



2017–2018 Minerals Yearbook

SOUTH AFRICA [ADVANCE RELEASE]

THE MINERAL INDUSTRY OF SOUTH AFRICA

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The Republic of South Africa remained one of the world's leading mining and mineral-processing countries. In 2017, South Africa's estimated share of world mined rhodium production amounted to 80%; mined platinum, 72%; refined rhodium, 63%; refined platinum, 66%; chromium, 46%; vermiculite, 44%; mined palladium, 39%; manganese and refined palladium, 31% each; ferrochromium, 29%; zircon, 24%; industrial garnet, 22%; vanadium, 11%; refined gold, 7%; diamond, 6%; fluor spar, 5%; coal, iron ore, and mined gold, 4% each; mined cobalt and nickel, 2% each; and aluminum, refined cobalt, mined lead, and stainless steel, 1% each. South Africa also played a globally significant role in the production of kyanite and related minerals, ilmenite, and rutile (BP p.l.c., 2018, p. 38; Cobalt Institute, 2018; CPM Group, 2018, p. 6–7, 100–101, 164–165; Merafe Resources Ltd., 2018, p. 10–11; World Gold Council, 2018; Bedinger, 2019a, b; Bray, 2019; Corathers, 2019; Curry, 2019; George, 2019; Klochko, 2019; McRae, 2019a, b; Olson, 2019a, b; Polyak, 2019; Schulte, 2019; Shedd, 2019; Singerling, 2019; Tanner, 2019a, b; Tuck, 2019).

In 2017, South Africa's estimated share of the world's coal consumption was 2.2%, and petroleum products, 0.6%. The country also accounted for 88% of total African coal consumption and 14% of total African petroleum products consumption in 2017 (BP p.l.c., 2018, p. 15, 39).

Minerals in the National Economy

The mineral industry accounted for 6.8% of the gross domestic product (GDP) in 2017 compared with 7% in 2016 and 7.8% in 2007. Employment in the mineral industry amounted to 464,667 workers in 2017, which was an increase of 1.6% compared with that of 2016. In 2017, platinum-group metal (PGM) mining accounted for 37.8% of the mineral industry's employment; gold, 24.1%; coal, 17.6%; iron ore, 4.7%; diamond, 3.9%; chromite, 3.8%; manganese, 1.8%; and other minerals, 6.3% (Chamber of Mines of South Africa, 2015, p. 8–9; 2018, p. 8, 11, 13, 15, 17, 19).

Government Policies and Programs

Mining of minerals and mineral fuels was governed by the Mineral and Petroleum Resources Development Act 28 of 2002 (MPRDA), which became effective in May 2004. Section 100(2)(a) of the MPRDA allowed for the establishment of a Mining Charter. The Mining Charter was published in 2004 and modified by the Amended Mining Charter of 2010.

Under the Amended Mining Charter of 2010, the Government's Black Economic Empowerment (BEE) program requires that black ownership of mining companies reach 26%. Companies are allowed to use the value of their domestic beneficiation activities as credit for up to 11% of their black ownership requirements. Companies are required to purchase 70% of their services, 50% of their consumable goods, and

40% of their capital goods from BEE entities. Companies are also required to report progress annually on the development of near-mine communities, the sustainability of growth and development, and mineral beneficiation. In 2016, mining companies reported that 75% of their services, 69% of their capital goods, and 68% of their consumable goods were purchased from BEE entities (Creamer, 2010; Chamber of Mines of South Africa, 2018, p. 31).

In June 2017, the Government introduced a new Mining Charter that made several changes to BEE requirements. The black ownership requirement was increased to 30% from 26%. Of the 30% black ownership in mining companies, at least 14% was required to be held by BEE entrepreneurs and at least 8% each by employee share ownership plans and mine communities to be invested in a community trust. The requirement to purchase services from South African companies was increased to 80%. The requirement to purchase goods from South African companies was increased to 70%. Companies that held new prospecting rights were required to have majority black shareholding. At yearend, the Amended Mining Charter of 2010 was still in effect because of legal disputes between the Chamber of Mines and the Government regarding the new charter (Beech and Livingston, 2017; Brand South Africa, 2018).

