

THE MINERAL INDUSTRY OF SOUTH AFRICA

By George J. Coakley and Thomas P. Dolley

The Republic of South Africa remained one of the world's most important mining and mineral processing nations in 1997. South Africa had the largest production of gold and was the largest or among the dominant producers of many other mineral commodities. Mineral production continued to be the cornerstone of the South African economy. Its gross domestic product (GDP) was about \$129 billion, and total exports of all goods were valued at \$30.9 billion.¹ Mining accounted for 43% of foreign exchange earnings, 8.1% of the GDP and more than 500,000 jobs. Gold mining alone accounted for about 4% of GDP (Washington Times, 1998). The most important mineral commodities produced in South Africa, in terms of value, continued to be gold, coal, and platinum-group metals (PGM). Additionally, significant output of metallic minerals included ores and/or smelted products of antimony, chromium, iron, manganese, titanium, uranium, vanadium, and zirconium. Important output of industrial minerals included andalusite, asbestos, diamond, dimension stone, fluorspar, phosphate rock, and vermiculite. South Africa was a major producer and the world's third largest exporter of coal. 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. Summarizing for the year, South Africa produced 55 different mineral commodities from about 695 mines and quarries, including about 61 coal mines, 54 diamond and 53 gold operations. Ongoing corporate restructuring of major mining investment houses in South Africa continued during the year (Mining Journal, 1997; Verster and van Luitingh, 1997; Gcabashe and others, 1998).

In 1997, total sales of primary minerals, as reported by the South African Minerals Bureau, amounted to about \$14.2 billion. Export sales of gold were \$5.3 billion; coal at \$1.8 billion; and PGM \$1.8 billion (Gcabashe and others, 1998). South Africa also produced significant amounts of a number of secondary or processed mineral commodities, notably ferroalloys and steel, cement, manufactured fertilizers, and refined petroleum products (from coal and crude petroleum), valued at more than \$3.5 billion. Almost 90% of South Africa's electricity was generated from coal and about 6% from uranium (U.S. Energy Information Administration, 1997, South Africa, accessed November 12, 1997 at URL <http://www.eia.doe.gov/emeu/cabs/safrica.html>).

Government Policies and Programs

The Ministry of Mineral and Energy's Department of Minerals and Energy (DME) was the primary Government entity

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

responsible for the establishment and implementation of minerals and energy policy and for oversight of the country's mineral industry. Within the DME were the Mineral Development Branch, which was responsible for regional mineral development, minerals economics (Minerals Bureau), mine rehabilitation, and mining rights; the Energy Branch, which promoted 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 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 South African mineral industry as a whole awaited reforms to the tax system and labor reform (Mining Journal Ltd., 1997). It operated under substantially the same laws in 1997 those of 1993. These included the Mining Titles Registration Act, 1967; Mining Rights Act, 1967; Central Energy Fund Act, 1977; Petroleum Products Act, 1977; Nuclear Energy Act, 1993; Diamonds Act, 1986; Electricity Act, 1987; Mineral Technology Act, 1989; Minerals Act, 1991; Minerals Amendment Act, 1993; and the Liquid Fuels and Oil Repeal Act, 1993. A number of these laws were expected to be subject to review during the next few years.

In response to the high accident and death rate in deep gold mining, in particular, the Mine and Safety Act was passed in June 1996 and went into effect on January 15, 1997, with some provisions pending. Under the new law, mine managers were given increased responsibilities for the environmental, health, and safety of the mine and mine labor. By year-end 1997, the DME had not yet officially released its long-awaited Green Paper on a new minerals and mining policy for South Africa. Expectations were that it would promote a positive environment for growth and employment in the mining sector. Government policy debate on the proposed paper also centered on whether to retain private ownership of mineral rights or to vest all rights in the State. In the South African system, a Green Paper represents the first draft of a proposed policy for public review and comment; while a White Paper is the Government Administration's final version submitted for final public review and for consideration for legislation by the Cabinet and Parliament.

Environmental Issues

In August 1995, the Department of Environmental Affairs and Tourism initiated a Consultative National Environmental Policy

Process, referred to as CONNEPP, to review the state of the environment in South Africa and to recommend a new environmental policy for the country. Following the receipt of public comment on the October 1996 draft Green Paper, the South African Department of Environmental Affairs and Tourism (DEAT) released its draft White Paper on Environmental Management Policy for South Africa in July 1997. The White Paper states among the tenets of South Africa's New Environmental Policy that "Equitable access to, and ownership and control of, renewable and non-renewable natural resources by South Africans, black and white, poor and rich, male and female, is critical to our survival as a country. Conservation and sustainable use of these environmental resources and their protection depends on changed behavior by all individuals, households, and private and public institutions. These changes must affect processes of resource extraction, spatial development, appropriate and clean production, waste minimization and pollution control strategies in order to guarantee a higher quality of life for all". The paper endorses a "polluter pays" principle. Furthermore the forward of the paper states that "Through this policy government undertakes to give effect to the many rights in the Constitution that relate to the environment. They include rights relating specifically to the environment, as well as those relating to governance such as the legal standing of parties, administrative justice, accountability and public participation. The policy furthermore defines the essential nature of sustainable development as the combination of social, economic and environmental factors. It takes ownership of sustainable development as the accepted approach to resource management and utilization in South Africa, thus entrenching environmental sustainability in policy and practice" (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).

In December 1997, the mining industry provided its comments on the paper that focused on clarification of definitions and enforcement of policies, expressing concerns that the new environmental management system could lead to a costly and "burgeoning bureaucracy" and questioning the operation of a proposed environmental rehabilitation fund and the division of regulatory powers between federal and regional authorities and between DEAT and other federal departments (Chamber of Mines of South Africa, December 1997, Mining industry comments on the draft White Paper on environmental management policy, accessed February 28, 1998 at URL <http://www.bullion.org.za/bulza/policy/eviman.htm>).

Production

In 1997, South Africa was one of the largest and most diverse minerals producers in the world. As shown in *table 1*, output levels were mixed. Since 1993, gold production has steadily decreased by more than 20% as a result of declining ore grades and increasing production costs associated with deeper mining. During 1997, world mineral commodity prices, in general, were depressed. In rand value, revenues from the sale of minerals increased significantly, with an exchange rate depreciation of 7%

helping to offset lower dollar-based sales. In revenue terms, processed mineral commodities in South Africa have shown increased performance during the past several years, particularly in the export terms. Local sales of minerals have increased significantly (Gcabashe and others, 1998). Domestic mineral commodity sales have been stimulated by a number of major industrial projects and the government's residential home construction program.

