1993; the Mineral and Energy Laws Rationalization Act, 1994 (which repealed the Mining Rights Act of 1967); and the Mine Health and Safety Act, 1996. A 1998 ruling by the Minister of Finance set the corporate tax rate at 35% for all companies entering offshore oil and gas subleases with Soekor (Pty.) Ltd. by the end of 1999. In 1998, the Government established a Gold Crisis Committee to monitor gold industry retrenchments and to study socioeconomic impacts and alternatives to mass retrenchments. The Committee is a tripartite commission of Government, labor, and industry representatives. The action was in response to the layoff of 135,000 gold miners during the past 5 years, and the threat of additional retrenchments as the South African gold industry struggles to remain competitive during a period of declining gold prices and historically high costs associated with deep underground mining.

¹Where necessary, values have been converted from South African rands (R) to U.S. dollars at the rate of R5.53=US\$1.00 for 1998, and R4.61 = US\$1.00 for 1997.

Environmental Issues

Following the Consultative National Environmental Policy Process (CONNEPP), an initiative by the Department of Environmental Affairs and Tourism (DEAT) to review the state of the environment in South Africa, DEAT released its draft White Paper on Environmental Management Policy for South Africa in May 1997 (Department of Environmental Affairs and Tourism, July 1997, White paper on environmental management policy, accessed December 12, 1998, at URL http://www.polity.org.za/govdocs/white_papers/envir.html). The white paper confirmed the constitutional right to a healthy environment and established a policy of sustainable development as the accepted approach to resource management and use in South Africa. Enactment of the environmental management bill, proposed in the white paper, was expected in 1999. Separately, the DME was preparing to publish new regulations for the Environment Management Program (EMP) performance assessment and monitoring for the mining industry in 1999. The EMP was provided for in the Minerals Act, 1991, and chapter 4 of the Minerals and Mining Policy White Paper.

Production

In 1998, South Africa was one of the largest and most diverse minerals producers in the world. As shown in table 1, output levels were mixed. Gold production decreased a further 5% between 1997 and 1998 as a result of declining ore grades and high production costs associated with deeper mining. The gold industry was going through a major corporate restructuring involving ore reserve asset swaps and workforce reductions to cut production cost in response to declining world gold prices. Production of most of the other major metals were up from 1% to 8% compared with that of 1997. Output of cobalt, iron ore, and manganese declined. Within the industrial mineral sector, most production levels increased, with major declines seen in asbestos, which was being phased out as a result of environmental concerns, and barite. Domestic mineral commodity sales have been stimulated by a number of major industrial projects and the Government's residential home construction program. On a value basis, about 23% of primary mined products and 18% of processed mineral materials were consumed domestically. More than 70% of coal production went for internal power generation and for value-added synthetic fuel and petrochemicals production. Using South Africa's natural comparative advantage in possessing these resources, iron ore, chromite, manganese, and nickel also were converted to value-added ferroalloy and steel products for world markets.

Trade

In 1998, the total value of sales of primary minerals, as reported by the Minerals Bureau, was \$12.95 billion, of which \$10.01 billion was exported. The total value of all processed mineral materials was \$3.16 billion, of which \$2.59 billion was exported. The major exports by value in 1998 were gold at

\$4.36 billion; PGM, \$2.10 billion; coal, \$1.75 billion, ferroalloys, \$1.11 billion; aluminum, \$660 million; iron ore, \$357 million; vanadium, \$227 million; and copper, nickel, and zinc, each more than \$100 million. Other significant exports, for which individual value data were not provided, included diamond, steel, titanium, and zirconium (Roux, 1999). With the help of new export-oriented and value-added aluminum, steel, and titanium capacity, as well as expanded coal exporting capacity, the total value of primary and processed mineral exports has increased progressively (54%) to R69.66 billion in 1998 from R45.17 billion in 1994. This helped offset lower dollar-based sales resulting from the 56% devaluation of the rand versus the U.S. dollar during the same period.

The majority, by value, of primary mineral exports, including precious minerals, went to European markets, followed by the Pacific Rim countries, the Middle East and the Near East, and North America and Central America, with less than 10% each. Exports within Africa accounted for less than 1% of the South African mineral export trade.

Although South Africa was self-sufficient in the vast majority of its mineral needs, some mineral commodities were imported. Significant mineral imports included alumina, coking coal, rough and cut diamonds, certain ferroalloys, magnesite, magnesia, nickel, precious metals, and sulfur.

Structure of the Mineral Industry

The South African minerals and energy industries operated on a free enterprise, market-driven basis. Ownership of mineral rights was held by either the Government or private entities. Government involvement in these sectors was minimal and primarily confined to ownership of Eskom, the national electric power utility, and Southern Oil Exploration Co. (Soekor), the national oil and gas exploration company, including additional declining subsidies provided to synthetic fuels programs of Mossgas (Pty.) Ltd. and Sasol Limited, two parastatals.

In South Africa, the bulk of mineral land holdings and production has been historically controlled by five mining investment houses—Anglo American Corporation (AAC) (including Johannesburg Consolidated Investment Limited (JCI)), Anglovaal Ltd., Gencor Limited (formerly General Mining and Finance Corp.), Gold Fields of South Africa (GFSA), and Randgold and Exploration Co. Ltd. (formerly Rand Mines). Since 1994, the industry has been undergoing a major corporate restructuring, or “unbundling,” aimed at simplifying a complex system of interlocking ownership, establishing separate core-commodity-focused profit centers, and diversifying and rationalizing nonperforming assets to make the newly restructured companies more competitive internationally. During 1998, most of the corporate restructuring was completed, putting in place an entirely new industry structure.

AAC dominated the news with its October 15, 1998, announcement of plans to merge with Minorco S.A., its international coal and base metals subsidiary, to form a new company, Anglo American plc. Anglo American, the world's largest mining company, will shift its headquarters and primary

stock listing from Johannesburg to London. Although the move was controversial in the eyes of the South African Government, it gives Anglo American access to the large international capital equity markets needed for global growth. De Beers Consolidated Mines Ltd., which had earlier severed its management ties with AAC, exchanged its 38.2% interest in AAC, its 22.5% interest in Minorco, and minority interest in several other nondiamond companies jointly held with AAC for shares equal to a 40% equity interest in the new company. Meanwhile, AAC transferred its interest in the diamond Central Selling Organization to De Beers, while retaining a 33% interest in De Beers/Centenary through its 58% holdings in Anglo American Investment Trust. In addition to diamond interests held through De Beers, Anglo American plc had previously restructured its assets into a number of separate operating companies as follows. AngloGold Ltd. was formed in November 1997 from AAC's gold assets and from JCI's major gold mines at Western Areas Ltd. and H.J. Joel, creating the world's largest gold company with an annual production of 186,600 kilograms (kg) (6 million troy ounces) of gold and reserves, in all categories, of 4,354 metric tons (t) (140 million troy ounces) (Anglo American Corporation, 1998).

In July 1998, AngloGold subdivided its Vaal Reefs, Free State, Western Holdings, H.J. Joel, and West Wits gold mining complexes on a production shaft basis into 16 separate business centers, most of which were given new African names. The 16 gold mines, or profit centers, of which 14 were in South Africa, include the Great Noligwa (formerly Vaal Reefs Shaft 8), Kopanang (formerly Vaal Reefs Shaft 9), Tau Lekoa (Vaal Reefs Shaft 10), Moab Khotsong (Vaal Reefs Shaft 11), Bambanani (formerly Freegold Shaft 1), Tsepong (Freegold Shaft 2), Masimong (Freegold Shaft 3), Majhabeng (formerly Western Holdings), Joel, Western Deeps-East, Western Deeps-West, Western Deeps-South, Deelkraal, and Elandsrand. Also included were the Navachab Mine in Namibia and the Sadiola Mine in Mali. In December 1998, AngloGold also paid \$550 million to acquire Minorco's gold holdings in Argentina, Brazil, and the United States. Anglo American Platinum Corp. Ltd. (Amplats), formerly Rustenburg Platinum Holdings Ltd. and the world's leading platinum producer, was established to run the combined platinum-group metal assets of AAC and JCI. Anglo American Coal Corp. Ltd. (Amcoal) was then established to operate as the AAC coal subsidiary. Following the merger with Minorco in 1998, Anglo American Base Metals (Ambase) was established to handle the base metal interests of Anglo American.

In September 1998, JCI Ltd., the old mining house, was delisted from the Johannesburg Stock Exchange. In May 1995, AAC had unbundled its holdings in JCI into three separate companies: JCI Ltd., with interests in gold, ferrochrome, coal and base metals; Amplats; and Johnnies Industrial Corp. (Johnnic), containing its nonmining industrial holdings. JCI Ltd. was subsequently sold off to a black empowerment group, African Mining Group (AMG) (Capital Alliance). AMG ran into operating difficulties in 1997, and a decision was made to break up JCI Ltd. in September 1997. The company was restructured into two separate and autonomous base metal and gold companies, JCI Projects and JCI Gold. The gold assets,

including Randfontein Estates Ltd., Western Areas Ltd., and H.J. Joel Ltd., were collapsed into JCI Gold. In November 1997, JCI Ltd. sold back to AAC its interests in H.J. Joel (60%) gold mine and of Western Areas (36.8%) gold mines and remaining interests in Amplats in exchange for De Beers' and AAC's 26% interest in Lonrho Plc. of the United Kingdom. In June 1998, JCI Gold created three separate and independent operating companies—Western Areas, Randfontein Estates, and Consolidated African Mines (CAM). Western Areas, which included Barnex Exploration and the South Deep gold project, had a 1998 production capacity of 11,200 kg (360,000 troy ounces) of gold and contained gold resources of 1,847 t (59.4 million troy ounces). In November 1998, a 50% interest in Western Areas was sold to Placer Dome Inc., a Canadian gold company, for around \$235 million. Randfontein Estates had a 1998 production capacity of 24,883 kg (800,000 troy ounces) of gold and contained measured, indicated, and inferred gold resources of 1,011 t (JCI Gold Ltd., October 1998, Presentation to Denver Gold Group—Mining Investment Forum, Slides 18, 19, and 35, accessed November 22, 1999, at URL <http://www.westernareas.co.za/>). CAM, established as a black economic empowerment vehicle focused on nongold mineral investment, was scheduled to merge with the remaining corporate part of JCI Gold. As part of its unbundling, JCI Ltd. sold its coal operations at Tavistock Collieries Ltd. to Lonrho's Duiker Mining Ltd. and its 57% interest in Consolidated Metallurgical Industries (CMI) chromite and ferrochrome operations to Metorex Pty. Ltd., while acquiring a 20% interest in Southern Mining Corp. and its Bothaville titanium deposit. Metorex was a subsidiary of Crew Development Corp., a Canadian company.

The megamerger of the gold assets of Gencor Ltd. and GFSA was finalized on February 2, 1998, creating Gold Fields Ltd., the world's second largest gold producer with an annual production of 93,300 kg (3 million troy ounces) of gold and gold minable resources of 2,538 t (81.6 million troy ounces) (Gold Fields Ltd., February 17, 1998, Results of the offers made by Gold Fields to shareholders of Evander and St. Helena, News—announcements, accessed June 1, 1999, at URL <http://www.goldfields.co.za/>). Operations were consolidated in South Africa under the Beatrix, the Driefontein, the Kloof, the Leeudoorn, the Libanon, the Oryx, and the St. Helena Mines and in Ghana as the Tarkwa Mine. Gold Fields also retained the technical rights to the BIOX gold biological leach process. Gencor, which had previously consolidated all its nongold holdings into the London-based Billiton plc, was left with Impala Platinum Holdings Ltd. (Implats), the second largest producer of PGM in South Africa, as its only direct mining asset. GFSA continued to divest its nongold assets during the year, liquidating its copper-lead-zinc operations of Tsumeb Corp. Ltd. in Namibia and in South Africa, selling the O'okiep copper mine to Metorex, its coal and Gamsberg zinc deposit interests to AAC, its Zinc Corp. of South Africa Ltd. (Zincor) zinc refinery equity to Iscor Ltd., and its chromite reserves to Associated Manganese Mines of South Africa Ltd. (Assmang). GFSA will be delisted as a corporate entity in 1999 after returning an estimated 80% of its asset market value to shareholders.