In the Witwatersrand basin, acid mine drainage from gold mining operations threatened to contaminate water supplies in Gauteng Province with increased levels of toxic heavy metals and radioactive particles. The acid mine drainage was the result of leaching from tailings piles and from abandoned deep underground mines that filled with water that became acidic. South Africa had about 270 tailings piles in the Witwatersrand basin that contained about 6 billion metric tons of pyrite. The oxidation of pyrite led to acid mine drainage. The tailings piles also contained an estimated 600,000 metric tons (t) of uranium. In 2017, the Government was engaged in an acid mine drainage remediation program with an estimated cost of \$870 million (Solomons, 2017b).

The mining industry was regulated by the Department of Mineral Resources. Exploration and production of natural gas and petroleum were regulated by Petroleum Agency South Africa. Environmental regulations were enforced by the Department of Environmental Affairs. The Department of Mineral Resources issued environmental permits for mining operations; decisions regarding permits could be appealed to the Department of Environmental Affairs.

Production

In 2017, slate production increased by 1,313%; that of pyrophyllite, by 188%; mica, by 163%; sodium sulfate, by 119%; kaolin, by 48%; fluor spar, by 43%; magnesite, by an estimated 33%; direct-reduced iron, by 32%; manganese ore, by 31%; silica sand, by 27%; phosphate rock, by 23%; gypsum, mined lead, and titaniferous slag, by 22% each; rutile, by an

estimated 20%; diamond, by 17%; zinc, by 15%; andalusite and iron ore, by 13% each; attapulgite, brick clay, chromite, and silver, by 12% each; and bentonite and silicomanganese, by 11% each (Mpuleng Galane, Deputy Director of Statistics, Department of Minerals and Energy of the Republic of South Africa, written commun., August 24, 2018).

In 2017, silicon metal production decreased by 82%; that of fire clay, by 56%; ferrosilicon, by an estimated 34%; ferromanganese, by 23%; tellurium, by an estimated 21%; natural gas liquids and shale for brickmaking, by 20% each; uranium, by an estimated 19%; industrial garnet, by 17%; talc, by 16%; selenium, by an estimated 14%; and metallurgical coal and ruthenium, by 13% each. Antimony production shut down in 2017 (Mpuleng Galane, Deputy Director of Statistics, Department of Minerals and Energy of the Republic of South Africa, written commun., August 24, 2018).

In 2017, fluor spar and phosphate rock production increased because of increased capacity utilization. Ferrosilicon production decreased because of plant closures in 2016. Data on mineral production are in table 1.

Structure of the Mineral Industry

Most of South Africa's mineral industry was privately owned; Government-owned PetroSA operated a gas-to-liquids plant and produced crude petroleum and natural gas in recent years. The production of diamond and gold, which were produced mostly by artisanal miners in some African countries, was dominated by large-scale producers in South Africa. The leading producer's share of total output varied widely by commodity. Ammonia, antimony, fluor spar, industrial garnet, mined lead, vermiculite, and mined zinc were produced by only one domestic company each. The leading producer of ferrosilicon accounted for about 76% of national production; that of iron ore, 60%; diamond, 54%; nickel, 35%; gold, 32%; and coal, 20%.

South Africa also had many producers of aggregates, clay and shale, and sand for construction. Capacity, location, ownership, and production information were not readily available for most of these operations. Major commodities and the companies that produced those commodities are listed in table 2.

Reserves and Resources

South Africa's estimated share of world reserves of PGMs amounted to 91%; chromite, 39%; manganese, 29%; zirconium, 19%; vanadium, 18%; fluor spar, 15%; rutile, 13%; gold, 11%; ilmenite, 7%; and nickel, 5%. The country also had substantial reserves of andalusite, antimony, coal, iron ore, phosphate rock, and vermiculite (table 3; Bedinger, 2018a, b; Corathers, 2018; George, 2018; Loferski, 2018; McRae, 2018; Polyak, 2018; Singerling, 2018a, b).

Mineral Trade

Unprocessed minerals accounted for 28% of the value of South Africa's total exports in 2017, which was about \$79 billion. About 69% of unprocessed mineral products, by value, were exported in 2017. South Africa's exports of gold were valued at \$4.7 billion in 2017; coal, \$4.42 billion; platinum, \$3.71 billion; iron ore; \$3.2 billion; manganese ore,

\$2.21 billion; palladium, \$1.69 billion; chromite, \$908 million; diamond, \$738 million; rhodium, \$544 million; nickel, \$355 million; iridium, \$143 million; ruthenium, \$57 million; and other crude mineral products, which included lead, ilmenite, rutile, and zircon, \$1.03 billion. Processed mineral products accounted for an additional 6% of total exports. Exports of ferrochromium were valued at \$2.7 billion; manganese alloys, \$294 million; and aluminum, antimony trioxide, phosphoric acid, silicon metal and alloys, titanium slag, vanadium alloys, and other vanadium products, \$1.79 billion (Chamber of Mines of South Africa, 2018, p. 8; Galane, 2018; Mpuleng Galane, Deputy Director of Statistics, Department of Minerals and Energy of the Republic of South Africa, written commun., August 24, 2018).