Trade

The Minerals Bureau compiles mine production, trade, and value data for most crude or primary minerals and selected processed mineral products. The following data are from the Minerals Bureau, unless otherwise indicated.

Primary mineral exports were about 37% of the total value of all exports. The contribution of mining to total export revenues has declined as the manufacturing sector of the economy has expanded during the past decade. The Minerals Bureau estimated that the inclusion of the various processed mineral products, such as ferroalloys and steel, would raise the contribution of the minerals sector to more than 50% of total export revenues.

In 1997, primary mineral exports were led by gold, valued at \$5.3 billion. Following gold, the most valuable crude mineral exports were coal valued at \$1.8 billion and PGM valued at \$1.8 billion. Other mineral exports were iron ore, at \$351 million; copper, at \$165 million; nickel, at \$132 million; and manganese ore, at \$125 million. Although individual data were officially withheld, exports of diamond, titanium, and zirconium minerals accounted for most of the \$2.8 billion reported by the Minerals Bureau as "miscellaneous" mineral exports. Other mineral exports were chrome ore valued at \$91 million and lead valued at \$33 million.

In the value-added sector, 1997 exports of processed ferroalloys included chrome alloys valued at \$739 million and manganese alloys valued at \$367 million. Some of the major destinations by value for primary mineral exports, including precious minerals, were Europe at 85.5%; the Pacific Rim Countries, 9.5%; Middle and Near East, 2.2%; and North America and Central America, 1.0%. Exports within Africa accounted for less than 1% of South African mineral export trade. With the end of economic sanctions, intra regional trade was expected to increase although the markets remain small compared to other trading regions (Gcabashe and others, 1998).

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, magnesite, 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 either by the Government or private entities. Government involvement in these sectors was minimal and was primarily confined to ownership of the national electric utility, Eskom, and the national oil and gas exploration company,

Southern Oil Exploration Co. (Soekor), including additional declining subsidies provided to synthetic fuels programs of the parastatals, Mossgas (Pty) Ltd. and Sasol. With the end of economic sanctions and freer access to world petroleum supplies, state subsidies were being phased out.

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), Gold Fields of South Africa (GFSa), Gencor Limited (formerly General Mining and Finance Corp.), Rand Gold and Exploration Co., (formerly Rand Mines), and Anglovaal Limited. These houses also historically had major holdings in most other sectors of the South African economy. Since 1994 the industry has been undergoing a major corporate restructuring or “unbundling” to simplify a complex system of interlocking ownership, to establish separate core-commodity-focused profit centers, and to diversify and rationalize nonperforming assets to make the newly restructured companies more competitive internationally.

In 1997, the major mining houses continued to divest themselves of their nonmining subsidiaries. The declining price of gold has helped accelerate this process. In November 1997, JCI Ltd.’s major gold mines of Western Areas and H.J. Joel, also owned by AAC, were merged into AngloGold, thus creating the world’s largest gold company with an annual production of 6 million troy ounces [186,600 kilograms (kg)] of gold and gold reserves, in all categories, of 140 million troy ounces [5,354 metric tons (t)]. In 1996, AAC had renamed the company’s gold and uranium division “AngloGold Limited”.

In 1996, Anglovaal Limited divided its assets into Anglovaal Minerals (Avmin Limited), which was to manage all of Anglovaal’s strategic mineral and mining investments, and Anglovaal Gold (Avgold Limited), which was to manage most of Anglovaal’s gold properties and exploration activities.

In May 1995, AAC had unbundled its holdings in JCI into three separate companies— JCI Limited, with interests in coal, ferrochrome, gold, and base metals; Anglo American Platinum Corporation Limited (Amplats), with interests in platinum mining and processing, and Johnnies Industrial Corp. (Johnnic), containing its nonmining industrial holdings. JCI Limited was subsequently sold off to a black empowerment group, African Mining Group controlled by Capital Alliance. When the company ran into operating difficulties in 1997, the decision was made to break up JCI Limited. In September, JCI Limited was restructured into two autonomous companies, JCI Projects Limited for its base metal assets and JCI Gold Limited for its gold assets. The gold assets, including H.J. Joel, Randfontein Estates, and Western Areas, were collapsed into JCI Gold. In November, JCI Limited sold back to AAC 60% of its interests in the H. J. Joel gold mine and 36.8% of Western Areas gold mines and remaining interests in Amplats in exchange for the 26% interest of De Beers Consolidated Mines Limited (De Beers) and AAC in Lonrho Plc of the United Kingdom.

The megamerger of the gold assets of GFSa and Gencor was announced in October 1997 and finalized on February 2, 1998, creating Gold Fields Ltd., the world’s second largest gold producer with an annual production of 3 million troy ounces (93,300 kg) of gold and gold minable resources of 81.6 million

troy ounces (2,538 t). Operations were consolidated in South Africa under the Beatrix, the Kloof and Dreifontein Consolidated Ltd., the Oryx, and the St. Helena Divisions and in Ghana at the Tarkwa Mine. Gold Fields also retained the technical rights to the BIOX gold biological leach process. Gencor, which had previously consolidated all its nonprecious metal holdings into the London-based Billiton Plc was left with Impala Platinum Limited (Implats), the second largest platinum producer in the world, as its only direct mining asset (Gold Fields Limited, 1998, The creation of Gold Fields Limited, accessed May 8, 1998 at URL [http:// www.goldfields.co.za/announce.asp](http://www.goldfields.co.za/announce.asp)).

Rand Gold and Exploration Co., formed in July 1997 from Rand Mines to acquire and rehabilitate marginal cost mines, restructured its holdings into Durban Roodeport Deep Ltd. (DRD) and into the London listed Randgold Resources Ltd. DRD operated the Durban Roodeport Deep, the East Rand Proprietary (ERPM), and the South Wits deep extension gold mines in South Africa. The Durban Roodeport Deep mining group represents the 1997 merger of three West Rand gold mines—Blyvooruitzicht, Buffelsfontein, and Durban Deep. Harmony Gold Mining Co. Ltd. was spun off by Rand Gold and Exploration Co. in 1997 as an independent company.