In February 1999, Driefontein, Gold Fields, AngloGold, AAC, and Anglo American Gold Investment Company Limited announced a complex set of transactions that will further improve the competitive position of the South African gold mining industry and complete the restructuring of one of the industry's most important gold assets. Three transactions were announced, as follows:

- ! The acquisition by Gold Fields of AngloGold's entire interest of 21.5% in Driefontein at a price of about \$230 million. The action will give Gold Fields controlling interest in the Western Ultra Deep Levels ore body.
- ! The parallel stock swap between Gold Fields and AAC. This will increase AAC's equity interest in AngloGold to 53.7%.
- ! The proposed acquisition of Driefontein by Gold Fields. The new Gold Fields would wholly own, as its core assets, the Beatrix, the Driefontein, and the Kloof gold mines, as well as 100% of the Leeudoorn, the Libanon, and the Oryx Mines, 70% of the Tarkwa gold mine in Ghana, and 54% of the St. Helena gold mine. The new Gold Fields will be the third largest gold producer in the world with an annual production of about 124,414 kg (4 million troy ounces) and total reserves of 2,986 t (96 million troy ounces) of gold (Gold Fields Ltd., February 8, 1999, [untitled], press release, accessed February 19, 1999, at URL <http://www.gfl.co.za/press/990218.html>). The Gold Fields/Driefontein merger was approved in May 1999.

Anglovaal Ltd. had completed its unbundling in 1996 with the formation of two companies, Anglovaal Gold Ltd. (Avgold) and Avmin, the latter to handle such nongold mineral investments as the Konkola North copper project in Zambia. In March 1998, Avgold purchased Fairview Consolidated Mines and its BIOX plant from Rand Gold for approximately \$16 million.

Rand Gold formed in July 1997 from Rand Mines to acquire and rehabilitate marginal cost mines, restructured its holdings into Durban Roodeport Deep Ltd. (DRD) and the London-listed Randgold Resources Ltd. DRD operated the Durban Roodeport Deep, the East Rand (ERPM), and the South Wits deep extension gold mines in South Africa. The Durban Roodeport Deep mining group represented the 1997 merger of three West Rand gold mines—Durban Deep, Blyvooruitzicht, and Buffelsfontein. Randgold Resources maintained an exploration and mining program in seven other African countries, including the Syama gold mine and the Loulo gold development in Mali and development of the Golden Ridge gold mine in Tanzania.

In September 1998, Harmony Gold Mining Co. Ltd., which was spun off by Rand Gold in 1997 as an independent company, acquired the Masimong Mine (formerly Freegold Shaft 3) from AAC for \$15 million and Gold Fields' 86% interest in the Evander group of gold mines (Kinross, Winkelhaak, Leslie, and Bracken) for \$93 million. The acquisition of Evander Gold Mines Ltd. increased Harmony's annual gold production capacity to nearly 40 t from 24.3 t and added an additional 311 t of proven and probable ore reserves (Gold Fields Ltd., June 24, 1998, Harmony acquires Evander, press release, accessed June 25, 1998, at URL <http://www.gfl.co.za/press/980624.html>). Harmony purchased the Bisset gold

mine in Manitoba, Canada, sold its Consolidated Modderfontein and Grootvlei gold mines to Petra Mining Ltd. for nearly \$16 million, and obtained authorization from the Reserve Bank of South Africa to refine its own gold production by using a new solvent extraction hydrometallurgical process developed by Mintek.

The Chamber of Mines, whose members represent the majority of coal, gold, and uranium producers, was responsible for a variety of advisory and service functions for mining interests in South Africa. One of its main activities was the annual wage negotiations between member mines and the National Union of Mineworkers.

The largest foreign-owned mining group operating in South Africa was Rio Tinto plc. of the United Kingdom, which jointly owned with AAC the Palabora copper mine in northeastern Transvaal, one of the largest copper mines in the world. Rio Tinto was also a 50% shareholder in Richards Bay Minerals Ltd., a major world producer of mineral sands, with operations in the coastal areas of KwaZulu-Natal Province. Further details of the structure of the minerals industry are shown in table 2.

Commodity Review

Metals

Aluminum.—Because South Africa has no economically exploitable deposits of bauxite and no alumina production capacity, all alumina feedstock for the production of aluminum metal was imported. Billiton Aluminium South Africa [formerly Aluminium South Africa (Pty.) Ltd. (Alusaf)] was the sole producer of primary aluminum from its Bayside smelter and the newer Hillside smelter at Richards Bay. Total production of aluminum metal increased by about 14% to 576,000 t in 1998. For the fiscal year ending June 30, 1998, the Hillside smelter produced 504,000 t of aluminum metal, and the Bayside smelter, 174,000 t. At Hillside, Billiton converted the bake and casthouse furnaces to gas from heavy oil to improve environmental performance and began an \$8 million upgrade of the casthouse. At Bayside, which Billiton planned to convert to value-added products, an \$18 million project to rebuild the Riedhammer furnace was approved.

Antimony.—Consolidated Murchison Ltd.'s operation at Gravelotte was South Africa's only producer of antimony (as stibnite concentrate); its output made South Africa the fourth largest producer after China, Russia, and Bolivia. In 1998, the world market price for antimony metal declined to a 40-year low, and several world producers cut back on production. Under new ownership, however, antimony production in South Africa increased by 24% to 4,243 t compared with that of 1997. Consolidated Murchison began to reactivate development of the Beta Shaft project at the Gravelotte operation in December 1998 and was continuing surface and underground exploration. The two operating shafts, Athens and Monarch, had 2 and 7 years of ore reserves remaining, respectively (Mining Journal, 1999).

Chromite.—Chromite ore production increased by 13% in

1998. South Africa was the global leader in chromite ore production and export. Production came from more than 20 mines located within the Bushveld Ultramafic Complex. About 86% of the ore went to supply domestic ferrochrome smelters, and the remainder was exported. Domestic consumption of chromite ore was the highest in the world, feeding the world's leading ferrochrome industry, as well as a world-class chromium chemicals and refractories industry. Chromite ore sales were valued at about \$165 million in 1998, of which about \$61 million was export revenue.

For the fiscal year ending June 30, 1998, Samancor Ltd. produced 3.2 million metric tons (Mt) of chromite ore, a 19% increase compared with that of 1997. At Samancor's Western Chrome mines, the Buffelsfontein Section was closed, with lost capacity being made up by expansion of the Mooinooi Section and by a new open pit operation on the Elandskraal ore body. At Samancor's Eastern Chrome mines, the Montrose Section was essentially depleted and scheduled for closure.

In early 1998, Südelektra Holdings AG of Switzerland (later renamed Xstrata Corp.) acquired Chromecorp Holdings Ltd. and CMI for \$179 million; Glencore International, a Swiss metals trading company, was a major shareholder in Xstrata. This acquisition shifted the majority ownership of the South African ferroalloys industry to Europe. Xstrata combined the adjacent Rustenburg chromite mining operations of Chromecorp and CMI into one mining unit and began a feasibility study to expand the Thornecliffe Mine production to 1.0 million metric tons per year (Mt/yr) from 0.6 Mt/yr. At the Wonderkop Mine, development work was underway to return production capacity to 350,000 metric tons per year (t/yr) of salable chromite ore. In September 1998, Assmang paid nearly \$30 million to Gold Fields to acquire the assets of Dwarsrivier Farms Ltd. The new Assmang assets included a high-quality chromite deposit of 20 Mt of indicated mineral resource and an additional 200 Mt of inferred mineral resources (Avmin Ltd., 1998, p. 9.)

Copper.—Copper mine production in South Africa increased by 8% in 1998. Palabora Mining Company Limited, by far the largest copper producer in the country, treated 28.8 Mt of ore grading 0.58% copper for the year, yielding 446,786 t of copper concentrates, containing 148,413 t of copper, the highest production in Palabora's history. Processed output included 119,042 t of copper. Palabora also produced 11,718 t of baddeleyite (70% of world demand), 289 t of nickel sulfate, 135,148 t of sulfuric acid, 104,950 kg of uranium oxide, 207,345 t of vermiculite concentrates, and 7,486 t of zirconium dioxide chemicals, as well as 11,546 kg of precious metals contained in 174 t of refinery tankhouse slimes. The Palabora Mine also generated 217,338 t of byproduct magnetite concentrates grading 61.7% iron and 1.6% titanium dioxide, which were either sold to the coal-washing industry or stockpiled for possible future use in a proposed new hot briquetted iron facility in Mozambique. Work progressed on schedule to transition from open pit to underground mining in 2002. Sinking of the exploration and service shaft was completed during the year; work on the production shaft expected to bottom out at nearly 1,000 meters (m) by August

1999. The \$380 million underground development project will extend the life of the mine for another 20 years, with production at a rate of 30,000 metric tons per day of copper ore (Palabora Mining Company Limited, 1999).

O'okiep, located in the North Western Cape Province, is one of the oldest mining districts in South Africa with aboriginal copper mining dating back to before 1685. Modern mining dates to 1846; O'okiep Copper Co. Ltd. was formed in 1937. Since 1937, 23 copper mines have been worked and depleted; the Carolusberg Mine was the most recent closure (1997). On October 7, 1998, Metorex purchased an 81.47% interest in O'okiep Copper from Gold Fields for a cash consideration of more than \$5 million. Nigramoep, the only mine operating in 1998, used a modified vertical crater retreat mining system to mine 65,000 metric tons per month (t/mo) of ore in three shifts with production scheduled to be increased to 80,000 t/mo of ore in 1999. Mineralization occurred chiefly as disseminated bornite within a norite host, associated in places with chalcopyrite and digenite. The Nigramoep Mine had about 7 years of reserves remaining; exploration and mine feasibility studies continued to assess two deeper deposits, the Flat Mine South and the Flat Mine East. In 1998, O'okiep milled 711,324 t of ore grading 2.20% copper, producing a concentrate grading 40.41% copper, with a contained copper content of 14,571 t, an 11% increase compared to that of 1997. The smelter had a capacity of approximately 35,000 t/yr of copper metal and required the acquisition of 40,000 to 50,000 t/yr of toll or custom smelting concentrate to supplement available in-house concentrate.

Copper was also produced in small amounts as a byproduct of lead-zinc and platinum mining.

Gold.—The continued unbundling of assets by major South African mining companies was the main highlight for the gold industry during the year. Faced with dropping ore grades and the increasing cost of deep mining, the gold industry continued its steady decline. In 1998, mine production was 464 t of gold with an average grade milled of 5.09 grams per ton (g/t) gold. This was 5% lower than that of 1997, but significantly lower than the historical peak production year of 1970 when 989 t of gold was produced at an average grade milled of 13.28 g/t gold. South Africa remained the world's leading gold producer, although its once-dominant share of total global new mined gold production dropped to 19% in 1998 from 68% in 1970 (Chamber of Mines of South Africa, 1998, Online statistical tables—1997/98, accessed February 20, 1999, at URL <http://www.bullion.org.za/panl/wmain2.htm>). Gold prices, which were at a 20-year low in 1998, as well as restructuring and streamlining of the South African gold industry, contributed to decreased gold output. The industry was making significant efforts to reduce operating costs, to improve productivity, to optimize reserve development by asset swaps of ore reserve holdings with neighboring mines, and to help stabilize production levels. The number of gold mines in a marginal position declined to five mines in 1998, representing 50 t of gold production and an employment level of nearly 28,000 workers, from nine mines in 1997 (Chamber of Mines of South Africa, 1999, Economic review, Annual

report—1998/99, accessed December 12, 1999, at URL <http://www.bullion.org.za/bulza/publications/99AnReport.pdf>).

Capital investment within the gold industry in 1998 was about \$380 million. In South Africa, where the extreme depths of new deposits add several years to underground development time, four major new gold projects continued on track—Avgold's Target project, Western Area's South Deep project, AngloGold's Moab project, and Gold Fields's developing Oryx Mine. Oryx, which was commissioned in 1996, reached more than 80% of operating capacity in 1998 and was expected to produce at full capacity of 10,550 kilograms per year (kg/yr) of gold in 1999. AngloGold was also considering plans to develop its experimental Western Ultra Deep Levels project that would run a single shaft to a depth of 5,000 m to access resources containing 1,500 t of gold at a grade of 10 g/t gold (Business Day, September 8, 1997, Deepest mine yet will stretch technology to the limit, accessed September 8, 1997, at URL <http://www.bday.co.za/97/0908/company/c7.htm>).

Iron and Steel.—Iron Ore.—In 1998, iron ore production in South Africa decreased to 32.97 Mt, or about 1% from that of 1997. Of total sales of iron ore in 1998 of 33.75 Mt, valued at about \$450 million, 65% was exported, and 35% was shipped to domestic steel plants. Iscor was South Africa's largest iron ore producer. Its two iron mines, Sishen and Thabazimbi, accounted for more than 80% of the country's total output. The Sishen Mine in the Northern Cape Province has the capacity to produce about 25 Mt/yr of iron ore grading 65% iron, and the Thabazimbi Mine in the Northern Province, 2.9 Mt/yr of iron ore grading about 60% iron.