The percentage of domestic consumption of mineral commodities produced in South Africa varied widely by commodity. In 2017, silver exports, by volume, amounted to 95% of total sales; diamond and iron ore, 90% each; PGMs, 89%; gold and nickel, 78% each; copper, 54%; granite, 38%; coal, 28%; flint clay, 3%; and lime, 1%. All sales of clays and shale other than flint clay, feldspar, gypsum, and sand for construction were domestic. Between October 2016 and March 2017, vermiculite exports accounted for 83% of total sales and phosphate rock accounted for 18%. Between April and September 2016 (the latest period for which data were available), zircon exports accounted for 99% of total sales (Munyu, 2016; Muravha, 2017; Radipabe, 2017; Mpuleng Galane, Deputy Director of Statistics, Department of Minerals and Energy of the Republic of South Africa, written commun., August 24, 2018).

Commodity Review

Metals

Aluminum.—South Africa produced primary aluminum from imported alumina. South32 Ltd. of Australia operated the Hillside primary aluminum smelter at Richards Bay; production at Hillside increased to 716,000 t in 2017 from 701,000 t in 2016 (South32 Ltd., 2017, 2018).

Chromium.—Most of South Africa's chromite production was metallurgical-grade. In 2017, chromite production was about 16.5 million metric tons (Mt) compared with 14.7 Mt in 2016 and 9.67 Mt in 2007. Increased production since 2006 was partially attributable to PGM mining companies producing chromite as a coproduct (table 1; Chamber of Mines of South Africa, 2015, p. 17; Mpuleng Galane, Deputy Director of Statistics, Department of Minerals and Energy of the Republic of South Africa, written commun., August 24, 2018).

Glencore plc of Switzerland and its joint-venture partner Merafe Resources Ltd. operated the Boshhoek, the Helena, the Kroondal, the Magareng, the Thorncliffe, and the Waterval Mines. Glencore and Merafe produced about 3.8 Mt of chromite in 2017 compared with 4 Mt in 2016; the lower output was attributable to decreased consumption of ore per ton of ferrochromium produced (Merafe Resources Ltd., 2018, p. 17–18).

Glencore and Merafe operated the Boshhoek, the Lion, the Lydernburg, the Rustenburg, and the Wonderkop ferrochromium plants, which had a total (combined) capacity

of 2.34 million metric tons per year (Mt/yr). The companies produced 1.93 Mt of ferrochromium in 2017, which was nearly unchanged from that of 2016. Production was limited by reduced ferrochromium demand on world markets (Merafe Resources Ltd., 2018, p. 17–18).

Samancor Chrome (Pty) Ltd. (International Mineral Resources BV of the Netherlands, 70%) produced chromite at the Eastern Chrome Mines in Mpumalanga Province and the Western Chrome Mines in North West Province. The company mined about 2 Mt/yr of chromite at the Eastern Chrome Mines and 1.5 Mt/yr at the Western Chrome Mines. About 80% of Samancor Chrome's production was consumed in its ferrochromium plants; the remainder was exported (Khaile, 2016, p. 13; Golder Associates Inc., 2017, p. 1).

Samancor Chrome operated the Ferrometals plant in Witbank, the Middelburg plant in Middelburg, and the Tubatse plant in Steelpoort; the plants had a combined capacity of more than 1.2 Mt/yr of ferrochromium (table 2). In early 2017, the company was producing at the rate of more than 1.1 Mt/yr of ferrochromium (Golder Associates Inc., 2017, p. 1).

In late 2016, Samancor Chrome purchased the Buffelsfontein plant from International Ferro Metals Ltd. The company restarted production in 2017 and planned to produce 150,000 t of ferrochromium by yearend (Khaile, 2017).

ASA Metals (Pty) Ltd. (Sinosteel Corp. of China, 60%, and Limpopo Economic Development Enterprise, 40%) operated the Dilokong chromite mine near Burgersfort and a ferrochromium plant near Pietersburg with capacities of 800,000 metric tons per year (t/yr) and 410,000 t/yr, respectively. In March 2016, ASA Metals was operating only one of its four furnaces when it entered bankruptcy proceedings because of its high-cost mining operation. In April 2017, the Competition Commission approved the purchase of ASA Metals' ferrochromium plant by a joint venture of Samancor Chrome and Sinosteel Corp. of China (Creamer, 2016a; Tex Report, The, 2016; van Wyngaardt, 2017).