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 the Palabora copper mine in northeastern Transvaal, one of the largest copper mines in the world, with AAC. Rio Tinto was also a 50% shareholder in Richards Bay Minerals Ltd. (RBM), a major world producer of mineral sands, with operations in the coastal areas of KwaZulu-Natal Province.

According to the Minerals Bureau, the overall South African mining industry employed an average of 551,677 workers compared with 541,100 employees in 1996. Employment in the mining industry represented about 3.8% of the country’s economically active population. The gold industry was the largest employer within the mining sector with 322,000 workers, or 62% of total employees in the sector. Total remuneration paid to the mining workforce in 1997 was 18.1 billion rands, equivalent to \$3.9 billion.

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 is imported. Aluminum South Africa (Pty.) Ltd. (Alusaf) was the sole producer of primary aluminum from its Bayside smelter and the newer Hillside smelter, at Richards Bay. Production of aluminum metal increased by about 15% to 673,000 t, in 1997. In its second year of full production, Alusaf operated the Hillside smelter at 2% to 3% above its design capacity of

490,000 t. Aluminum output from the Hillside smelter was intended for the export market, and that from the Bayside smelter for the domestic market. South Africa's aluminum exports for 1997 totaled 567,000 t (Joseph, 1998a).

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 1997, the world market price for antimony metal declined dramatically owing mainly to global oversupply. For 1997, South African antimony concentrate production declined by more than 33% compared with that of 1996; declining ore grades and amount of tonnage milled were major factors.

In other developments, JCI Limited sold its 33.1% interest in Consolidated Murchison to Metorex (Pty.) Ltd., affiliated with Canada's Crew Development Corp. During the year, Consolidated Murchison suspended development of the Beta Shaft project at the Gravelotte operation, citing lackluster projections for antimony prices. The company did not rule out future reevaluation of the project (Joseph, 1998b).

Chromite.—Chromite ore production increased significantly during the year, fueled by global demand for its use in stainless steel production. 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 22% of the ore was exported, and the remainder went to supply domestic ferrochrome smelters. 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 \$206 million in 1997, of which \$91 million was export revenue (Bates, 1998a). Further details on the South Africa chromite and ferrochromium industry in 1997 are available in the 1997 U.S. Geological Survey Minerals Yearbook chapter on chromium accessible at URL <http://minerals.usgs.gov/minerals/pubs/commodity/chromium/>.

Copper.—Copper production in South Africa increased marginally in 1997, reflecting the falling global demand for copper in the second half of 1997. Palabora Mining Company Limited, by far the largest copper producer in the country, treated 28.8 million metric tons (Mt) of ore grading 0.55% copper for the year, yielding 133,662 t of copper in concentrates. Processed output included 119,042 t of copper. Palabora also produced 13,500 t of baddeleyite (70% of world demand), 343 t of nickel sulfate, 87,070 kg of uranium oxide, 207,070 t of vermiculite concentrates, and 9,387 t of zirconium dioxide chemicals, as well as 15,546 kg of precious metals contained in refinery tankhouse slimes. The Palabora mine also generated 183,600 t of byproduct magnetite concentrates grading 65.5% 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. Development of production and service shafts reached 816 and 997 meters respectively, in anticipation of transitioning from open-pit to underground mining in 2002. The \$440 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, 1998).

O'okiep Copper Co., owned by GFSA, operated a copper mine and smelter located near Springbok, Northern Cape Province. As one of the oldest mining districts in South Africa, aboriginal copper mining in the Province pre-dates 1685, and modern mining dates to 1846; O'okiep was formed in 1937. Since 1937, twenty-three different copper mines have been worked and depleted; the Carolusberg Mine was the most recent closure (1997). The Nigramoep Mine, the only ore body being mined in 1997, used a modified vertical crater retreat mining system to mine 65,000 metric tons of ore per month (t/mo). During 1997, the mine milled 863,364 t of copper ore grading 1.7% copper, with a mill recovery rate of 89%. Contained copper in concentrates amounted to 13,070 t, with a concentrate grade of 42.23% copper. The O'okiep smelter, located at Nababeep, had the capacity to produce 42,000 metric tons per year (t/yr) of blister copper, about half of which came from Nigramoep concentrates. Additional smelter feed has been supplied by concentrates from the Prieska copper mine in South Africa and the Otjihase copper mine in Namibia. Copper was also produced in small amounts as a byproduct of lead-zinc and platinum mining.

Gold.—Faced with dropping ore grades and the increasing cost of deep mining, the gold industry continued its steady decline. In 1997, mine production was 492 tons of gold with an average grade per ton milled of 5.09 grams (g) of gold. This was only about 1% lower than that of 1996, but significantly lower than the historical peak production year of 1970 when 989 t of gold was produced at an average grade per ton milled of 13.28 g of gold. South Africa remained the world's leading gold producer, although its once-dominant share of total global new mined gold production dropped to 12% in 1997 from 68% in 1970. In a similar trend based on Chamber of Mines data, employment levels in the gold industry have also declined to 322,000 workers in 1997, compared to 344,000 in 1996 and 522,000 in 1987 (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>).

Low world gold prices, as well as restructuring and streamlining of the South African gold industry and increased mining costs, contributed to decreased gold output.

For Chamber members, working costs (in rands) rose by about 10% per metric ton of ore milled and 9% per kilogram of gold recovered in 1997. Increases reflected generally high inflation levels, including higher wages, and, notwithstanding labor-intensive mining methods, the great technical difficulties of mining at extreme depths. The number of gold mines in a marginal position increased to nine in 1997, from seven mines in 1996, owing to a decline in profitability (Chamber of Mines of South Africa, 1998, Annual report 1997/98: "Regeneration"—Economic Review: 1997 section, p. 61, accessed October 12, 1998 at URL <http://www.bullion.org.za/bulza/pgs/onlpub.htm>).

The continued unbundling of assets by major South African mining companies was the main highlight for the gold industry during the year.

Iron and Steel.—Iron Ore.—In 1997, Iron ore production in South Africa increased owing primarily to increased demand by steel producers and the elimination of bottlenecking and capacity constraints on the 861-kilometer (km) railway line from Iscor Ltd.'s Sishen Mine to the port at Saldanha Bay. Iron ore exports, primarily hematite, amounted to about 20.7 Mt, worth about \$347 million (Grobler, 1998a).