Iron and Steel.—South African crude steel production dropped by 9% in 1998 owing, in part, to operational problems at Columbus Stainless early in the year. Iscor's production dropped to 6.48 Mt but still accounted for more than 80% of the country's total crude steel production. Iscor remained the largest steel maker in Africa. The highlight of the steel industry in 1998 was the commissioning of Saldanha Steel (Pty) Ltd.'s \$1.5 billion export-oriented steel plant at Saldanha Bay about 140 kilometers (km) northwest of Cape Town. Saldanha Steel was a joint venture between Iscor (50%) and the state-owned Industrial Development Corporation (IDC) (50%). The first shipment of hot-rolled steel coil was made in August 1998, and the project was fully commissioned with the first products from the Corex and Direct Reduction units in January 1999. This was the world's first steel minimill to combine the Corex and the Midrex technologies (replacing blast furnace technology) and was designed to be environmentally clean. Saldanha Steel will reach full production capacity of 1.25 Mt/yr of hot-rolled coil steel by the end of 1999. The design layout was planned to permit a doubling of capacity in the future. The plant will use iron ore pellets instead of scrap, and while initial feed is being imported, the plant will be supplied from Iscor's Sishen iron ore mine. At full operation, the plant will consume 950,000 t/yr of iron ore for the Corex plant, 850,000 t/yr of direct reduced iron for the Midrex plant, 850,000 t/yr of coal, and 228,000 t/yr of metallurgical dolomite. The rolling mill had the capacity to produce 2 Mt/yr of hot-rolled steel coil

rolled to a final thickness of 1.0 to 8.5 millimeters.

Approximately 67% of production will be directly exported as hot-rolled coil, with the remaining 33% sent to the adjacent Duferco Steel Processing Ltd. cold-rolling slab plant where it will be cold rolled into thinner slabs. The Duferco processing also will include pickling, oiling, and galvanizing stages (Saldanha Steel (Pty.) Ltd., 1999, Our process, and Milestones, accessed April 20, 2000, at URL <http://www.ssteel.co.za>).

Weak global steel markets, particularly in Asia, forced South African producers to cut back on production capacity by yearend and subjected them to antidumping actions by the United States. During the year, Iscor decommissioned its 45-year-old Hot Strip Mill South and Blast Furnace B at its Vanderbijlpark Works and mothballed the ironmaking facilities at its Pretoria Works, thus freeing up 500,000 t of iron ore for export. Highveld Steel and Vanadium Corp. Ltd. (Highveld) also closed two of its seven steel-processing furnaces.

In response to complaints that alleged unfair trade practices were actually hurting the U.S. steel industry by U.S. steel producers, the U.S. Department of Commerce (DOC) in October imposed a high 31.8% dumping duty on stainless steel plate exported by Columbus Stainless. The duty was based on calculations of the difference between the transport-adjusted price of Columbus Stainless's product in the United States and the higher amount it had been charging at home. The duty came on top of a 2.1% countervailing duty assessed by the United States in August 1998 in response to allegations that Columbus Stainless was receiving unfair Government subsidies. The DOC actions were subject to a final determination by the U.S. International Trade Commission. Iscor's sale of cold-rolled steel to the United States was also expected to be impacted by the increased countervailing duties (U.S. International Trade Administration, 1998, 1999).

Ferroalloys.—For 1998, ferrochromium production increased by 4% to more than 2 Mt compared to that of 1997. Total export volume for South African ferrochrome was 1.65 Mt valued at \$699 million. Other ferroalloy production and sales included manganese alloys, production of 847,000 t, and sales of 858,000 t valued at \$383.7 million, of which 85% was exported, and silicon alloys, production of 165,700 t and sales of 170,800 t valued at \$128 million, of which 58% was exported (Roux, 1999).

In two yearend 1998 moves, Billiton and Anglo American cemented their roles as major players in the world ferroalloys industry by joint venturing to purchase outstanding minority shares of Samancor's South African ferrochromium operations for \$200 million and by purchasing Broken Hill Proprietary Co. Ltd's Australian manganese operations for \$375 million. When the transactions are complete, Billiton and Anglo American will control 60% and 40% equity interest, respectively, in both mining and ferroalloy companies. Billiton picked up about 1.8 Mt in manganese ore and 200,000 t in manganese ferroalloy capacity through the BHP Manganese acquisition (Mining Journal, 1998).

Billiton's main competitor in the ferroalloys industry became Xstrata. As the world's two largest producers, these two companies each controlled more than 1 Mt/yr of ferrochrome capacity. Xstrata, which had previously acquired the South

Africa vanadium producer, Rhoex Pty. Ltd., was also South Africa's second largest vanadium pentoxide producer after Highveld. In 1998, Xstrata reported production of ferrochromium of 588,825 t at Chromecorp and 391,090 t at CMI; plans were to increase ferrochrome production capacity at CMI to 460,000 t/yr. Samancor commissioned a new \$56 million pelletizing plant at its Ferrometals Division, which will add an additional 60,000 t/yr of ferrochrome capacity (Mintek, August 28, 1998, Ferroalloys, BusInfo, accessed February 9, 1999, at URL <http://mintek.co.za/businfo/Businfo19980828.htm>).

Lead and Zinc.—In South Africa, Anglo American consolidated its position in the lead-zinc industry by purchasing GFSa's 55% share and Phelps Dodge Corp.'s 45% share in Black Mountain Mineral Development Co. (Pty.) Ltd., a base metals producer, and by announcing planned investments of \$720 million to develop the Gamsberg zinc mine, mill, and smelter project, which would have the capacity to produce 200,000 t/yr of refined zinc. The Gamsberg deposit, located 22 km from Black Mountain in Northern Cape Province, contains a resource of 90 Mt grading about 6.4% zinc. The deposit has a high manganese content, making the extractive metallurgy difficult. Anglo American was examining the potential to use the direct-current plasma-arc smelting technology currently (1998) operational at its Namakwa Sands titanium plant in Saldanha Bay to treat the Gamsberg zinc ore (David McKay, September 8, 1998, Anglo to develop R4bn zinc mine, Business Day, accessed September 9, 1998, at URL <http://www.bday.co.za/98/0908/news/news2.htm>).

In October 1998, as part of its divesting of nongold assets prior to its merger with Gencor, GFSa sold its 65% interest in the Zincor zinc smelter to Iscor for around \$44 million. Zincor, currently (1998) the only producer of refined zinc in southern Africa, produced 107,400 t of zinc metal and 166,412 t of sulfuric acid for the financial year ending June 30, 1998 (WOZA, October 21, 1998, Gold Fields sells Zincor to Iscor, WOZA online news, accessed July 8, 1998, at URL <http://www.woza.co.za/mining/zincoro.htm>).

Billiton's and IDC's plans to build a new zinc smelter at Ngqura port, near Port Elizabeth, Eastern Cape, were set back in December when the Japanese partners, a consortium led by Mitsui Mining and Smelting Company, withdrew from the project. While continuing to seek new technical partners, Billiton proceeded with studies needed to develop the \$560 million 250,000-t/yr zinc smelter (T.H. Zwane, 1998/99, Zinc, South Africa Minerals Bureau, accessed October 12, 1999, at URL <http://www.dme.gov.za/minerals/zinc.htm>).

Manganese.—South Africa possessed the world's largest resources of manganese ore, reported to be 12 billion metric tons, and challenged China as the world's largest producer (Samancor Ltd., 1998, Manganese—Ores, accessed September 22, 1998, at URL <http://www.samancor.co.za>). In 1998, South Africa produced 3.04 Mt gross weight of manganese ore and concentrates, primarily metallurgical grades ranging from 30% to more than 48% manganese. Samancor accounted for about two-thirds of the national production from its Mamatwan open

pit and Wessels underground mines near Hotazel; production of manganese ore decreased by 9% to 2.1 Mt in 1998 compared with that of the 1997 fiscal year ending June 30. Samancor was upgrading the Sinter Plant at a cost of \$17 million. About 40% of Samancor's manganese ore production was exported to ferroalloy producers worldwide. The remainder was converted into alloys at Samancor's Manganese Division works at Meyerton, Gauteng, and into manganese metal by the Manganese Metal Co. Pty. Ltd. The Manganese Division, in turn, exported 85% of its production.

Assmang was the other major producer with sales of just under 1 Mt in 1998. Both companies had downstream ferromanganese- and silicomanganese-processing facilities.

Nickel.—South Africa's nickel production was in the form of metal, metal-in-concentrate, and sulfate. The nation's nickel output, which has primarily been produced as a byproduct of PGM and copper processing, was supplemented by primary production from the new Nkomati nickel mine during its first full year of production in 1998. Domestic sales of nickel in 1998 amounted to about \$73 million; export sales of nickel were valued at more than \$112 million. The Nkomati Joint Venture, controlled by Avmin (75%), continued on track with its Nkomati nickel mine, which yielded about 3,000 t/yr of nickel in concentrate. Nkomati brought the \$35 million MSB Mine, a small, high-grade portion of the area nickel resource, into production in January 1997 at a rate of 10,000 t/mo run-of-mine ore, yielding 3,000 t/mo of concentrate containing an average of 210 t nickel, 67 t of copper, 4 t of cobalt, 4.9 kg of platinum, and 14.4 kg of palladium. The feasibility study on expanding mining operations to include the large low-grade reserve base in three adjacent ore bodies continued.

Platinum-Group Metals.—South Africa's production of PGM, which originated almost exclusively from mines in the Bushveld Complex north of Pretoria, accounted for a dominant share of world production of these commodities in 1998, including platinum (80%), palladium (47%), and rhodium and other PGM (77%). Additionally, South Africa possessed around 88% of the identified global reserve base of PGM.

In 1998, South Africa produced 200,143 kg of PGM and exported 183,510 kg valued at \$2.1 billion. Export shipments included 114,461 kg of platinum, 56,608 kg of palladium, and 12,441 kg of rhodium. The 100% price rise in rhodium and 60% rise in palladium and shortfalls in Russian PGM production and exports during 1998 were major incentives for South African producers to expand production.

Amplats was the largest PGM producer in the world at about 37% of global platinum supply, all from South African operations. Amplats production came from three operating subsidiaries—Rustenburg Platinum Mines Ltd. (RPM), Potgietersrust Platinums Ltd. (PPRust), and Lebowa Platinum Mines Ltd. (Leplats) in Northwest and Northern Provinces. In its annual report for the year ending June 30, 1998, Amplats outlined three major expansion projects. RPM was spending \$160 million to develop the Bafokeng Rassimone platinum mine at Boschkoppe in the western part of the Bushveld Complex. The mine was expected to be in full production in

2002 at a rate of 7,776 kg/yr of refined platinum. The Bafokeng Rassimone Mine development was based on probable underground reserves in the Merensky Reef of 53 Mt grading 7.34 g/t platinum-group elements (PGE) and in the UG2 chromite layer of 76.4 Mt grading 4.91 g/t PGE. An additional 1.5 Mt grading 6.13 g/t PGE within the Merensky Reef is accessible for open pitting. During fiscal year 1998, Amplats milled 21.4 Mt of ore from all operations with an average head grade of 5.56 g/t PGE. PPRust invested more than \$55 million to expand the mine's concentrator capacity to 425,000 t/mo from 250,000 t/mo. This would allow an increase of an additional 1,555 kg/yr in refined platinum production by the end of 1998. Leplats will invest \$12 million to open the near surface Middlepunt Hill UG2 deposit at Atok. The mine, which will take 18 months to complete, will process 30,000 t/mo at a head grade of 5.12 g/t PGE, adding 653 kg/yr of refined platinum to Leplats' capacity. Amplats total corporate refined production included 59,047 kg of platinum, 29,533 kg of palladium, and 5,421 kg of rhodium. As of June 30, 1998, Amplats ore reserves within the Merensky Reef and Platreef were 99 Mt of proven reserves grading 6.31 g/t PGE, 412 Mt of probable reserves grading 5.61 g/t PGE, and 167 Mt of indicated reserves grading 4.9 g/t PGE. Within the UG2 chromite layer, Amplats reported 37 Mt of proven reserves grading 5.19 g/t PGE, 598 Mt of probable reserves grading 5.61 g/t PGE, and 1.2 Mt of indicated reserves, grading 5.3 g/t PGE (Anglo American Platinum Corp. Ltd., 1998, p. 68-107).

Implats, the second largest producer in South Africa, operated 13 shafts within the Merensky and the UG2 Reefs, a concentrator, smelter, and an enhanced precious-metals refinery, producing 32,721 kg of platinum, 17,325 kg of palladium, and 3,484 kg of rhodium, for the financial year ending June 30, 1998. Between 1998 and 2000, Implats planned on investing more than \$200 million to install a new decline shaft and to upgrade concentrating and smelting facilities. During early 1999, Implats resolved a longstanding dispute with the Royal Bafokeng Nation with a stock and royalty settlement that will give Implats access to mineral rights on Bafokeng land that will allow it to maintain mining rates at or more than 32,400 kg/yr of platinum for at least 30 years. Impala reported total mineral reserves as of June 30, 1999, of 210.6 Mt grading 5.15 g/t PGE and mineral resources of 223.7 Mt grading 8.5 g/t PGE (Impala Platinum Holdings Ltd., 1999, p. 22).