In fiscal year 2017 (which started on October 1, 2016, and ended on September 30, 2017), Tharisa Minerals (Pty) Ltd. of Cyprus produced about 1.33 Mt of chromite at the Tharisa Mine compared with 1.24 Mt in fiscal year 2016. The company planned to increase production to 2 Mt/yr by 2020. The remaining life of the open pit was estimated to be 17 years, which could be followed by an underground mine with a life of 40 years (Tharisa Minerals (Pty) Ltd., 2017, p. 1–2, 8).

Assore Ltd. operated the Dwarsrivier Mine in Mpumalanga. In fiscal year 2017 (which started on July 1, 2016, and ended on June 30, 2017), sales from Dwarsrivier increased to 1.28 Mt of chromite from 1.15 Mt in fiscal year 2016. Increased sales were attributable to improvements in the efficiency of the mining process and upgrades to the beneficiation plant (Assore Ltd., 2017, p. 29–30).

African Rainbow Minerals Ltd. and its joint-venture partner MMC Norilsk Nickel of Russia operated the Nkomati chromite mine. Chromite sales from Nkomati increased to 343,000 t in 2017 from 174,000 t in 2016. ARM and Impala Platinum Holdings Ltd. (Implats) also operated the Two Rivers Mine; chromite sales from the mine decreased to 248,125 t in 2017 from 285,706 t in 2016. ARM planned to sell a total of nearly 650,000 t/yr of chromite from Nkomati Chrome and Two Rivers

through at least mid-2020 (African Rainbow Minerals Ltd., 2017a, p. 37, 40–41; 2017b, p. 14, 16; 2018b, p. 51, 53).

Hernic Ferrochrome (Pty) Ltd. (a subsidiary of Mitsubishi Corp. of Japan) operated the Bokone and the Morula Mines, which had a capacity of 1.5 Mt/yr, and a ferrochromium plant with a capacity of 420,000 t/yr (table 2). The company produced 376,000 t of ferrochromium in 2016; output was limited by the high cost of its mining operations. In September 2017, Hernic entered bankruptcy proceedings (Creamer, 2016a; Davies, 2018).

Traxys Group operated a ferrochromium plant at Richards Bay with a capacity of 130,000 t/yr. In September 2017, the plant's production was suspended for 3 months because of low ferrochromium prices on world markets. The plant was at a competitive disadvantage because of its distance from chromite deposits in the Bushveld Complex (Roskill Information Services, 2017).

PGM producers and other companies also mined chromite as a coproduct of mining of Upper Group 2 (UG2) ore in the Bushveld Complex. Production of chromite from UG2 ore had increased in recent years because of the declining profitability of PGM mining. UG2 ore had a much lower production cost than the Lower Group 6 (LG6) chromite ore mined by ferrochromium producers (Ryan's Notes, 2012).

Lonmin plc of the United Kingdom's sales of chromite from UG2 ore were 1.37 Mt in 2017 compared with 1.51 Mt in 2016. The company's BTT project would increase chromite production by 360,000 t/yr by treating UG2 tailings. The estimated life of the project was 7 years. Lonmin planned to start production in 2018 (Lonmin plc, 2017a, p. 13, 33, 52; 2017b; 2018b).

In 2017, Anglo American Platinum Ltd. (Amplats) produced 978,800 t of chromite from UG2 ore compared with a revised 751,600 t in 2016 and 566,500 t in 2015. In August 2016, the company started production at a new plant at the Amandelbult Mine with a capacity of 700,000 t/yr. Amplats planned to produce between 600,000 and 650,000 t/yr at the new plant. Production at Amandelbult increased to 654,400 t in 2017 from 234,700 t in 2016, and at the Union Mine, to 324,400 t from 262,100 t (Slater, 2017; Anglo American Platinum Ltd., 2018, p. 33, 46, 50).

Sibanye-Stillwater Ltd. (formerly Sibanye Gold Ltd.) purchased the Rustenburg PGM mine from Amplats in October 2016. In 2017, the company produced 736,000 t of chromite from its Waterval plant at the Rustenburg Mine. The company was engaged in a scoping study to increase recovery rates at Waterval (Sibanye-Stillwater Ltd., 2018, p. 11, 50, 52).