Iscor was South Africa's largest iron ore producer. Its two iron mines, Sishen and Thabazimbi—accounted for about 80% of the country's total output. In 1997, the Sishen Mine produced 21.6 Mt iron ore and the Thabazimbi Mine 2.6 Mt. Sishen contains about one-half the world's known reserves of lumpy iron ore, grading 65% iron. Iron ore grades from the Thabazimbi Mine are about 60% (South Africa Minerals Bureau, 1996; Grobler, 1998a).

Steel.—South African crude steel production dropped in 1997. 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.

Despite a strike in late 1997, Saldanha Steel (Pty) Ltd., an independently incorporated company equally owned by Iscor and the Industrial Development Corporation of South Africa (IDC), was on schedule to commission its new \$1.5 billion plant at Saldanha Bay in late 1998. The plant will be the world's first steel minimill to combine Corex and Midrex iron and steelmaking technologies and was being designed as an environmentally clean facility (Saldanha Steel (Pty.) Ltd, 1998, Saldanha Steel, accessed December 12, 1998 at URL <http://www.ssteel.co.za>). Production at full capacity of 1.25 million metric tons per year (Mt/yr) of hot-rolled steel coil was expected by the end of 1999; the plant layout was designed so that this capacity can be doubled in the future. Approximately two-thirds of production will be exported as hot-rolled coil, with the remaining one-third sent to the new adjacent Duferco Steel Processing Ltd. coldrolling slab plant where it will be cold rolled into thinner slabs. The Duferco processing will also include pickling, oiling, and galvanizing stages.

Ferroalloys.—During the year, ferrochromium production increased to about 1.9 Mt. Total export volume for South African ferrochrome exceeded 1.7 Mt, valued at \$739 million. Other ferroalloy production, reported by the Minerals Bureau, included 824,997 t of manganese alloys valued at \$414.5 million, of which 87.3% was exported, and 102,152 t of ferrosilicon valued at \$79.1 million, of which 46.5% was exported. In addition, 34,000 t of silicon metal valued at \$48.7 million was produced.

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, 1998, *Manganese: Ores*, accessed at URL <http://www.samancor.co.za/home.htm>). In 1997, South Africa produced 3.12 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 national production from its Mamatwan open pit and Wessels underground mines, near Hotazel. The Associated Manganese Mines of South Africa Ltd. (Assmang), controlled 50.2% by Anglovaal Minerals (Avmin), is the other major

producer, with sales of 1, 146,000 t in 1997. Both companies have downstream ferromanganese and silicomanganese processing facilities. Additional information on chromite and manganese mine and ferroalloy production in South Africa is available through a Minerals Bureau special publication (Bates, and Armitage, 1998).

Nickel.—South Africa's nickel production was in the form of metal, metal-in-concentrate, and sulfate. The nation's nickel output was mostly a byproduct of PGM production, with some byproduct production from the Palabora copper mine. In 1997, output increased owing to the production startup at South Africa's first primary nickel mine, the Nkomati Joint Venture. Nkomati, controlled by Avmin (75%), brought the \$ 35 million MSB Mine, a small, high grade portion of the area nickel resource, into production in January 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 copper, 4 t cobalt, 4.9 kg platinum, and 14.4 kg palladium. The feasibility study on developing three adjacent orebodies was continuing (Avmin Ltd., 1997). Domestic sales of nickel amounted to about \$86 million, and South Africa's export of nickel was valued at more than \$132 million (Damarapurshad, 1998a).

Platinum-Group Metals.—South Africa's production of PGM, which originated almost exclusively from mines in the Bushveld Complex, north of Pretoria, has increased by more than 4% per year during the past 10 years, and has continued to be the world's largest. Additionally, South Africa possessed more than 55% of identified global resources of PGM.

For 1997, production of PGM in South Africa increased to 196,466 kg, an increase of 4.1% from that of 1996. Of the 1997 South African PGM production total, platinum accounted for 58%, and palladium accounted for 28.6%. Reduced output of PGM from Russia helped stimulate South African production. Total sales revenues for PGM were valued at about \$1.8 billion (*table 1*). Global production and price of iridium increased during the year because of its growing use in iridium-containing alloys in automobile exhaust catalysts. As PGM production continued to expand in South Africa, increased production of all these closely related metals can be expected (Lourens, 1998).

Amplats was the largest PGM producer in the world at about 37% of global platinum supply, all from South African operations. In 1997, Amplats announced the development of a new PGM mine, the Bafokeng Rassimone, in the western part of the Bushveld Complex. It expected the new mine to reach full production in 2002 (Lourens, 1998). South Africa's other dominant platinum producer was Implats.

Titanium and Zirconium.—Globally, South Africa ranked second in titanium production and third in titanium exports in 1997. Titanium slag production in South Africa showed a marginal increase during the year. RBM, owned jointly by Rio Tinto and Billiton, produced ilmenite, rutile, and zircon from beach sands north of Richards Bay. Richards Bay Iron and Titanium (Pty.) Ltd., a sister company, produced an 85% titanium dioxide slag from ilmenite concentrates at the Richards Bay smelter, as well as low-manganese pig iron. RBM was the largest

titanium mineral producer in the country and produced about 980,000 t in 1997. Titaniferous magnetite also was recovered at the Phalaborwa carbonatite as a byproduct of copper and phosphate rock production, and titaniferous slag was produced with magnetite ores from Highveld Steel & Vanadium Corp. Ltd's Mapochs Mine for the Highveld steel plant. Additionally, research was carried out during the year to recover titanium dioxide from the massive slag heap at Highveld Steel & Vanadium. The slag heap contained a 30% titanium dioxide content, current technologies, however, are incapable of recovering the material economically (Mining Journal, 1999).