Lonrho Platinum operated three mines, a smelter, a base metals smelter, and a precious-metals refinery. For the financial year ending September 30, 1998, Lonrho mined and treated 9.2 Mt of ore, yielding a refined production of 19,518 kg of platinum, 9,054 kg of palladium, and 2,743 kg of rhodium. Estimated proven and probable in situ minable reserves were reported to be 335 Mt grading 5.9 g/t PGE (Lonrho Platinum, 1999, p. 40). Lonrho's strategic plan called for maintaining an average production growth of 1.5% for the next 25 years, which will involve the sinking of additional major vertical shafts, beginning in 2000, to replace the current (1998) Westplats South operation and the Eastern Platinum Incline Shafts. A shift of mining from the Merensky Reef to the higher grade UG2 ore reserves had already begun.

Aquarius Platinum Ltd. of Australia, a new entrant to the PGM sector, controlled the Marikana deposit, containing a PGM-bearing resource of 20 Mt, and the new Kroondal platinum mine development in North West Province. Implats also held a 45% interest in Kroondal Platinum Mines Ltd., which expected to start up production by July 1999. The Kroondal operation will produce at a rate of 3,110 kg/yr of platinum, 1,555 kg/yr of palladium, and 467 kg/yr of rhodium, all in concentrates, that will be sold to Implats for refining. Capital costs were \$56 million. Reserves were sufficient for 14 years of operation at this rate. Measured reserves in two seams were reported to be 2.6 Mt grading 5.8 g/t PGE and indicated reserves to be 13.3 Mt grading 6.3 g/t PGE. Unlike the meter-high mining panels used elsewhere in South African platinum mines, Kroondal will use a "wide reef" concept, digging tunnels big enough for mechanical equipment and for miners to stand up straight. Waste will be separated by a gravity system on the surface before the ore goes to the mill for grinding (Jones, 1999).

Titanium and Zirconium.—Globally, South Africa ranked second in titanium production and third in titanium exports in 1998. Richards Bay Minerals, owned jointly by Rio Tinto and Billiton, produced ilmenite, rutile, and zircon from beach sands north of Richards Bay. Richards Bay Minerals was the trading name for two registered companies—Tisand (Pty.) Ltd. and Richards Bay Iron & Titanium (Pty.) Ltd. (RBIT). Tisand was responsible for the dune mining operation and mineral separation, and RBIT undertook the smelting and beneficiation process. RBIT produced an 85% titanium dioxide slag from ilmenite concentrates at the Richards Bay smelter, as well as low-manganese pig iron. The flow sheet for the operation was available on the company web site accessible at URL <http://www.richardsbayminerals.co.za>. The Richards Bay

operation was the largest titanium mineral producer in the country, with production exceeding 1 Mt of titanium dioxide slag in 1998. RBM was investing \$150 million to develop a new mine site, Pond-E, north of existing operations, and to upgrade the existing mineral-processing plant. The expansion project, which should be operational by late 1999, will permit RBM to maintain slag output of 1 Mt/yr as ore grades gradually decline (Billiton plc, 1998, p. 15-37).

Namakwa Sands Limited operated a heavy minerals sand mine at Brand-se-Baai and a mineral separation plant at Koekenapp, located 340 km northwest of Cape Town, and a smelter at Vredenburg, near the export harbor at Saldanha Bay. The project was being developed in two phases by the owners, Anglo American (80%) and De Beers (20%); IDC provided an \$80 million loan. Since the startup of Phase I in 1994, the operation has mined 4 Mt/yr of ore yielding approximately 400,000 t/yr of heavy medium concentrates with an average composition of 55% ilmenite, 15% zircon, 4% rutile, 16% other heavy minerals, and 10% quartz. The smelter, using Mintek-developed direct-current plasma-arc technology, produced titanium slag and a coproduct pig iron from ilmenite concentrates. Planned Phase I production rates were 56,000 t/yr of pig iron, 36,000 t/yr of rutile, 97,000 t/yr of titanium

slag, and 123,000 t/yr of zircon. Actual 1998 production, however, was lower owing to lost time resulting from an explosion in the main furnace, which has since been repaired. The \$220 million Phase II expansion began in 1997 and was expected to be completed by 2001. Mining and ore treatment will expand to 12 Mt/yr. A second direct-current plasma-arc furnace, commissioned in March 1999, will double slag output. Production at full capacity will be 230,000 t/yr of high titanium slag, 140,000 t/yr of zircon, 120,000 t/yr of pig iron, and 42,000 t/yr of rutile, generating an expected total export revenue of about \$190 million per year on the basis of 1998 exchange rates (Personal communications, February 1999).

Titaniferous magnetite also was recovered at the Phalaborwa carbonatite as a byproduct of copper and phosphate rock production, and titaniferous slag was produced from Mapoch Mine magnetite ores at Highveld's Witbank steel plant. Additionally, research was carried out during the year to recover titanium dioxide from the massive slag heap at Highveld. The slag heap contained 30% titanium dioxide. Current (1998) technologies, however, are incapable of recovering the material economically (Mining Journal, 1999).

In 1998, South Africa ranked second worldwide in the production and export of zirconium minerals. Zirconium was produced as a zircon byproduct of mining at the Richards Bay and the Namakwa Sands mineral sands operations. Palabora produced 70% of the world's baddeleyite, which is a zirconium sulfate mineral used in specialized applications in the ceramics, refractory, and tanning industries and in kidney dialysis machines. Sales of all zirconium products at Palabora fell to 7,486 t compared with 9,387 t in 1997, principally owing to reduced access to ore as the open pit narrows. Palabora produced only 263 t of zirconium basic sulfate (ZBS) from zircon sands at its new plant in 1998. Full production capacity was expected to be 7,895 t/yr of ZBS product containing 38% ZrO_2 by 1999 (Palabora Mining Company Limited, 1999, p. 7-8).

Uranium.—In 1998, uranium oxide production decreased to 1,138 t from the 1,324-t output in 1997. Uranium was produced as a byproduct from the Vaal Reefs and the Hartbeestfontein gold mines and the Palabora copper mine, which produced 105 t in 1998. More than 90% of uranium oxide production was as a byproduct of gold mining. The gold industry treated 4.81 Mt of material grading 221 g/t of uranium oxide and yielding 1,061 t of uranium oxide.

Vanadium.—South Africa was the world's largest producer and exporter of vanadium. Vanadium was produced from titaniferous magnetite mined from the Bushveld Complex. The largest producer was Highveld with an annual capacity of 50,000 t of vanadium pentoxide. Highveld's main products were vanadium slag and vanadium pentoxide flake, although modest amounts of vanadium trioxide also were produced, as was a small amount of ferrovanadium. Xstrata was the second largest South African producer of vanadium, having acquired Rhoex and Vanadium Technology (Pty.) Ltd. (Vantech) in 1997. During 1998, Rhoex, with its new leaching facility in place, produced 5,579,193 kg of vanadium pentoxide (V_2O_5), a

48% increase compared with that of 1997. Xstrata planned another \$5 million investment to upgrade the crushing and milling process at Rhoex. Xstrata reported an 11% increase in production at Vantech to 5,805,989 kg of V_2O_5 and announced a prefeasibility study to examine development of the Steelpoortdrift vanadium deposit. Xstrata reported that its South African vanadium resources were 22.02 Mt of proven reserves grading 0.71% V_2O_5 , 18 Mt of probable reserves grading 0.63% V_2O_5 and 130.83 Mt of inferred resources grading 0.94% V_2O_5 (Südelektra Holding AG, 1999, Annual report for 1998, accessed January 20, 2000, at URL http://www.xstrata.com/reports/doc/sue-ar1998_en.pdf).

Industrial Minerals

South Africa produced about 33 different industrial minerals from 467 mines and quarries. The industrial minerals sector was a significant contributor to total mineral sales in 1998. The value of total sales of industrial minerals produced was about \$717 million. Approximately 72% of those sales was on the domestic market. In terms of sales, the three dominant industrial mineral commodities were aggregate and sand, limestone and dolomite, and phosphate rock. The largest domestic consumers of South Africa's industrial minerals were the building and construction, metallurgical, and agricultural sectors. Total export earnings for industrial minerals were more than \$200 million in 1998. Granite and norite dimension stone accounted for 51% of industrial mineral exports, with the other major export commodities being, by value, phosphate rock, andalusite, vermiculite, fluorspar, and asbestos (Roux, 1999).

Diamond.—Spurred by new entrants into sector, rough diamond production increased by 7% to 10.76 million carats in 1998. As in years past, mines owned by De Beers dominated the sector with more than 90% of the total production. Total diamond production for De Beers' South African operations in 1998 amounted to 9.65 million carats recovered from 22.9 Mt of material treated. The Venetia Mine, the largest De Beers operation, recovered 4.5 million carats; the Finsch Mine, 2.17

million carats; the Premier Mine, 1.39 million carats; the Namaqualand Mine, 768,480 carats; the Kimberley Mine, 682,924 carats; and the Koffiefontein Mine, 158,480 carats. Diamond recovery rates varied considerably within the De Beers operations, with Venetia recovering 135.2 carats per metric ton, Finsch, 54.5 carats per ton, Premier, 45.5 carats per ton, the Kimberley Mine, 16.4 carats per ton, the Namaqualand Mine, 12.5 carats per ton, and the Koffiefontein Mine, 6.9 carats per ton (De Beers, 1998). At Kimberly, De Beers was examining the feasibility of extending the life of the Dutoitspan Mine by 6 years by replacing its 40-year-old treatment plant with a newer, more efficient technology that would permit recovery from old surface dumps and previously uneconomic underground reserves.

The sharp drop in demand and prices for diamonds, accounted for, in part, by the financial crisis in Asia, led De Beers to begin cutting back production at some South African

operations by yearend. In October, however, De Beers announced that it was considering investing \$230 million to expand the production capacity at the Premier diamond mine to about 3 million carats per year. Development of the so-called "C-Cut" at Premier would access reserves between 750 and 1,000 m and extend the life of the mine from 12 to 32 years. At the Venetia Mine, optimization of the pit design and ore haulage equipment selection will permit the open pit mine to reduce through the 400-m level until about 2020.

SouthernEra Resources Ltd. of Canada brought the Sugarbird Blow Mine at Klipspringer and the Marsfontein property, near Potgietersrust in Northern Province, into production after a lengthy legal battle over ownership of the mining rights; 60% will go to De Beers who bought out the original owner. The Marsfontein joint venture treated 116,000 t of material in its first year of operation, yielding 533,337 carats of diamonds. The unusually high recovery at Marsfontein was attributed to enriched secondary gravels overlying the main M1 kimberlite ore body. In February 1999, De Beers sold its 60% interest in the Marsfontein property to a black empowerment group comprising New Diamond Corp., Domba Investments, and Vuwani Projects for \$36 million. SouthernEra commissioned its \$8.5 million dense medium separation plant at Klipspringer in February 1998. In addition to the Marsfontein production, the Klipspringer Plant treated 85,537 t of ore from the Sugarbird Blow, yielding 68,166 carats of diamonds. Exploration by SouthernEra in the Klipspringer area since 1995 has identified a complex fissure system containing 10 mineralized kimberlite bodies. Besides Marsfontein, development work on two of the kimberlites, at the Sugarbird Blow and at the underground Leopard Fissure, was underway in 1998.

Fluorspar.—Phelps Dodge owned and operated the Witkop open pit fluorspar mine and a mill in the western Transvaal during most of 1998. Witkop produced a total of 101,800 t of acid-grade fluorspar in 1998 compared with 97,800 t in 1997. Acid-grade fluorspar concentrates were shipped to customers in South Africa, the United States, Europe, Australia and Asia. In late 1998, the Witkop Mine was sold to the Australian-owned South Africa Land & Exploration Company (Sallies). Sallies planned on upgrading the metallurgical process at the plant to return it to its full capacity of 120,000 t/yr of fluorspar.

Vermiculite.—Production of exfoliated vermiculite increased by 5% to 221,300 t in 1998, representing about 75% of reported world supply, compared with that of 1997. The major producer was the Vermiculite Operations Division of Palabora, which extracted vermiculite from the pyroxenite units of the mineralogically diverse Phalaborwa Carbonatite Complex. The company reported vermiculite concentrate production of 207,070 t grading 90.74% vermiculite (Palabora Mining Company Limited, 1999). Vermiculite production at the Natkruit Vermiculite Mine Pty. Ltd. mine and beneficiation plant in the Northern Province was at a rate of about 14,000 t/yr of unexfoliated vermiculite; the mine closed in March 1999.