In its 2017 fiscal year (which started on July 1, 2016, and ended on June 30, 2017), Northam Platinum Ltd. produced 581,000 t of chromite from UG2 ore at its Booyensdal North and Zondereinde Mines compared with 538,405 t in fiscal year 2016 and 371,051 t in fiscal year 2015. Increased production was attributable to the shift in the company's PGM mining operations from the Merensky Reef to the UG2 Reef. Northam's output was expected to increase to 1 Mt/yr as its PGM operations expanded (Creamer, 2016b; James, 2018; Liedtke, 2018b).

Implats held a 65% share in Impala Chrome (Pty) Ltd., which produced about 200,000 t/yr of chromite. The company produced chromite by processing about 4 Mt/yr of tailings from Implats' PGM operations. Implats also produced chromite from its joint-venture Makgomo Chrome project at the Marula Mine.

In February 2017, mining at Makgomo Chrome was suspended after protests regarding the management of the local community's 50% interest in the project (Creamer, 2017; Impala Platinum Holdings Ltd., 2017a, p. 52).

Cobalt.—Refined cobalt production decreased to 1,062 t in 2017 from 1,101 t in 2016, most of which was from South African PGM mining operations. ARM and Norilsk also produced 851 t of mined cobalt at the Nkomati Mine in 2017 compared with 831 t in 2016 (African Rainbow Minerals Ltd., 2017a, p. 41; 2017b, p. 16; 2018b, p. 53; Cobalt Institute, 2018).

Gold.—The long-term decline in South Africa's mined gold output continued in 2017, with production decreasing to 137,133 kilograms (kg) from a revised 142,202 kg in 2016 and 254,685 kg in 2007. During the same period, the country's share of world gold production decreased to about 4% from 10%. Decreased output was primarily attributable to mines operating at depths as great as 4 kilometers, which led to difficult geologic conditions, high ore haulage and refrigeration costs, and low labor productivity (table 1; du Venage, 2013; Chamber of Mines of South Africa, 2015, p. 27–28; Mpuleng Galane, Deputy Director of Statistics, Department of Minerals and Energy of the Republic of South Africa, written commun., August 24, 2018).

Sibanye-Stillwater mined gold at the Beatrix, the Driefontein, and the Kloof Mines, which were underground mines. Production at the Kloof Mine increased to 16,432 kg in 2017 from 15,210 kg in 2016. Production at Driefontein decreased to 15,004 kg in 2017 from 16,130 kg in 2016, and at Beatrix, to 9,091 kg from 10,041 kg. The Cooke Operations, which were a combination of underground mines and tailings retreatment sites, produced 3,107 kg in 2017 compared with 5,653 kg in 2016. Sibanye-Stillwater placed the underground mines at the Cooke Operations on care-and-maintenance status in 2017; the tailings that supplied the surface mining operations were likely to be depleted by mid-2019. Sibanye planned to produce a total of between 38,500 and 40,000 kg of gold in 2018 (Sibanye-Stillwater Ltd., 2018, p. 45, 47, 49, 59).

Sibanye-Stillwater was engaged in the development of the West Rand Tailings Retreatment Project (WRTRP) in 2017. Production in the first phase of mining between 2018 and 2022 could be as much as 2,600 kilograms per year (kg/yr) of gold recovered from tailings. In the second phase of mining between 2023 and 2034, production could be as much as 4,300 kg/yr. In the third phase of mining between 2035 and 2039, production could be as much as 3,800 kg/yr. The second and third phases of mining depended on the results of a feasibility study that was expected to be completed in 2020. In November, the company proposed to sell its WRTRP assets to DRDGold Ltd. in return for a 38% share in DRDGold (Pretorius and others, 2018, p. 4, 17, 23; Sibanye-Stillwater Ltd., 2018, p. 26, 46–47).

In 2017, Sibanye-Stillwater was engaged in the reopening of the Burnstone Mine. The company planned to restart mining at Burnstone in the second half of 2018 and to produce at the full capacity of 3,900 kg/yr of gold between 2022 and 2028. Average production during the estimated 20-year life of the mine was likely to be nearly 3,000 kg/yr (Sibanye Gold Ltd., 2017, p. 44; Sibanye-Stillwater Ltd., 2018, p. 50–51).

Sibanye-Stillwater also was engaged in the development of projects to extend the lives of the Driefontein and the Kloof Mines.