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 is being developed in two phases by the owners, Anglo American (80%) and De Beers Consolidated Diamond Mines Ltd. (De Beers) (20%); the state-owned Industrial Development Corp. provided a R370 million (\$80 million) loan. In late 1994, the \$260 million first phase started up, treating 4 Mt/yr of ore. The approximately 400,000 t/yr of heavy medium concentrates produced during Phase I had an average composition of 55% ilmenite, 15% zircon, 4% rutile, 16% other heavy minerals and 10% quartz. The smelter, using Mintek-developed plasma-arc technology, produced titanium slag and a coproduct pig iron from ilmenite concentrates. Planned Phase I production rates were 97,000 t/yr titania slag, 36,000 t/yr rutile, 123,000 t/yr zircon, and 56,000 t/yr pig iron. Actual production, however, was lower owing to lost time resulting from an explosion in the main furnace. 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, scheduled for startup in March 1999, will double slag output. Production at full capacity will be 230,000 t/yr of high titanium slag, 42,000 t/yr rutile, 140,000 t/yr zircon, and 120,000 t/yr pig iron, generating an expected total export revenue of more than 1 billion annually.

In 1997, 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 refractory, ceramics, and tanning industries and in kidney dialysis machines. Sales of all zirconium products at Palabora fell to 10,799 t compared with 13,611 in 1996 principally owing to lower ore grades and plant operating difficulties in the first half of the year. Palabora invested an estimated \$13 million during the year in a new plant that will produce zirconium basic sulfate (ZBS) from zircon sands. Equipment failures and mechanical problems delayed the commissioning of the ZBS plant until 1998. Full production capacity was expected to be 7,895 t/yr of product containing 38% ZrO₂ by 1999 (Palabora Mining Company Limited, 1998).

Uranium.—In 1997, uranium oxide production decreased to 1,324 t from the 1,706 t of that of 1996. The decrease in production was mostly attributable to the closure of Vaal Reef's

No. 9 plant and the cessation of uranium production at Western Areas. Three South African gold mines produced uranium—Hartebeesfontein, Vaal Reefs, and Western Areas. More than 90% of uranium oxide production was as a byproduct of gold mining, and the remainder was produced as a byproduct of copper mining at Palabora. Additionally, the Atomic Energy Corp. began its commercialization program in response to declining funding from the Government (Harding, 1998).

Vanadium.—South Africa was the world's largest producer and exporter of vanadium in 1997. Vanadium was produced from titaniferous magnetite mined from the Bushveld Complex. Domestic output and sales value increased significantly, owing to strong world crude steel production and a concomitant rise in the market price for vanadium. The total domestic sales value of vanadium was about \$190 million. The largest producer was Highveld Steel and Vanadium. 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 ferrovandium.

Rhombus Exploration (Rhoex) was the other major South African producer of vanadium (Mining Journal, 1997; Bates, 1998b). At yearend, the Swiss firm, Südelektra Holdings AG, consolidated its increasing control of the South African ferroalloys industry by purchasing from its parent company, Glencore International AG, Glencore's 87.1% stake in Rhoex and 100% interest in Vanadium Technology (Pty) Ltd. (Vantech) for about \$152 million. Glencore International AG, a Swiss metal trading company, which had acquired its South African holdings in July 1997, agreed to purchase all the Rhoex and the Vantech output of vanadium pentoxide and ferrovandium for the next 3 years as part of the deal. The combined vanadium production capacity of Rhoex and Vantech is around 10,000 t/yr, compared with Highveld's vanadium production level of around 28,000 t/yr. Südelektra was also offering to buy out the remaining minority shares of Chromecorp Holdings it did not already own. (Ingrid Salgado, December 17, 1997, Stakes in SA vanadium firms sold for R700 million, Business Day Online [Johannesburg], accessed January 12, 1998, at URL <http://www.bday.co.za/97/1217/news/news4.htm>).

Industrial Minerals

During the year, South Africa produced about 33 different industrial minerals from approximately 467 mines and quarries. The industrial minerals sector was a significant contributor to South Africa's total minerals sales, which approached 6% in 1997. The value of total sales of industrial minerals produced was about \$803 million. Approximately 68% 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 \$260 million in. Commodities that contributed more than 90% of total industrial mineral export value were granite at 44.1%; phosphate rock, value withheld owing to proprietary reasons; andalusite, 10.8%;

vermiculite, 8.3%; fluorspar, 7.8%; and asbestos, 5.7% (Botha and others, 1998).

Cement.—The dissolution of the cement cartel—the South African Cement Producers Association (SACPA)—in 1996, has increased competition, marketing has become more aggressive, product quality has improved, and product variety has increased among current operators. As of yearend 1997, cement in South Africa was produced by three main companies—Pretoria Portland Cement Co. Ltd., Alpha Ltd., and Lafarge South Africa Ltd. The three companies had equal interest in Natal Portland Cement Co. (Pty.) Ltd., which served much of the Natal market. South Africa was the third largest cement consumer in Africa, following Egypt and Algeria, and accounted for about 14% of all cement consumed in Africa. Cement demand was driven predominantly by the building sector, whose performance was mixed during the year. Government initiatives aimed at helping provide low-cost and affordable housing may stimulate the cement industry. South African cement imports were minimal, and accurate cement export figures are difficult to obtain owing to the disbanding of SACPA (Tradeship Publications, 1998).

Diamond.—According to the Minerals Bureau, South Africa's rough diamond production increased marginally in 1997 to an estimated 10 million carats (Mkt) from 9.9 Mkt in 1996. As in years past, mines owned by De Beers dominated the sector with more than 95% of the total production. Total diamond production for De Beers' South African operations in 1997 amounted to 9.56 Mkt recovered from 21.9 Mt of material treated. The Venetia Mine, the largest De Beers operation accounted for 45.3% of production; the Finsch Mine, 23.3%; the Premier Mine, 15.2%; the Namaqualand Mine, 8.3%; the Kimberley Mine, 6.4% and the Koffiefontein Mine, 1.4%. Diamond recovery rates varied considerably within the De Beers operations, with Venetia recovering 127 carats per ton (kt/t), Finsch, 59.5 kt/t, Premier, 45.3 kt/t, the Kimberley Mine, 16.1 kt/t, the Namaqualand Mine, 13.8 kt/t, and the Koffiefontein Mine, 6.6 kt/t. (De Beers, 1997).

Of the 65 officially permitted diamond mines in South Africa, 48 produced diamonds during the year. Of these, 19 recovered diamonds from marine environments, 16 mined kimberlites, and 13 mined alluvial deposits. Kimberlite operations produced 8.94 Mkt, much of it attributable to increased production from the Finsch and the Venetia Mines. Alluvial diamond operations contributed 1.04 Mkt, and marine diamond recovery totaled 60,041 carats. Additional diamond production came from approximately 400 artisanal operations mining alluvial deposits in the Free State, the North-West and Northern Cape Provinces. In 1997, South African rough diamond export sales mass and the value of rough diamonds available for the domestic cutting and polishing industry increased (Damarupurshad, 1998b).