Mineral Fuels

Coal.—Following gold, coal was one of the most important sectors of the mineral economy of South Africa. South Africa remained the fifth largest coal-producing country in the world and the third largest coal exporter. Production and export levels continued on an upward trend in 1998. Of the 223.6 Mt of coal produced in 1998, valued at \$3.25 billion, 66.2 Mt, valued at \$1.75 billion, was exported primarily through the Richards Bay Coal Terminal (RBCT). Export destinations for South African coal were Europe, Asia and the Middle East, Africa, and South America. The RBCT was undertaking a major investment program to progressively increase the port coal export capacity to 81 Mt/yr by 2010. In addition, Portnet began a feasibility study to examine the potential development of a new 12-Mt/yr coal export facility at South Dunes Coal Terminal. In 1998, 162.8 Mt were consumed domestically. Domestic sales went to electricity (89.72 Mt), industry (35.45 Mt), synthetic fuels (27.69 Mt), metallurgy (5.82 Mt), and traders and households (4.11 Mt) (Department of Minerals and Energy, 1999, p. 15). Almost 90% of South Africa's electricity was generated from coal and about 6% from uranium. Three companies—Ingwe Coal Corp. Ltd., Amcoal, and Sasol Mining (Pty.) Ltd.—

continued to account for more than 80% of the country's coal production. Other producers included Lonmin plc (formerly Lonrho plc) and Iscor, which mined coal for its own internal use. In addition, numerous medium-to-small, independent coal companies mined coal. Approximately 55% of all coal mined in South Africa was through underground operations. South Africa's coal reserves were mainly bituminous with relatively high ash content (about 45%) and low sulfur content (about 1%). Three fields—Waterberg, Witbank, and Highveld—hold 70% of total recoverable reserves. Several areas, including parts of the Waterberg Field, were identified as having potential for future coal bed methane development (U.S. Energy Information Administration, 2000, Country analysis briefs—South Africa, accessed February 17, 2000, at URL <http://www.eia.doe.gov/emeu/cabs/safrica.html>). The estimates of recoverable coal reserves of 55.3 billion tons were last calculated in 1987. During 1998, the DME began a new evaluation of coal resources and reserves to be based on guidelines from the United Nations Economic Commission for Europe Standards and Proposals. The new evaluation will also include an assessment of the recovery of usable energy from coal discard dumps. In 1998 alone, 62 Mt of discard coal was generated.

Petroleum and Natural Gas.—Soekor E and P (Pty.) Ltd., a subsidiary of Soekor, controlled all offshore oil and gas prospects. Crude oil production from the Oribi Field, South Africa's first offshore oilfield, which was commissioned in 1997, was nearly 6 million barrels in 1998. The Oribi Field, owned by Soekor E and P (80%) and Energy Africa (20%), was expected to produce at a rate of 20,000 barrels per day (bbl/d) of crude petroleum in 1999, providing for 6% of South Africa's daily oil requirements. This project is expected to save South Africa about \$166 million in oil import substitution during the

4-year life of the well (Mbendi Information Services, January 11, 2000, Soekor—Nature of business, accessed February 10, 2000, at URL <http://mbendi.co.za/soekor/index.htm>). South Africa's total throughput refining capacity for crude oil was 465,000 bbl/d from four refineries.

Mossgas, which uses natural gas to produce synthetic motor fuel at its plant at Mossel Bay, produced natural gas from several offshore fields. Main production was from the FA Field, which was discovered in 1984 and is situated 85 km south of the town of Mossel Bay. Two nearby satellite fields, FAH and FAR, which are situated 16 km and 8 km, respectively, northwest of the FA platform, were brought into production in May 1997. The EM gasfield, 49 km west of FA, and the smaller EBF Field were scheduled for commissioning in 2000 because the FA reserves will be depleted in 2001. These fields will provide Mossgas with gas until 2006. Mossgas was also doing additional drilling to outline newly discovered reserves of oil in the Bredasdorp Basin (Mossgas, 1999, About Mossgas, accessed December 28, 1999, at URL <http://www.mossgas.com/about.htm>).

Synthetic Fuels.—As summarized by the U.S. Energy Information Administration, South Africa had a highly developed synthetic fuels industry that took advantage of the country's abundant coal resources and offshore natural gas and condensate in Mossel Bay. The two major players were Sasol (coal-to-oil/chemicals) and Mossgas (natural-gas-to-petroleum products). Sasol had the capacity to produce 150,000 bbl/d, and Mossgas, 45,000 bbl/d. The Government decided to end Sasol's annual subsidy of about \$200 million in stages finally ending in July 1999; the subsidy was to protect it against cheaper imported crude oil.

Sasol was the world's largest manufacturer of oil from coal, with coal liquefaction plants located at Secunda (oil) and Sasolburg (petrochemicals). Started by the Government in the 1950's to help reduce South Africa's dependence on imported oil, the company was privatized in 1979. In the coal liquefaction plants, coal is first gasified, then turned into a range of liquid fuels and petrochemical feedstocks. Sasol was investing \$143 million to upgrade its Secunda facilities to reduce costs and to help it remain competitive. The project will improve the efficiency of gas to liquids conversion and reduce operating and maintenance costs. Seven new units were scheduled to be operational by the end of 1999. Sasol was also expanding its coal-to-chemical operations. Two new gas-separation plants were scheduled to be built at Secunda with the first coming online in 1999. The second unit was tentatively expected to be operational in 2001 (U.S. Energy Information Administration, 2000, Country analysis briefs—South Africa, accessed February 17, 2000, at URL <http://www.eia.doe.gov/emeu/cabs/safrica.html>).

Reserves

South Africa's mineral reserves are large and varied and reflect the country's complex geology. A detailed description of the geology and mineral resources of South Africa was

updated by the Council for Geosciences in 1998 (Wilson and Anhaeusser, 1998, 740 p.). The bulk of South Africa's mineral production is from the northern half of the country. Table 3 lists the reserve base for a number of South Africa's major minerals; diamond reserve data are unavailable. Although data for many of the minerals listed are incomplete for the world, South Africa's reserves appear to rank among the top five countries and would rank first in the world for andalusite, chromite, gold, manganese, PGM, and vanadium.

Infrastructure

The country had a well-developed and extensive road and railroad infrastructure serving not only South Africa, but also the surrounding region. Roadways totaled 331,265 km, of which 137,475 km was paved. Railroad infrastructure totaled 21,431 km, of which 9,087 km was electrified. Portnet maintained the largest and most efficient commodity export harbors in Sub-Saharan Africa, most of which handled minerals, notably Cape Town, Durban, East London, Mossel Bay, Port Elizabeth, Richards Bay, and Saldanha Bay. In addition to fulfilling the requirements of South Africa itself, the country's ports also served as outlets for such landlocked countries as Botswana, Lesotho, Swaziland, Zambia, and Zimbabwe. South Africa was also a regional supplier of electricity and petroleum products, two of a number of examples of the dependence of neighboring countries on South Africa's infrastructure and transportation networks. Richards Bay handled more than half the volume of cargo among South African ports. The RBCT had a coal export capacity of about 60 Mt/yr out of a total bulk cargo port capacity of 75 Mt/yr. A second coal export facility was being built at South Dunes near Richards Bay to handle an additional 12 Mt/yr of coal exports. Coal exports through Durban and the Mozambican port of Maputo were only a fraction of those through the RBCT. Durban's port facilities were designed mainly for small consignments of high-quality lump bituminous coal and anthracite that cannot be properly handled at Richards Bay.

Eskom had a nominal capacity of 39,872 megawatts, predominantly from coal-fired sources, with a small percentage of electricity being generated from nuclear sources (Eskom, 1999, Key statistics, Eskom annual report for 1998, accessed March 30, 1999, at URL <http://www.eskom.co.za/annreport/key.htm>). South Africa also maintained 931 km of pipeline for the distribution of crude oil, 1,748 km for petroleum products, and 322 km for natural gas.

Outlook

Significant labor issues within the minerals sector, such as housing of migrant workers, wage parity, worker health and safety, and job training, will likely continue for the next several years. The high incidence of HIV/AIDS in South Africa also poses a threat to the workforce and economic development. Additionally, the ongoing corporate restructuring in South Africa and concomitant mine closures could further stimulate job losses in the mining industry, particularly the gold sector. Wildcat strikes and other labor disturbances were ongoing in

1998 and were continuing into 1999.

Increased attention was expected to be given to environmental issues, which also would be factors in projects requiring financing from international lending institutions. The major mining companies will likely continue to increase their holdings and activities overseas, including the forming of strategic alliances with major overseas customers. The extent to which this will contribute to new investment in South African mining is uncertain, although the large and high-quality resource base should remain attractive to new foreign investors, provided that the political risk climate remains stable.

South Africa was expanding its value-added mineral-processing capacity, especially for refined metals and alloys, during the late 1990's, with room for significantly more growth and investment in this direction. For example, in steel, the country's ready access to domestic sources of nearly all the steelmaking raw materials gave it a natural competitive advantage in this industry, offset partially by its long distances to world markets. In this regard, if labor and energy costs remained low and world markets remained buoyant, then South Africa had the potential to increase greatly its market share for many mineral commodities.

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Major Sources of Information

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Internet site: <http://www.geoscience.org.za>
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Fax: (27) (12) 322-4954
Internet site: <http://www.dme.gov.za>
- Mine Health and Safety Inspectorate
Telephone: (27) (12) 317-9127
Fax: (27) (12) 320-2105
Internet site: <http://www.dme.gov.za/mhs/default.htm>
- Mineral Development Branch
Mineral Economics Directorate (Minerals Bureau)
Telephone: (27) (12) 317-9000
Fax: (27) (12) 320-4327
Internet site: <http://www.dme.gov.za/minerals/default.htm>
- Energy Branch
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Fax: (27) (12) 320-2105
Internet site: <http://www.dme.gov.za/energy/default.htm>
- Department of Trade and Industry
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Internet site: <http://www.dti.pwv.gov.za/dtiwww/Home.htm>
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3051 Massachusetts Ave., NW
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Internet site: <http://usaembassy.southafrica.net/>
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Internet site: <http://www.mintek.ac.za>
National Union of Mineworkers
P.O. Box 2424
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Telephone: (27) (11) 833-7012

Fax: (27) (11) 836-0201
Internet: <http://www.anc.org.za/num>

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Chamber of Mines of South Africa:

Annual Report.

Statistical Tables 1997, and 1998.

Department of Mineral and Energy Affairs:

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TABLE 1
SOUTH AFRICA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998
METALS					
Aluminum metal, primary	172,111	195,292	569,600 r/	673,043	692,500
Antimony concentrate: 2/					
Gross weight e/	7,800	9,550	8,860	5,888	7,316
Sb content	4,534	5,537	5,137	3,415	4,243
Chromite, gross weight:					
More than 48% chromic oxide	thousand tons	16	--	--	--
44% to 48% chromic oxide	do.	1,612	1,792	1,862	2,123
Less than 44% chromic oxide	do.	2,030	3,296	3,155	3,617
Total	do.	3,642	5,104	5,017	5,740
Cobalt:					
Mine output, Co content	358	288	350	465 e/	435 e/
Refinery output	258	190	247	318	296
Copper:					
Mine (company output), Cu content	165,213	165,573	152,595	153,058	166,000
Metal:					
Smelter	154,700	151,200	148,400 r/	163,600	160,000
Refined, primary	129,600	124,300	116,000	130,200	125,600
Gold, primary	kilograms	580,201	523,809	496,846 r/	491,680
Iron and steel:					
Ore and concentrate:					
Gross weight	thousand tons	30,489	31,946	30,830	33,225
Fe content	do.	18,903	19,806	19,115	20,600 e/
Metal:					
Pig iron	do.	6,982 r/	7,137 r/	6,876 r/	6,192
Direct-reduced iron	do.	980	950	900 r/	1,090 e/
Ferroalloys, electric arc furnace:					
Chromium ferroalloys	do.	1,104	1,341	1,478 r/	1,940
Ferromanganese	do.	591	480	562 r/	525 e/
Ferrosilicon	do.	120	90	118 r/	102
Ferrovanadium e/	do.	1	1	1	5
Silicomanganese e/	do.	290 3/	280	241	300
Silicon metal	do.	36	30	29 r/	34
Crude steel	do.	8,525 r/	8,741 r/	7,999 r/	8,311
Lead:					
Concentrate, Pb content	95,824	88,449	88,613	83,114	84,128
Smelter, secondary	31,900	32,100	32,200 r/	41,500	39,200
Manganese:					
Ore and concentrate, gross weight:					
Metallurgical:					
More than 48% manganese	thousand tons	1,533	1,708	1,845	1,809
45% to 48% manganese	do.	67	106	86	84
40% to 45% manganese	do.	196	191	118	116
30% to 40% manganese	do.	1,006	1,145	1,133	1,111
Total, metallurgical 4/	do.	2,801	3,151	3,182	3,120
Chemical, 35% to 65% manganese dioxide	do.	50	48	58	33
Grand total	do.	2,851	3,199	3,240	3,153
Metal, electrolytic e/	do.	35	35	39 r/	40
Nickel:					
Mine output, concentrate, nickel content e/	31,800	30,700	33,861 r/ 3/	34,830 3/	36,700
Metal, electrolytic	30,751	29,803	33,362	33,700	35,200 e/
Platinum-group metals: e/					
Platinum	kilograms	98,285	102,300	105,440	115,861
Palladium	do.	46,655	51,000	52,560	55,675
Rhodium	do.	10,264	10,900	11,200	11,664
Other 5/	do.	28,722	18,897	19,436	13,266
Total	do.	183,926 3/	183,097 r/ 3/	188,636 r/ 3/	196,466 3/
Silver	do.	197,767	174,279	168,689 r/	144,004
Thorium, monazite concentrate, gross weight e/		131 3/	--	--	--

See footnotes at end of table.