The life of the Driefontein Mine would be extended until 2042, and the Kloof Mine, until 2034. Additional production from Driefontein was expected to be an average of 3,000 kg/yr between mid-2020 and 2042, and from Kloof, an average of 1,200 kg/yr between mid-2020 and 2034. Development of the Driefontein Decline project could be delayed by reduction of capital expenditures in 2017 (Sibanye Gold Ltd., 2017, p. 45; Sibanye-Stillwater Ltd., 2018, p. 50–51).

Sibanye planned to complete a prefeasibility study on the Bloemhoek project, which had resources of more than 130,000 kg of contained gold, by mid-2017. The development of the Beisa project, which had resources of 22,000 kg of contained gold and 7,300 t of contained uranium, depended on increased uranium prices (Sibanye Gold Ltd., 2018, p. 51–52, 58).

Harmony Gold Mining Company Ltd. produced a total of 31,815 kg of gold from its South African operations in 2017. The Tshepong operations produced 9,303 kg in 2017; the Kusasaletu Mine, 4,458 kg; the Kalgold, the Phoenix, and other surface mining operations, a total of 3,262 kg; the Target 1 Mine, 3,082 kg; the Doornkop Mine, 3,001 kg; the Masimong Mine, 2,811 kg; the Bambanani Mine, 2,680 kg; the Joel Mine, 1,856 kg; and the Unisel Mine, 1,362 kg (Harmony Gold Mining Company Ltd., 2018).

For fiscal year 2018, Harmony's planned production at Tshepong was about 9,400 kg; Kusasaletu, about 4,400 kg; Kalgold, Phoenix, and other surface mining operations, a total of about 3,000 kg; Doornkop and Target 1, about 2,900 kg each; Bambanani, about 2,600 kg; Masimong, 2,200 kg; Joel, about 2,100 kg; and Unisel, 1,700 kg. The remaining life of Doornkop was 18 years; Tshepong, 17 years; the surface operations, at least 14 years; Joel, 9 years; Target 1; 7 years; Bambanani, Kusasaletu, and Unisel, 5 years each; and Masimong, 4 years (Harmony Gold Mining Company Ltd., 2017, p. 83).

AngloGold Ashanti Ltd. operated mines in the Vaal River area near Klerksdorp and the West Wits area near Carletonville. The company's gold production decreased to about 28,100 kg in 2017 from 30,100 kg in 2016. Production at the Moab Khotsong Mine was 9,100 kg in 2017; the Mponeng Mine, 7,000 kg; the surface operations in North West Province, 6,300 kg; the Tau Tona Mine, 2,800 kg; and the Great Nologwa and Kopanang Mine, a total of 2,800 kg. Production increased at Mponeng by 5% and at the surface operations, by 3%. In 2017, ore grades decreased at every operation except for the surface operations. Tau Tona was closed in late 2017 (AngloGold Ashanti Ltd., 2018, p. 74, 118).

In October 2017, AngloGold Ashanti agreed to sell the Moab Khotsong and the Great Nologwa Mines to Harmony and Kopanang to Heaven-Sent SA Sunshine Investment Company Ltd. At yearend, the sales had not been completed. Kopanang had an estimated remaining life of more than 51 years, and Moab Khotsong, more than 23 years (Perold, 2017, p. 3–4; AngloGold Ashanti Ltd., 2018, p. 61).

Gold Fields Ltd. produced about 9,000 kg of gold at the South Deep Mine in 2016, which was an increase of 47% from that of 2015. The company had planned to produce about 9,800 kg in 2017; actual production was about 8,700 kg. Gold Fields planned to ramp up production to full capacity in 2021 or 2022; output was expected to be about 15,500 kg/yr

between 2023 and 2031. Production was expected to decrease to about 15,000 kg/yr after 2031 because of lower ore grades. The estimated remaining life of the mine was 77 years (Kotze, 2017b; Seccombe, 2019).

In its 2017 fiscal year (which started on July 1, 2016, and ended on June 30, 2017), Pan African Resources plc produced 5,390 kg of gold compared with 6,374 kg in fiscal year 2016. Production at the Barberton Mine was 2,232 kg in fiscal year 2017; the Evander Mine, 1,409 kg; the Evander Tailings Retreatment Project (ERTP), 917 kg; and the Barberton Tailings Retreatment Project (BTRTP), 832 kg. The Barberton and Evander Mines had capacities of nearly 3,000 kg/yr each, and the BTRTP and the ETRP, 930 kg/yr each. The estimated remaining life of the Barberton Mine was 20 years; the Evander Mine and the ETRP, 15 years each; and the BTRTP, 14 years. Pan African planned to produce a total of about 6,200 kg/yr from the Barberton and Evander Mines and the BTRTP and the ETRP (Pan African Resources plc, 2017, p. 5, 54; Cornish, 2018a).