Vermiculite.—Production of exfoliated vermiculite remained around 211,000 t in 1997, representing about 75% of reported world supply. 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. Vermiculite production at the Natkruid Vermiculite Mining Co. mine and beneficiation plant in the Northern Province was expected to startup in March 1998 at a rate of 22,000 t/yr of unexfoliated vermiculite (Palabora Mining Company Limited, 1998).

Mineral Fuels

Most of South Africa's primary energy needs were supplied by coal; most electricity was generated by coal-fired power stations; and coal was also the raw material for South Africa's production of synthetic fuels. South Africa's synfuels program has been in place for many years. Soekor controlled all offshore oil and gas prospects. During the year, Soekor began crude oil production from the Oribi Field, South Africa's first offshore oilfield. Soekor estimated that the Oribi Field, 140 km southwest of Mossel Bay, had reserves of 20 million barrels of crude oil and had targeted a production of 20,000 barrels per day (bbl/d) from two wells (Knott, 1997; Prevost, 1998a). South Africa's total throughput refining capacity for crude oil was 465,000 bbl/d from four refineries. Owing to the high cost of synfuels compared with conventional crude oil products, the Government emplaced various tariffs and controls on the petroleum marketing sector. Industry observers generally agreed that the South African energy industry and tariff system was in need of restructuring and/or privatization (Knott, 1997).

Coal.—South Africa remained the fifth largest coal-producing country in the world and the third largest coal exporter. Coal exports for 1997 were 59 Mt valued at \$1.7 billion and were shipped primarily through the Richards Bay Coal Terminal

(RBCT). Export destinations for South African coal were Europe (54.1%), Asia and the Middle East (38%), Africa (4.2%), and South America (3.6%). Coal produced for domestic use totaled 157 Mt valued at \$1.6 billion (Prevost, 1998b). Three companies, Ingwe Coal Corp., Anglo American Coal Corp. Ltd. (Amcoal), and Sasol Mining (Pty.) Ltd., continued to account for more than 80% of the country's coal production. Ingwe had been formed through the merger of Trans-Natal Coal Corp. Ltd. and Randcoal in 1994. Other producers included Iscor, which mined coal for its own internal use. In addition, numerous medium-to-small, independent coal companies mined coal. Approximately 45% of all coal mined in South Africa was through open-cast methods (Prevost, 1998b).

Reserves

South Africa's mineral reserves are large and varied and reflect the country's complex geology. A detailed account of the geology of many of South Africa's mineral deposits is available from the Geological Society of South Africa and a useful background geologic summary is given in Mining Magazine (Anhaeusser and Maske, 1986; Mining Magazine, 1995). The bulk of South Africa's mineral production is from the northern half of the country. [Table 2](#) 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 shown 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 has a well-developed and extensive road and railroad infrastructure, serving not only South Africa but also the surrounding region. Roadways totaled 182,329 km, of which 55,428 km were paved. Railroad infrastructure totaled 21,431 km, of which 9,087 km was electrified. A number of ports 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 Richards Bay Coal Terminal (RBCT) had a coal export capacity of about 60 Mt/yr out of a total bulk cargo port capacity of 75 Mt/yr. 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.

South Africa's national electrical power utility, Eskom, had a nominal capacity of 39,154 megawatts, predominantly from coal-fired sources, with a small percentage of electricity being generated from nuclear sources (Eskom, 1999, Key statistics, Annual Report for 1998, accessed March 30, 1999, on the World Wide Web at URL <http://www.eskom.co.za/annreport/main.htm>).

Outlook

Significant labor issues within the minerals sector, such as housing of migrant workers, wages, job training, and work schedules, 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 1997 and could be recapitulated in 1998.

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's mining industry is highly dependent on export revenues—more than 78% of total sales in 1997 were to various world markets. The South African Minerals Bureau predicts a rise in revenue into the next century from exports of base metals, coal, industrial minerals, ferrous minerals, PGM, and processed mineral products. The notable exception in the forecast is gold. The Minerals Bureau, however, asserts that the forecast is dependent on the short duration for the Asian financial turmoil and the continued strength in the economies of western European countries which are traditional markets for South African minerals (Gcabashe and others, 1998).

South Africa appeared to be entering a phase of rapid expansion of value-added mineral processing capacity, especially for metals. For example, in steel, its ready domestic access to nearly all the steelmaking raw materials give it a potentially, natural competitive advantage, 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 greatly increase its market share for many commodities.

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Major Sources of Information

Chamber of Mines of South Africa

P.O. Box 61809
2107 Marshallton, South Africa
Telephone: (27) 11 838-8211
Fax: (27) 11 834-1884
Internet site: <http://www.bullion.org.za>

Council for Geosciences (Geological Survey)

Private Bag X112
0001 Pretoria, South Africa
Telephone: (27) 12 841-1911
Fax: (27) 12 841-1203 or 1221
Internet site: <http://www.geoscience.org.za>

Department of Mineral and Energy Affairs

Government Mining Engineer
Private Bag X59
0001 Pretoria, South Africa
Telephone: (27) 12 322-8561
Fax: (27) 12 322-3416
Internet site: <http://www.dme.gov.za>

Minerals Bureau

Private Bag X4
2017 Braamfontein, South Africa
Telephone: (27) 11 339-4414
Fax: (27) 11 403-2061
Internet site: <http://www.dme.gov.za/minerals/default.htm>

Department of Trade and Industry

Private Bag X274
0001 Pretoria, South Africa
Telephone: (27) 12 3322-7677
Fax: (27) 12 322-7851
Internet site: <http://www.dti.pwv.gov.za/dtiwww/Home.htm>

Embassy of South Africa

Minerals and Energy Liaison Office
3051 Massachusetts Ave., NW
Washington, DC 20008
Telephone: (202) 232-4400
Fax: (202) 232-3402

Industrial Development Corp. of South Africa Ltd.