TABLE 1--Continued
SOUTH AFRICA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998
METALS--Continued					
Titanium: e/					
Ilmenite concentrate thousand tons	1,314	1,680	2,100	2,237	2,190 e/
Rutile concentrate do.	78	90	115 r/	123	240 e/
Total, titanium minerals do.	1,392	1,770	2,215	2,360 3/	2,430
Titaniferous slag 6/ do.	819	990	1,000 e/	1,090	1,043
Uranium oxide	2,069	1,702	1,706	1,324	1,138
Vanadium, vanadium metal content	16,350 r/	16,297 r/	14,770 r/	15,590	18,868
Zinc:					
Concentrate:					
Gross weight e/	140,000	130,000	142,000	132,000	129,000 e/
Zn content	76,361	70,241	76,853	71,062	69,630
Metal, smelter, primary	93,850	98,782	101,100	108,500	107,400
Zirconium concentrate (baddeleyite and zircon) e/	240,000	260,000	260,000	265,000 3/	265,000
INDUSTRIAL MINERALS					
Aluminosilicates:					
Andalusite	206,291	206,378	233,728 r/	251,203	236,200
Sillimanite	525	317	-- r/	--	65
Asbestos:					
Chrysotile	85,857	81,246	51,776	49,754	27,195
Crocidolite	6,273	7,396	5,344	232	--
Total	92,130	88,642	57,120	49,986	27,195
Barite	1,945	6,048	7,428	2,071	610
Calcite	14,660	10,666	13,749 r/	2,886	2,764
Cement, hydraulic thousand tons	7,905	9,071	9,580	9,980	9,000 e/
Clays:					
Attapulgite	10,230	8,049	14,318	9,349	7,671
Bentonite	71,773	70,927	48,076	33,326	48,382
Fire clay	110,131	74,751	101,452	131,307	180,885
Flint clay, raw and calcined	131,590	118,688	113,645	92,397	82,787
Kaolin	131,863	146,587	150,600 r/	122,800 r/	101,300
Brick clay, local sales thousand tons	1,386	2,909	2,919 r/	3,615 r/	3,171
Diamond, natural:					
Gem e/ thousand carats	4,900	4,300	4,400	4,500	4,700 e/
Industrial e/ do.	5,954	5,383	5,546	5,541	6,056 e/
Total 4/ do.	10,854	9,683	9,947 r/	10,041	10,756
Feldspar	37,156	47,874	53,644 r/	59,688	56,761
Fluorspar:					
Acid-grade	166,761	177,000	202,018 r/	201,000	222,000
Ceramic-grade e/	--	--	--	4,000	--
Metallurgical-grade	7,497 3/	18,794 3/	10,000 r/	2,000	15,000
Total	174,258	195,794	202,018 r/	207,000	237,000
Gemstones, semiprecious Tiger's eye kilograms	531,418	242,607 r/	18,650 r/	64,300	87,200
Gypsum, crude	304,337	288,178	340,688	365,279	485,749
Industrial or glass sand (silica) thousand tons	1,920	2,180	2,168 r/	2,439	2,273
Lime 7/ do.	2,891	1,688	1,650	1,585	1,523
Magnesite, crude	71,726	84,639	71,358	76,699	74,300
Mica, scrap and ground	1,973	2,137	1,515	1,423	1,556
Nitrogen, N content of ammonia	754,000	758,500	769,800	752,400 r/	722,800
Perlite	914	1,338	1,300	403	400 e/
Phosphate rock:					
Gross weight thousand tons	2,545	2,787	3,077	2,732	2,739
Phosphorus pentoxide content e/ do.	995	1,087	1,200	1,038	977

See footnotes at end of table.

TABLE 1--Continued
SOUTH AFRICA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998
INDUSTRIAL MINERALS--Continued					
Pigments, mineral, natural:					
Ochers	1,789	2,316	484	186	122
Oxides	295	2,940	159	98	64
Total	2,084	5,256	643	284	186
Salt	414,463	311,388	253,403	320,000	356,059
Sodium sulfate, natural	44,544	43,971	46,947	49,071	48,613
Stone, n.e.s.:					
Dimension:					
Granite and norite 7/	618,781	718,100 r/	708,700 r/	804,300	669,363
Marble 8/	5,268	1,307	2,570	--	--
Slate 7/	21,900 r/	23,500 r/	37,800 r/	11,000	23,547
Crushed and broken:					
Limestone and dolomite	19,548	19,738	22,038	22,214	19,754
Nepheline syenite	98,667	145,459	137,706 r/	114,201	11,500 e/
Quartzite 6/	9,258	9,123	8,515	8,500	10,203
Shale:					
For cement	371	325	338 r/	334	280
Other 6/	2,157	3,248	3,000 e/	3,000 e/	3,707 e/
Total	2,528	3,573	3,338	3,334	3,986
Aggregate and sand, n.e.s.	18,294	20,594	20,792	32,950	33,980
Sulfur:					
S content of pyrite	252	159	160 e/	133 e/	120 e/
Byproduct:					
Metallurgy e/	118	117	80 e/	86 e/	93 e/
Petroleum	209	233	195 e/	230 e/	223 e/
Total 4/	579	509	435	449	436
Talc and related materials:					
Talc	8,202	9,173	16,397	24,400	21,900
Pyrophyllite (wonderstone)	5,507	5,519	2,140	2,129	2,532
Vermiculite	223,478	221,748	184,300 r/	212,000	229,300 e/
MINERAL FUELS AND RELATED MATERIALS					
Coal (salable product):					
Anthracite	2,225	2,137	2,465 r/	1,997	2,101
Bituminous	193,625	204,073	203,803 r/	216,453	222,283
Total 4/	195,850	206,210	206,269 r/	218,450	224,385
Natural gas	1,980	1,980	980	1,756	1,560 e/
Petroleum: 9/	--	--	--		
Crude	--	--	--	3,744	6,549 e/
Refinery products:					
Liquefied petroleum gases	1,825	3,285	3,285 r/	3,000 e/	3,000 e/
Gasoline	59,860	73,730	66,795 r/	67,000 e/	67,000 e/
Jet fuel	7,665	8,760	10,220 r/	10,000 e/	10,000 e/
Kerosene	5,475	7,300	6,935 r/	7,000 e/	7,000 e/
Distillate fuel oil	35,770	50,005	49,275 r/	50,000 e/	50,000 e/
Residual fuel oil e/	20,075 3/	22,995 3/	25,550 r/	25,000 e/	25,000 e/
Lubricants (including greases) e/	1,280 3/	3,000	3,000 e/	3,000 e/	3,000 e/
Bitumen e/	895 3/	2,000	2,000 e/	2,000 e/	2,000 e/
Other e/	380 3/	4,855	5,950 r/	6,000 e/	6,000 e/
Total 10/	133,225	175,930	173,010 r/	173,000 e/	173,000 e/

e/ Estimated. r/ Revised.

1/ Table includes data available through December 1999.

2/ Data are for the year ending June 30 of that stated.

3/ Reported figure.

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

5/ Difference between total production reported by the Minerals Bureau and platinum, palladium, and rhodium supplies (shipments) reported in Johnson and Matthey Annual Platinum Review. Includes ruthenium and iridium production plus excess platinum, palladium, or rhodium inventory.

6/ Except for about 45,000 metric tons per year of slag derived from titaniferous magnetite by Highveld Steel and Vanadium Corp. Ltd., titaniferous slag is all from the smelting of ilmenite and likely represents most of that mineral's production, for which complete data are unavailable.

7/ Domestic sales plus exports.

8/ Converted from reported cubic meters using 1 cubic meter = 2.7 metric tons.

9/ In addition, Sasol produces about 67 million barrels per year of synthetic liquid petroleum fuels from coal.

10/ Excludes refinery fuel and losses.

TABLE 2
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY 1/

(Thousand metric tons unless otherwise specified)

Major commodities	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Aluminum	Billiton Aluminium South Africa (Pty.) Ltd. (Billiton plc, 100%)	Bayside smelter at Richards Bay	175.
Do.	do.	Hillside smelter at Richards Bay	500+.
Andalusite	Rhino Minerals (Pty.) Ltd. (Mircal South Africa (Pty.) Ltd., 100%, acquired from Avmin July 1999)	Rhino Mine near Thabazimbi	120.
Do.	do.	Havercroft Mine at Penge, N. of Steelpoort	60.
Do.	Samrec Pty. Ltd. of France (private, 100%)	Annesley Mine at Penge, 50 kilometers north of Steelpoort	75.
Do.	do.	Andalusite Refractories Mine at Groot Marico 60 kilometers west of Rustenburg	12.
Do.	do.	Krugerspost Mine, near Lydenburg	50.
Do.	Hoogenoeg Andalusite (Pty.) Ltd.	Hoogenoeg Mine, 60 kilometers northeast of Potgietersrus	15.
Antimony	Consolidated Murchison Ltd. [Metorex Pty. Ltd., 34.3%; Crew Development Corp. (Canada), 3.3%]	50 kilometers west of Phalaborwa	7 Sb concentrate, 1,000 kg gold byproduct.
Asbestos	Kaapsehoop Asbestos Pty. Ltd.	New Amianthus Mine in Mpumalanga	NA (chrysotile).
Do.	African Chrysotile Asbestos Ltd.	Msauli Mine near Barberton	NA (chrysotile).
Do.	Anglo Dutch Exploration & Mining Co. (Pty.) Ltd.	Stella Mine, 25 kilometers east of Barberton	NA (chrysotile).
Do.	Griqualand Exploration and Finance Corp.	Kuruman Mine (closed in 1998)	NA (crocidolite).
Cement	Anglo Alpha Ltd. (Holderbank; Anglovaal Industries Ltd.)	Dudfield kiln near Lichtenburg, also grinding mill at Roodepoort	1,830.
Do.	do.	Ulco kiln 60 kilometers northwest of Kimberley	1,615.
Do.	Lafarge South Africa Ltd. [Lafarge (France) (formerly Blue Circle Cement (Pty.) Ltd.)]	Lichtenburg kiln	2,200.
Do.	do.	White's kiln	200.
Do.	Natal Portland Cement Co. (Pty.) Ltd. (co-owned by Anglo Alpha, Lafarge, and Pretoria Portland Cement companies).	Simumu plant, 125 kilometers southwest of Durban; also grinding mills at Durban and Newcastle	1,500.
Do.	Pretoria Portland Cement Co. Ltd. (Barlow Rand Group, 60.3%)	De Hoek, Dwaalboom, Herculese, Jupiter, Slurru, Riebeeck West, and Port Elizabeth kilns	5,500 (combined), clinker.
Chromite	Samancor Ltd. (Billiton plc, 60%, Anglo American plc, 40%)	Eastern Chrome Mines in Steelpoort Valley, Mpumalanga Province, includes: Lannex, Groothoek, Jagdlust, Mooihoek, Tweefontien, and Steelpoort mines	2,200 run-of-mine ore.
Do.	do.	Western Chrome Mines in Northern Province includes Elandsdrift, Mooinooi, Ruighoek, and Waterkloof-Millsell mines	1,800 run-of-mine ore.
Do.	Chromecorp Holdings Ltd. [Xstrata Ag, nee (Sudelektra Holdings AG, (Switzerland) 100%]	Kroondal Mine east of Rustenburg	1,260 ore; 880 concentrate.
Do.	do.	Wonderkop Mine east of Rustenburg	720 ore; 400 concentrate.
Do.	do.	Chroombronne Mine, near Rustenburg	576 ore; 432 concentrate.
Do.	do.	Purity Mine, near Rustenburg	360 ore; 252 concentrate.
Do.	Hernic Ferrochrome Pty. Ltd., [E.L. Haniel (Germany); Nittetsu Shoji (Japan)]	Hernic Chrome Mine	NA.
Do.	Bayer Pty. Ltd.	Rustenburg Chrome Mine	NA.
Do.	Lavino South Africa (Pty.) Ltd. (Anglovaal Minerals Ltd., 51%; Middle Witwatersrand, 49%)	Grootboom Mine, near Lydenburg	500 ore.
Do.	Dilokong Chrome Mine (Pty.) Ltd. (Mining Corp. Ltd., 100%)	Dilokong Mine, near Lydenburg	480 ore.
Do.	Associated Manganese Mines of South Africa Ltd. (Anglovaal Minerals Ltd., 50.2%; Associated Ore & Metal Corp., 45.2%)	Dwarsrivier Mine to open 2000	1,000 run-of-mine ore.
Coal	Amcoal Colliery and Industrial Operations Ltd. (Anglo American Plc., 52%)	8 collieries: Amot, Bank, Goedehoop, Kriel, New Denmark, New Vaal, SA Coal Estates, and Vryheid Coronation, in Mpumalanga and KwaZulu-Natal	52,000 anthracite and bituminous.
Do.	Ingwe Coal Corp. Ltd. (Billiton Plc., 100%)	10 collieries in Mpumalanga and KwaZulu-Natal Provinces	59,000 anthracite and bituminous.
Do.	Duiker Mining Ltd. (Lonmin Plc., 68%)	Duiker and Tavistock collieries (6 mines, includes Tweefontein and Spitzkop collieries)	20,000.
Do.	Duvha Opencast Services (Pty.) Ltd. (Rand Mines Ltd., 71%)	Duvha Colliery, 18 kilometers southeast of Witbank	11,000 bituminous.
Do.	Kangra Group Pty. Ltd.	Savamore, Springlake, Taaboschpruit, and Welgedacht collieries	4,300 bituminous and steam.