In September 2017, Pan African started construction of the Elikhulu tailings project. Pan African planned to start gold production from the project in the fourth quarter of 2018. The company planned to produce more than 1,700 kg/yr by processing tailings from the Kinross, the Leslie, and the Winkelhaak tailings facilities near the Evander Mine in the first 8 years of the project and 1,400 kg/yr in the remaining 5 years (Cornish, 2018a).

In its 2016 fiscal year (which started on July 1, 2015, and ended on June 30, 2016), DRDGold produced 4,462 kg of gold at the Ergo tailings retreatment operation. Production was limited by decreased gold grades in the tailings; the company planned to increase recovery rates in the processing plant. DRDGold had planned to produce between 4,500 and 4,700 kg in fiscal year 2017 at Ergo, which is located near Johannesburg. Actual production in fiscal year 2017 was about 4,200 kg. Ergo had an estimated remaining life of more than 20 years (Creamer, 2016c, 2018b; Perold, 2017, p. 5).

Gold One International Ltd. operated the Modder East Mine in Gauteng Province; the company produced gold at the rate of about 3,200 kg/yr. The estimated remaining life of the Modder East Mine was more than 17 years (Perold, 2017, p. 6).

Village Main Reef Ltd. operated the Tau Lekoa Mine, which produced gold at the rate of about 2,800 kg/yr. The company planned to increase production at Tau Lekoa to more than 3,100 kg/yr; it was unclear when the expansion would be completed (Village Main Reef Ltd., undated).

Amplats produced about 2,200 kg of gold from its South African PGM mining operations in 2017 compared with a revised 2,100 kg in 2016. The Mogalakwena Mine, which accounted for 32% of Amplats' total PGM production in 2017, produced 81% of the company's gold output (Anglo American Platinum Ltd., 2018, p. 40, 44, 46, 48, 50, 52, 54, 56).

White Rivers Exploration (Pty) Ltd. and Harmony were considering the development of the EJV project, which was adjacent to Harmony's Target 1 Mine. In 2016, White Rivers completed a scoping study on a new mine at EJV. Depending on the results of prefeasibility and feasibility studies, the companies could produce at least 7,500 kg/yr of gold between years 4 and 17 of mining operations. The planned average production during the estimated 33-year life of the project was 6,300 kg/yr.

White Rivers planned to complete a prefeasibility study in June 2017 and a feasibility study in June 2018. At yearend, the prefeasibility study had not been completed (Andrews, 2017b; White Rivers Exploration (Pty) Ltd., 2017, p. 6, 9, 11–12; Washbourne, 2018).

Rand Refinery Ltd. (AngloGold Ashanti, 53%; Gold Fields, 33%; DRDGold, 10%; and Avgold Ltd. and Western Areas Ltd., 2% each) refined most of the newly mined gold in South Africa. The company produced at about 50% of its capacity of 600,000 kg/yr. Rand Refinery sourced about 50% of its gold from other African countries. South Africa also had small refineries that recycled gold (Seccombe, 2017).

Iron Ore and Iron and Steel.—In 2017, iron ore production was about 74.3 Mt compared with 74.9 Mt in 2016 and 42.1 Mt in 2007. The long-term increase was attributable to increased production from the Palabora and the Sishen Mines and the opening of the Khumani and the Kolomela Mines (Chamber of Mines of South Africa, 2015, p. 18; Mpuleng Galane, Deputy Director of Statistics, Department of Minerals and Energy of the Republic of South Africa, written commun., August 24, 2018).

Kumba Iron Ore Ltd.'s iron ore production increased to 45 Mt in 2017 from 41.5 Mt in 2016. In 2017, production at the Sishen Mine increased to 31.1 Mt from 28.4 Mt. At the Kolomela Mine, output increased to 13.9 Mt from 12.7 Mt. The Thabazimbi Mine closed in mid-2016 after producing 0.4 Mt. Kumba planned to maintain production at Sishen of about 30 Mt/yr, and at Kolomela, about 14 Mt/yr. Kolomela had an estimated remaining life of 14 years, and Sishen, 13 years (Kumba Iron Ore Ltd., 2018, p. 5, 12–13, 58, 60).