P.O. Box 784055
2146 Sandton, South Africa
Telephone: (27) 11 883-1600
Fax: (27) 11 883-1655

Minerals and Energy Policy Centre

76 Juta St., 9th Floor
2050 Braamfontein, South Africa
Telephone: (27)-11-403-8013
Fax: (27)-11-403-8023

Mintek (Council for Mineral Technology)

Private Bag X3015
2125 Randburg, South Africa
Telephone: (27) 11 709-4111
Fax: (27) 11 793-2413 or 709-4326
Internet site: <http://www.mintek.ac.za>

National Union of Mineworkers

P.O. Box 2424
2000 Johannesburg, South Africa
Telephone: (27)-11-833-7012
Fax: (27)-11-836-0201
Internet: <http://www.anc.org.za/num>

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TABLE 1
SOUTH AFRICA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1993	1994	1995	1996	1997
METALS					
Aluminum metal, primary	174,700	172,111	195,292	569,600 r/	673,043
Antimony concentrate: 2/					
Gross weight e/	7,182 3/	7,800	9,550	8,860	5,390
Sb content	4,111	4,534	5,537	5,137	3,415 e/
Cadmium, Cd content of cadmium cake	70 e/	--	--	--	--
Chromite, gross weight:					
More than 48% chromic oxide	4	--	16	--	--
44% to 48% chromic oxide	1,808	1,612	1,792	1,862	2,123
Less than 44% chromic oxide	1,014	2,030	3,296	3,155	3,617
Total 4/	2,827	3,642	5,104	5,017	5,740
Cobalt:					
Mine output, Co content	265	358	288	350	450
Refinery output:	243	258	190	244 r/	317
Copper:					
Mine (company output), Cu content	166,348	165,213	165,573	152,595	153,058
Metal:					
Smelter	156,600	154,700	151,200	148,400 r/	163,600
Refined, primary	127,900	129,600	124,300	116,000	130,200
Gold, primary	619,201	580,201	523,809	496,846 r/	491,680
Iron and steel:					
Ore and concentrate:					
Gross weight	29,385	30,489	31,946	30,830	33,225
Fe content	19,100 e/	18,903	19,806	19,115	20,600 e/
Metal:					
Pig iron	6,121	6,982 r/	7,137 r/	6,876 r/	6,192
Direct-reduced iron	833	980	950	900 r/	1,090 e/
Ferrous alloys, electric arc furnace:					
Chromium ferroalloys	834	1,104	1,341	1,478 r/	1,890
Ferromanganese	393	591	480	562 r/	499
Ferrosilicon	99	120	90	118 r/	102
Ferrovanadium e/	1	1	1	1	1
Silicomanganese e/	268 3/	290 3/	280	241	286
Silicon metal	38	36	30	29 r/	34
Crude steel	8,726	8,525 r/	8,741 r/	7,999 r/	8,311
Lead:					
Concentrate, Pb content	100,171	95,824	88,449	88,613	83,114
Smelter, secondary	31,800	31,900	32,100	32,200 r/	41,500
Manganese:					
Ore and concentrate, gross weight:					
Metallurgical:					
More than 48% manganese	1,239	1,533	1,708	1,845	1,809
45% to 48% manganese	237	67	106	86	84
40% to 45% manganese	299	196	191	118	116
30% to 40% manganese	665	1,006	1,145	1,133	1,111
Total, metallurgical 4/	2,440	2,801	3,151	3,182	3,120
Chemical, 35% to 65% manganese dioxide	67	50	48	58	33
Grand total	2,507	2,851	3,199	3,240	3,153
Metal, electrolytic e/	35	35	35	39 r/	40
Nickel:					
Mine output, concentrate, nickel content e/	30,800	31,800	30,700	33,861 r/ 3/	34,830 3/
Metal, electrolytic	29,868	30,751	29,803	33,362	33,700
Platinum-group metals: e/					
Platinum	104,506	98,285	102,300	105,440	115,080
Palladium	43,389	46,655	51,000	52,560	56,300
Rhodium	8,647	10,264	10,900	11,200	11,500
Other 5/	19,625	28,722	18,897	19,436	13,586
Total	176,167 3/	183,926 3/	183,097 r/ 3/	188,636 r/ 3/	196,466 3/
Silver	192,418	197,767	174,279	168,689 r/	144,004
Thorium, monazite concentrate, gross weight e/	400	131 3/	--	--	--

See footnotes at end of table.

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

(Metric tons unless otherwise specified)

Commodity	1993	1994	1995	1996	1997
METALS--Continued					
Tin:					
Cassiterite concentrate:					
Gross weight e/	1,200	--	--	--	--
Sn content	452	--	--	--	--
Metal:					
Primary 6/	452	43	--	--	--
Secondary e/	50	50	--	--	--
Titanium: e/					
Ilmenite concentrate	1,516	1,314	1,680	2,100	2,237
Rutile concentrate	86	78	90	115 r/	123
Total, titanium minerals	1,602	1,392	1,770	2,215	2,360 3/
Titaniferous slag 7/	937	819	990	1,000 e/	1,100 e/
Uranium oxide	2,008	2,069	1,702	1,706	1,324
Vanadium, vanadium metal content	15,051	16,350 r/	16,297 r/	14,770 r/	15,590
Zinc:					
Concentrate:					
Gross weight e/	140,000	140,000	130,000	142,000	132,000
Zn content	77,096	76,361	70,241	76,853	71,062
Metal, smelter, primary	96,154	93,850	98,782	101,100	108,100
Zirconium concentrate (baddeleyite and zircon) e/	243,000	240,000	260,000	260,000	265,000 3/
INDUSTRIAL MINERALS					
Aluminosilicates:					
Andalusite	187,708	206,291	206,378	233,728 r/	251,203
Sillimanite	569	525	317	-- r/	--
Asbestos:					
Chrysotile	92,380	85,857	81,246	51,776	49,754
Crocidolite	11,614	6,273	7,396	5,344	232
Total	103,994	92,130	88,642	57,120	49,986
Barite	2,000	1,945	6,048	7,428	2,071
Calcite	14,094	14,660	10,666	13,749 r/	2,886
Cement, hydraulic	7,356	7,905	9,071	7,668	7,490
Clays:					
Attapulgite	7,032	10,230	8,049	14,318	9,349
Bentonite	50,441	71,773	70,927	48,076	33,326
Fire clay	91,839	110,131	74,751	101,452	131,307
Flint clay, raw and calcined	89,352	131,590	118,688	113,645	92,397
Kaolin	147,349	131,863	146,587	146,496	120,148
Brick clay, local sales	1,028	1,386	2,909	3,013	3,227
Diamond, natural:					
Gem e/	4,600	4,900	4,300	4,400	4,500
Industrial	5,724	5,954	5,383	5,546	5,541
Total 4/	10,324	10,854	9,683	9,947 r/	10,041
Feldspar	56,761	37,156	47,874	53,644 r/	59,688
Fluorspar:					
Acid-grade	194,778	166,761	177,000	202,018 r/	201,000
Ceramic-grade e/	3,800	--	--	--	4,000
Metallurgical-grade e/	19,000	7,497 3/	18,794 3/	10,000 r/	2,000
Total	217,578	174,258	195,794	202,018 r/	207,000
Gemstones, semiprecious:					
Rose quartz	85,500	--	--	--	--
Tiger's eye	548,386	531,418	242,607 r/	18,650 r/	64,300
Gypsum, crude	284,389	304,337	288,178	340,688	365,279
Industrial or glass sand (silica)	1,738	1,920	2,180	2,168 r/	2,439
Lime 6/	1,599	2,891	1,688	1,650	1,585
Magnesite, crude	67,403	71,726	84,639	71,358	76,699
Mica, scrap and ground	1,991	1,973	2,137	1,515	1,423
Nitrogen, N content of ammonia	683,400	754,000	758,500	769,800	770,000
Perlite	328	914	1,338	1,300	403
Phosphate rock:					
Gross weight	2,466	2,545	2,787	3,077	2,732
Phosphorus pentoxide content e/	962	995	1,087	1,200	1,038