See footnotes at end of table.

TABLE 2--Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY 1/

(Thousand metric tons unless otherwise specified)

Major commodities	Major operating companies and major equity owners	Location of main facilities	Annual capacity	
Coal	Sasol Mining (Pty.) Ltd. (Sasol, 100%)	Sigma Colliery, 2 mines, 75 kilometers south of Johannesburg (closing end 1999)	5,500 bituminous.	
Do.	do.	Secunda Collieries, 6 mines, 75 kilometers south of Witbank	43,000 bituminous.	
Do.	Iscor Mining (Iscor Ltd., 100%)	Grootegeeluk Mine, 120 kilometers north of Thabazimbi	12,000 steam coal, 2,000 coking coal, 450 metallurgical coal.	
Do.	do.	Leeuwan Colliery in Mpumalanga Province	1,250 steam coal.	
Do.	do.	Durnacol Mine at Dannhauser, 40 kilometers south of Newcastle	530 coking coal.	
Do.	do.	Tshikondeni Mine in Venda, about 100 kilometers southeast of Messina	410 coking coal.	
Do.	Anglovaal Minerals Ltd. (100%)	Dortfontein Colliery	700.	
Do.	do.	Forzando Colliery	1,350.	
Do.	New Coal (Amcoal/Ingwe empowerment vehicle)	Matla, Arnot underground, Glisa, and, New Clydesdale collieries	NA.	
Do.	Kuyasa Mining (Pty.) Ltd.	Ikhewezi mine, near Delmas	350.	
Do.	Gold Fields Coal Ltd	Greenside and New Clydesdale collieries	3,000.	
Do.	Anker Holdings B.V. (Netherlands)	Elandsfontein, Golfview, Van Oudshoornstrom, and Woestalleen collieries	5,000. e/	
Do.	Wakefield Coal Division, [Metorex Pty. Ltd., 40.07% (Canada)]	Leeuwfontein and Side collieries in Witbank Coalfield	1,300 steam.	
Copper	Palabora Mining Co. Ltd. (Rio Tinto Ltd., 46.4%, Anglo American plc /De Beers, 29%)	Palabora open pit mine and plant at Phalaborwa (Switch to underground mining in 2002)	130 metal, then reduces to 75 metal.	
Do.	do.	Copper smelter at Phalaborwa	140 anodes.	
Do.	do.	Copper refinery at Phalaborwa	125 cathodes	
Do.	O'okiep Copper Co. Ltd. [Metorex (Pty.) Limited, 89%]	Nigramoep copper mine, near Nababeep, Northern Cape Province	15 Cu in concentrates.	
Do.	do.	O'okiep copper smelter at Nababeep	42 blister.	
Do.	Black Mountain Mineral Development Co. (Pty.) Ltd. (Anglo American plc., 100%)	Black Mountain Mine near Aggeneys, 100 kilometers northeast of O'okiep	5 Cu in concentrate.	
Do.	Maranda Mining Co. [Metorex (Pty.) Limited, 29.1%]	Maranda zinc-copper mine in Murchison Range in Northern province Province	1.6 Cu metal.	
Diamond	thousand carats	De Beers Consolidated Mines Ltd., (Anglo American plc, 29%)	Finsch Mine, 100 kilometers west of Kimberley	2,500. e/
Do.	do.	do.	Kimberley Mines, Kimberley	800. e/
Do.	do.	do.	Koffiefontein Mine, 70 kilometers south of Kimberley	200. e/
Do.	do.	do.	Namaqualand Mines, 50 kilometers north of Port Nolloth	800. e/
Do.	do.	do.	Premier Mine, 70 kilometers east of Pretoria	1,700. e/
Do.	do.	De Beers, 50%; Saturn Partnership, 50%, (of which Avmin, 87.5%, Industrial & Commercial Holding group, 12.5%)	Venetia Mine, 150 kilometers north of Potgietersrus	5,000. e/
Do.	do.	SouthernEra Resources Ltd (Canada), (In joint venture with De Beers or Randgold Resources on some operations	Klipspringer project, includes 10 kimberlite fissures and pipes near Potgietersrus in Northern Province	1,000.
Do.	do.	Benguela Concessions Ltd.	Several marine operations along Namaqualand coast; Moonstone mining ship	40.
Do.	do.	Trans Hex Group Ltd.	Baken deposit on Orange River; So Ver, Reuning, Komagass, and Hondklip Bay mines, and 3 marine operations off Northern Province	200.
Fluorspar	Vergenoeg Mining Corp. (Pty.) Ltd. [Metorex Pty. Ltd., 70%; Minerale y Productos Derivados SA (Spain), 30%)	Vergenoeg Mine, 90 kilometers east of Pretoria	100 acid grade fluorspar, 10 metallurgical grade fluorspar.	
Do.	South Africa Land & Exploration Co., [Athlone International (Australia), 100%]	Witkop Mine, 130 kilometers west of Johannesburg	100 acid-grade fluorspar (plan to double capacity).	
Do.	Van den Heever Fluorspar Works	Van Den Heever Mine, 120 kilometers west of Johannesburg	50 e/ metallurgical grade fluorspar.	

See footnotes at end of table.

TABLE 2--Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY 1/

(Thousand metric tons unless otherwise specified)

Major commodities		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Gold	tons	AngloGold Ltd.	13 mines southwest of Johannesburg: Great Noligwa (ex-Vaal Reefs Shaft 8), Kopanang (Vaal Reefs #9), Tau Lekoa (Vaal Reefs #10), Moab Khotsong (Vaal Reefs #11), Bambanani (Freegold #1), Tsepong (Freegold #2), Majhabeng (ex-Western Holdings), H.J. Joel, Western Deeps-East, Western Deeps-West, Western Deeps-South, Deelkraal, and Elandsrand, plus Western Ultra Deep Levels project	186 Au. South African operations only.
Do.	do.	Gold Fields Ltd.	Beatrix, Driefontein, Kloof, Leeudoorn, Oryx, Libanon, St.Helena, and Target mines; west and southwest of Johannesburg	125 Au. South African operations only.
Do.	do.	Harmony Gold Mining Co. Ltd.	Harmony, Evander, Masimong (ex-Freegold #3) and Brand mines, in Free State area	49 Au.
Do.	do.	Avgold Ltd. (Anglovaal Mining Ltd., 60.1%)	Eastern Transvaal Consolidated, and Loraine mines near Klerksdorp, plus Target and Sun developments	20 Au.
Do.	do.	Durban Roodeport Deep Ltd.	Blyvooruitzicht, Buffelsfontein, Crown, Durban Deep and West Wits Sections; Hartebeestfontein Mine plus Argonaut Project	20 Au in 1999, 37 Au in 2000.
Do.	do.	Randfontein Estates Ltd. (JCI Gold, 100%) (JCI Gold, 100%)	Cooke 1, 2 and 3 Shafts, Doornkop, Lindum and Western Areas North Shaft near Randfontein, Doornkop South Reef development	26 Au.
Do.	do.	Western Areas Ltd. (JCI Gold, 50%, and Placer Dome Inc., 50%)	Western Areas and South Deep	12 Au.
Do.	do.	Kalahari Goldridge Mining Co. Ltd.	Kalgold Mine near Kraaipan	3.2 Au.
Do.	do.	Rand Refinery Ltd.	Gold Refinery, Germiston, Gauteng Province	1,200 refined Au.
Iron and steel:				
Iron ore		Iscor Ltd.	Sishen Mine at Sishen	27,000 ore, to 32,000 by 2002.
Do.		do.	Thabazimbi Mine at Thabazimbi	2,900 ore.
Do.		Highveld Steel and Vanadium Corp. Ltd. (Anglo American Industrial Corp. Ltd., 51.8%)	Mapochs Mine at Roossenekal, 60 kilometers west of Lydenburg	3,000 titaniferous and vanadiferous magnetite ore.
Do.		Associated Manganese Mines of South Africa Ltd. (Anglovaal Minerals Ltd., 50.2%)	Beeshoek Mine near Postmasburg	4,500 ore.
Ferroalloys 2/		Samancor Chrome Division (Billiton plc., 54.6%, Anglo American plc, 28.9% , other private, 16.5%)	Ferrometals plant at Witbank (6 furnaces) (2 furnaces, 110,000 capacity closing in 1999)	450 ferrochromium.
Do.		do.	Tubatse Ferrochrome plant at Steelpoort (6 furnaces)	340 ferrochromium.
Do.		do.	Middelburg Ferrochrome plant 35 kilometers east of Witbank, (3 furnaces)	235 ferrochromium.
Do.		do.	Palmiet Ferrochrome plant at Krugersdorp, 30 kilometers west of Johannesburg, (3 furnaces)	120 ferrochromium.
Do.		do.	Bathlako Ferrochrome plant at Ruigoek, northwest of Rustenburg	20 ferrochromium.
Do.		Chromecorp Holdings Ltd., [Xstrata AG, formerly Sudelektra Holding AG (Switzerland), 100%]	Rustenburg (6 furnaces)	400 ferrochromium.
Do.		do.	Lydenburg (4 furnaces)	350 ferrochromium.
Do.		do.	Wonderkop (4 furnaces)	320 ferrochromium.
Do.		do.	Rustenburg slag retreatment plant	25 ferrochromium.
Do.		do.	Wonderkop slag retreatment plant	20 ferrochromium.
Do.		do.	Silicon Technology plant at Ballengeich, KZN	55 ferrosilicon.
Do.		Hernic Ferrochrome Pty. Ltd., [ELG Haniel (Germany); Nittetsu Shoji (Japan)]	Plant near Brits, (2 furnaces). expanding to 260,000 metric tons by 2000	135 ferrochromium.
Do.		Feralloys Ltd. (Associated Manganese Mines of South Africa Ltd., 100%)	Machadodorp plant, (3 furnaces), 80 kilometers east of Middelburg	150 ferrochromium, 175 by 2000.
Do.		do.	Cato Ridge, 75 kilometers west of Durban	245 high-carbon ferromanganese.
Do.		Samancor Manganese Division, (Billiton plc., 54.6%, Anglo American plc, 28.9% , other private, 16.5%)	Meyerton plant, (10 furnaces), 50 kilometers south of Johannesburg; can switch between FeMn and SiMn	532 high-carbon ferromanganese, 200 silicomanganese.
Do.		Manganese Metal Co. (Pty.) Ltd. (Samancor Ltd.)	Plants at Krugersdorp and Nelspruit	44 electrolytic manganese.
Do.		Transalloys Division (Highveld Steel and Vanadium Corp. Ltd., 100%)	Witbank	50 medium-carbon ferromanganese, 175 silicomanganese.
Do.		ASA Metals Pty. Ltd. (Eastern Asia Metal Investment Co. Ltd., 60%; Northern Province Development Corp., 40%)	Plant near Pietersburg, Northern Province (associated with Dilokong Chrome)	50 ferrochrome.

See footnotes at end of table.