See footnotes at end of table.

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

(Metric tons unless otherwise specified)

Commodity	1993	1994	1995	1996	1997	
INDUSTRIAL MINERALS--Continued						
Pigments, mineral, natural:						
Ochers	1,175	1,789	2,316	484	186	
Oxides	11	295	2,940	159	98	
Total	1,186	2,084	5,256	643	284	
Salt	613,301	414,463	311,388	253,403	320,000	
Sodium sulfate, natural	36,380	44,544	43,971	46,947	49,071	
Stone, n.e.s.:						
Dimension:						
Granite and norite 6/	528,310	618,781	812,220	635,005	764,000	
Marble 8/	20,615	12,450	5,837	689	1,700	
Slate 6/	22,019	15,501	11,891	11,940	11,900	
Crushed and broken:						
Limestone and dolomite	thousand tons	18,215	19,548	19,738	22,038	22,214
Nepheline syenite		--	98,667	145,459	137,706 r/	114,201
Quartzite 6/	thousand tons	8,224	9,258	9,123	8,515	8,500
Shale:						
For cement	do.	331	371	325	383	47
Other 6/	do.	2,767	2,157	3,248	3,000 e/	3,000 e/
Total	do.	3,098	2,528	3,573	3,383	3,047
Aggregate and sand, n.e.s.	do.	15,824	18,294	20,594	20,792	31,692
Sulfur:						
S content of pyrite	do.	323	252	159	184	167
Byproduct:						
Metallurgy e/	do.	82	118	117	91	110
Petroleum	do.	171	209	233	200	293
Total 4/	do.	575	579	509	475	470 e/
Talc and related materials:						
Talc		8,798	8,202	9,173	16,397	21,055
Pyrophyllite (wonderstone)		4,287	5,507	5,519	2,140	2,129
Vermiculite		211,143	223,478	221,748	186,082	211,001
MINERAL FUELS AND RELATED MATERIALS						
Coal (salable product):						
Anthracite	thousand tons	3,246	2,225	2,137	2,465 r/	1,997
Bituminous	do.	178,980	193,625	204,073	203,803 r/	216,453
Total 4/	do.	182,226	195,850	206,210	206,269 r/	218,450
Petroleum:						
Crude	thousand 42-gallon barrels	--	--	--	--	4,380
Refinery products:						
Liquefied petroleum gases	do.	2,460	1,825	3,285	3,300 e/	3,300 e/
Gasoline	do.	57,446	59,860	73,730	74,000 e/	74,000 e/
Jet fuel	do.	6,346	7,665	8,760	9,000 e/	9,000 e/
Kerosene	do.	4,678	5,475	7,300	7,300 e/	7,300 e/
Distillate fuel oil	do.	31,136	35,770	50,005	50,000 e/	50,000 e/
Residual fuel oil e/	do.	16,000	20,075 3/	22,995 3/	23,000	23,000
Lubricants (including greases) e/	do.	2,503 3/	1,280 3/	3,000	3,000	3,000
Bitumen e/	do.	1,784 3/	895 3/	2,000	2,000	2,000
Other e/ 9/	do.	700	380 3/	4,855	4,900	4,900
Total 10/	do.	123,053	133,225	175,930	176,500 e/	176,500 e/

e/ Estimated. r/ Revised.

1/ Table includes data available through July 19, 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 Minerals Bureau and Pt, Pd, and Rh supplies (shipments) reported in Johnson and Matthey Annual Platinum Review. Includes ruthenium and iridium production plus excess Pt, Pd, or Rh inventory.

6/ Domestic sales plus exports.

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

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

9/ Includes naphthas, paraffin wax, petroleum coke, petrochemical feedstocks, unfinished oils, white spirits, and blending compounds.

10/ Excludes refinery fuel and losses.

TABLE 2
SOUTH AFRICA: RESERVE BASE OF MAJOR MINERALS IN 1997 1/

(Million metric tons unless otherwise specified)

Commodity	Reserve base
Andalusite 2/	51
Antimony	250
Asbestos, fiber	8.2
Chromium, ore	3,100
Coal, recoverable	55,300
Cobalt	15
Copper	13
Fluorspar	36
Gold	40
Iron ore	5,900
Lead	3
Manganese	4,000
Nickel	11.8
Phosphate rock, concentrates	2,500
Platinum-group metals	62.8
Silver	10
Titanium	72
Uranium 3/	204.7
Vanadium	12.5
Vermiculite	80
Zinc	15
Zirconium	14.3

1/ Metallic minerals are contained metal.

2/ Includes the aluminosilicate, sillimanite.

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

Source: 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, 1997.