TABLE 2--Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY 1/

(Thousand metric tons unless otherwise specified)

Major commodities	Major operating companies and major equity owners		Location of main facilities	Annual capacity
Ferroalloys 2/--Continued		Rand Carbide Division, Highveld Steel and Vanadium Corp. Ltd. (100%)	Plant at Witbank, Mpumalanga Province	58 ferrosilicon.
Do.	tons	Vametco Minerals Corp. (Starategic Minerals Corp., USA, 100%)	Smelter near Brits	5,250 ferrovanadium.
Steel		Isacor Ltd.	Vanderbijlpark Works	3,200 flat products.
Do.		do.	Newcastle Works	2,000 profile products.
Do.		do.	Vereeniging Works	450 e/ specialty steels.
Do.		Highveld Steel and Vanadium Corp. Ltd. (Anglo American Industrial Corp. Ltd., 51.8%; De Beers, 3.8%)	Witbank	1,000.
Do.		Columbus Stainless Steel Ltd. (Samancor, 33.3%; Highveld Steel and Vanadium Corp. Ltd., 33.3%; Industrial Development Corp. (IDC), 33.3%)	Stainless steel plant at Middelburg	500.
Do.		Saldanha Steel (Pty.) Ltd. (Isacor Ltd., 50%, IDC, 50%)	Hot-rolled steel coil plant at Saldanha Bay	1,200.
Do.		Davsteel Division, Cape Gate Pty. Ltd.	Vanderbijlpark plant, Gauteng.	400.
Manganese		Associated Manganese Mines of South Africa Ltd. (Avmin Ltd., 50.2%)	Gloria and N'Chwaning Mines near Black Rock, 70 kilometers north of Sishen	1,500 ore.
Do.		Samancor Ltd. (Billiton plc., 60%, Anglo American plc, 40%).	Mamatwan Mine	2,200 ore.
Do.		do.	Wessels Mine, both near Hotazel	1,200 ore.
Do.		Manganese Metal Co. Pty. Ltd. (Samancor Ltd., 100%)	Electrolytic plant at Nelspruit	26 manganese metal.
Do.		do.	Electrolytic plant at Krugersdorp	18 manganese metal.
Do.		Metmin (Metorex Pty. Ltd., 100%)	Open pit mine in North West Province (Used as catalyst for extracting uranium from gold)	24 manganese dioxide.
Nickel		Nkomati Joint Venture (Anglovaal Mining Ltd., 75%; Anglo American plc., 25%)	Nkomati Mine in Mpumalanga Province	15 nickel in concentrate.
Do		do.	do.	do.
Petroleum, crude million 42-gallon barrels		Soeker (Government, 100%)	Oribi field 140 kilometers southwest offshore from Mossel Bay	9.1.
Do.	do.	do.	Oryx field in production 1999	1.8. e/
Do.	do.	Mossgas (Pty.) Ltd. (Government, 100% through Central Energy Fund).	9 wells in Mossel Bay	3.5.
Do.	do.	Shell and BP Refineries Pty. Ltd. (Shell South Africa, 50%; BP Group, 50%)	Sanref refinery in Durban	60 crude.
Do.	do.	Caltex Oil SA Pty. Ltd. (private, 100%)	Refinery in Cape Town	41 crude.
Do.	do.	National Petroleum Refiners of South Africa Pty. Ltd. (Sasol Ltd., Total SA)	Natref Refinery in Secunda, 100 kilometers southeast of Johannesburg	32 crude.
Do.	do.	Engen Ltd. (62%)	Gencor Refinery in Durban	38 crude.
Phosphate		Phosphate Development Corp. Ltd. (Foskor (Foskor Ltd.) (IDC, 100%)	Foskor mine and plant at Phalaborwa	2,900 phosphate rock. 3/
Platinum-group metals kilograms		Anglo American Platinum Corp. Ltd., (Anglo American plc., 100%).	Rustenburg Section near Rustenburg, Union and Amandelbult Sections about 50 kilometers south of Thabazimbi	70,000 platinum metal, 34,000 palladium metal, 6,500 rhodium metal.
Do.	do.	do.	Lebowa Platinum (Atok) Mine, 70 kilometers east of Potgietersrus; and Potgietersrust Platinum Mine near Potgietersrus	
Do.	do.	do.	Bafokeng Rasimone mine in Northern Province opening in 2000	7,776 PGM metal.
Do.	do.	Impala Platinum Ltd. (Implats) (Impala Platinum Holdings Ltd., 100%)	13 mine shafts, concentrator, and smelter near Rustenburg, NW Province; refinery near Springs, Gauteng Province	33,000 platinum, 18,000 palladium, 4,500 rhodium.
Do.	do.	Lonmin Platinum (Lonmin Plc., 73%; Impala Platinum Holdings Ltd., 27%)	3 mines (Eastern Platinum, Karee, and Western Platinum) near Rustenburg	37,324 PGM (in concentrates).
Do.	do.	do.	Smelter and precious metals refinery, at Western Platinum, 20 kilometers east of Rustenburg	20,600 platinum, 9,330 palladium, 2,800 rhodium.
Do.	do.	Northam Platinum Ltd. (Gold Fields of South Africa, 82%)	Northam Mine 20 kilometers south of Thabazimbi	6,220 platinum.
Do.	do.	Kroondal Platinum Mines Ltd., [Aquarius Platinum Ltd., (Australia), 45%, and Implats, 15%].	Kroondal Mine, 10 kilometers east of Rustenburg; opening in 2000	3,110 platinum, 1,866 palladium, 933 other PGM.
Do.	do.	Messina Holdings Ltd. (SouthernEra Resources Ltd., 54%)	Messina platinum deposit, near Klipspringer diamond mine, Northern Province	3,730 PGM + gold, Startup in 2001.

See footnotes at end of table.

TABLE 2--Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY 1/

(Thousand metric tons unless otherwise specified)

Major commodities	Major operating companies and major equity owners		Location of main facilities	Annual capacity
Pyrophyllite	Alpha Ltd.		Idwala Industrial Minerals plant, and Witpoort Quarry	NA.
	Wonderstone Ltd. (The Associated Ore & Metals Corp. Ltd.)		Pyrophyllite (wonderstone) mine in North-West Province	NA.
Do.	G&W Base and Industrial Minerals Pty. Ltd.		Masala Mine, Mpumalanga	NA.
Silicon	Silicon Smelters (Samancor Ltd.)		Near Pietersburg, Northern Province (3 submerged arc furnaces)	40 silicon.
Synthetic fuels million 42-gallon barrels	Sasol Ltd. (Government, 100%)		Coal to oil plant at Secunda and a coal to petrochemical plant at Sasolburg	54.8.
Do.	do.	Mossgas (Pty.) Ltd. (Government, 100% through Central Energy Fund).	Natural gas to petroleum products plant at Mossel Bay	16.4.
Titanium:				
Titanium concentrates	Richards Bay Minerals trading for Tisands (Pty.) Ltd. and Richards Bay Iron and Titanium (Pty.) Ltd. (Rio Tinto Plc., 50%; Billiton Plc., 50%)		Opencast operations near Richards Bay	1,280 ilmenite concentrate, e/ 125 rutile concentrate. e/
Do.	Namakwa Sands Ltd. (Anglo Operations Ltd, a subsidiary of Anglo American plc, 100%)		Opencast mine near Brand-se-Baai and mineral separation plant at Koekenaap, 300 kilometers northwest of Cape Town	540 ilmenite concentrate, 42 rutile concentrate.
Titanium slag	Richards Bay Iron and Titanium (Pty.) Ltd./ Richards Bay Minerals (Rio Tinto Plc.)		Smelter at Richards Bay	1,000 titania slag.
Do.	Namakwa Sands Ltd. [Anglo Operations Ltd (a subsidiary of Anglo American plc), 100%]		Smelter at Vredenberg, Saldanha Bay area	230 titania slag (by 2000), 120 pig iron.
Do.	Highveld Steel and Vanadium Corp. Ltd.		Steel plant at Witbank	48 titania slag. e/
Uranium tons	AngloGold Ltd. (Anglo American plc., 60%; De Beers, 40%)		Vaal Reef's Mine and plant near Klerksdorp	2,000 uranium oxide e/ (900 @=1998-99 output).
Do.	do.	Avgold Ltd. (Anglovaal Minerals Ltd, 100%).	Hartebeestfontein Mine and plant, 5 kilometers southeast of Klerksdorp	400 uranium oxide e/ (<200 @=1998-99 output).
Do.	do.	Palabora Mining Co. Ltd.	Palabora Mine and plant at Phalaborwa	160 uranium oxide. e/
Vanadium do.	Highveld Vanadium and Chemicals Corp. Ltd. (Anglo American Industrial Corp. through Highveld Steel and Vanadium Corp. Ltd.)		Mapochs Mine near Lydenburg	25,000 vanadium pentoxide. e/
Do.	do.	do.	Highveld steel plant in Witbank	17,000 vanadium pentoxide.
Do.	do.	do.	Highveld Vantra plant in Witbank	8,000 vanadium pentoxide.
Do.	do.	Vametco Minerals Corp. (Strategic Minerals Corp., USA, 100%)	Krokodilkraal Mine and plant near Brits	5,000 vanadium pentoxide. e/
Do.	do.	Transvaal Alloys Pty. Ltd., (Highveld Steel and Vanadium Corp., 100%)	Wapadskloof Mine and plant, 60 kilometers northeast of Middelburg	2,250 vanadium pentoxide. e/
Do.	do.	Vanadium Technology Pty. Ltd. [Xstrata AG, formerly Sudelektra Holding AG (Switzerland), 100%]	Kennedy's Vale (ex-Vansa Vanadium) Mine and plant, near Lydenburg	5,900 vanadium pentoxide, 1,500 ferrovandium.
Do.	do.	Rhombus Vanadium Holdings Ltd. [Xstrata AG, formerly Sudelektra Holding AG (Switzerland), 100%]	Ba-Mogopa Mine and Usko plant	13,500 vanadium.
Vermiculite	Palabora Mining Co. Ltd.		Palabora mine and plant at Phalaborwa	230 concentrate. e/
Do.	Natkrut Vermiculite Mine Pty. Ltd., (Verimex Trading Pty. Ltd.)		Mine near Soutpansberg, Northern Province	22 concentrate (closed, March 1999).
Zinc	Zinc Corp. of South Africa Ltd. (Isacor Ltd., 100%)		Struisbult Springszinc refinery at Springs, southeast of Johannesburg	120 Zn.
Do.	Black Mountain Mineral Development Co. (Pty.) Ltd. (Anglo American plc., 100%).		Black Mountain Mine near Aggeney's, 100 kilometers northeast of Okiep	26 Zn (in concentrate).
Do.	Maranda Mining Co. [Metorex (Pty.) Ltd., 29.1%]		Maranda zinc-copper mine in Murchison Range in Northern Province	15 Zn metal in concentrates.
Do.	Pering Mine (Pty) Ltd. (Billiton plc., 100%)		Pering mine in Northern Cape Province (Phased closure begun in 1999)	27 Zn in concentrate 6 Pb in concentrate
Zirconium	Tisand (Pty.) Ltd./Richards Bay Minerals Ltd.		Opencast mines near Richards Bay	300 zircon concentrate.
Do.	Namakwa Sands Ltd. [Anglo Operations Ltd. (a subsidiary of Anglo American plc), 100%]		Opencast mine near Brand-se-Baai and mineral separation plant at Koekenaap	140 zircon concentrate.
Do.	Palabora Mining Co. Ltd.		Palabora Mine and plant at Phalaborwa	14 baddeleyite. e/
Do.	do.		Zirconium basic sulfate plant at Phalaborwa	8 Zr basic sulfate (by 1999).
Do.	Phosphate Development Corp. Ltd. (Foskor Ltd) (IDC, 100%)		Plant at Phalaborwa	3 baddeleyite. e/
Do.	do.		Fused zirconia plant	6 synthetic zirconia.

e/ Estimated.

1/ Based on information available as of September 1999.

2/ Depending on markets furnace capacity can switch between FeCr and FeMn.

3/ Most of Foskor's phosphate output is from phosphate concentrates supplied by the neighboring Palabora copper mine.

TABLE 3
SOUTH AFRICA: RESERVE BASE OF MAJOR MINERALS IN 1998 1/

(Million metric tons unless otherwise specified)

Commodity	Reserve base
Andalusite 2/	50.8
Antimony	thousand tons 250
Asbestos, fiber	8.2
Chromium, ore	3,100
Coal, recoverable	55,333
Cobalt 3/	thousand tons 15
Copper	13
Fluorspar	36
Gold	thousand tons 40
Iron ore	5,900
Lead	3
Manganese	4,000
Natural gas	million cubic meters 1,557
Nickel 3/	11.8
Petroleum	million barrels 29
Phosphate rock, concentrates	2,500
Platinum-group metals	thousand tons 62.8
Silver	do. 10
Titanium	146
Uranium 4/	thousand tons 204.7
Vanadium	12.5
Vermiculite	80
Zinc	15
Zirconium	14.3

1/ Metallic minerals are contained metal.

2/ Includes the aluminosilicate, sillimanite.

3/ Minerals Bureau estimates as of December 31, 1997.

4/ Recoverable at a cost of less than \$80 per kilogram.

Sources: Chamber of Mines Online Statistical Tables 1997, accessible at URL <http://www.bullion.org.za/panl/genrl/sawmres.htm>. Minerals Bureau estimates as of December 31, 1998. U.S. Energy Information Administration, Country Analysis Briefs--South Africa.