Assmang produced iron ore at the Beeshoek and the Khumani Mines. In 2017, production at Beeshoek and Khumani increased to 18.2 Mt from 16.7 Mt in 2016. The company planned to maintain production at Khumani of 14.3 Mt/yr and to increase production at Beeshoek to 3.7 Mt/yr from nearly 3.2 Mt/yr by mid-2018 (African Rainbow Minerals Ltd., 2017a, p. 44, 52, 2017b, p. 9; 2018b, p. 45).

Palabora Mining Company Ltd. produced magnetite from the Palabora Mine. Foskor (Pty) Ltd. sold magnetite from a stockpile at its phosphate rock mine at Phalaborwa; the company did not produce or process magnetite. Palabora Mining and Foskor's exports of magnetite from the ports of Komatipoort and Richards Bay were at the rate of nearly 9.6 Mt/yr between January and August 2017 (Foskor (Pty) Ltd., 2017, p. 4; Tex Report, The, 2017f; Transnet SOC Ltd., 2018, p. 62–63, 66).

In July 2017, Afrimat Ltd. restarted production at the Diro Mine in Northern Cape Province, which had been placed in bankruptcy proceedings by its previous owners in June 2016. Afrimat was producing at the rate of between 400,000 and 500,000 t/yr in early November; the company planned to increase production to 1 Mt/yr by March 2018 (Odendaal, 2017).

Ferrum Crescent Ltd. of Australia was considering the development of a new mine at its Moonlight magnetite deposit. Depending on the results of a feasibility study, production at Moonlight was expected to be 6 Mt/yr of iron ore pellets. Ferrum Crescent decided to withdraw from South Africa in April 2017 because of world market conditions and the high costs to develop Moonlight. The company sold its South African interests in July (Andrews, 2015a; Ferrum Crescent Ltd., 2017).

Lead and Zinc.—The Black Mountain Mine, which was operated by Vedanta Resources Ltd. of the United Kingdom, produced copper, lead, silver, and zinc. Lead mine production increased to 48,150 t in 2017 from 39,344 t in 2016, and zinc, to 30,778 t from 26,695 t. At the beginning of 2017, the remaining estimated life of the Black Mountain Mine was 20 years (Kotze, 2017a; Mpuleng Galane, Deputy Director of Statistics, Department of Minerals and Energy of the Republic of South Africa, written commun., August 24, 2018).

In 2017, Vedanta was engaged in construction of the Gamsberg Mine. The company planned to produce 250,000 t/yr of zinc in concentrate in the first phase of mining, which had an estimated life of 13 years. Mining was expected to start in mid-2018. The company also was considering a second phase of mining in which production could increase to 450,000 t/yr of zinc in concentrate and a new smelter could be built at the mine site. Resources at Gamsberg were estimated to be 214 Mt at a grade of more than 6% zinc (Tredway, 2015; Kotze, 2017a).

Manganese.—In 2017, manganese ore production was about 14.14 Mt compared with a revised 10.81 Mt in 2016 and 6 Mt in 2007. The long-term increase was attributable to increased production from the Mamatwan, the Nchwaning, and the Wessels Mines and the opening of the Kalahari, the Kudumane, and the Tshipi Borwa Mines (Chamber of Mines of South Africa, 2015, p. 19; Mpuleng Galane, Deputy Director of Statistics, Department of Minerals and Energy of the Republic of South Africa, written commun., August 24, 2018).

Hotazel Manganese Mines (Pty) Ltd. (South32 Ltd., 60%) operated the Mamatwan open pit mine and the Wessels underground mine near Hotazel in Northern Cape Province. In 2017, Samancor Manganese's production of manganese ore increased to 3.72 Mt from 3.15 Mt in 2016. Ore grades from the company's sales were about 40% manganese in 2016 and 2017. Samancor Manganese planned to produce at the rate of about 3 Mt/yr in the first half of 2018 (South32 Ltd., 2017, 2018).

In 2017, Samancor Manganese produced 120,000 t of manganese alloys at its Meyerton plant compared with a revised 137,000 t in 2016. At yearend, the company was operating only one of its four furnaces (South32 Ltd., 2017, 2018).

Assmang produced manganese ore at the Gloria and the Nchwaning Mines. Output at Gloria and Nchwaning increased to 3.62 Mt in 2017 from 2.71 Mt in 2016; average ore grades were about 45% manganese. Assmang's Black Rock project was expected to increase total production to 4.6 Mt/yr; the company planned to complete the expansion by late 2019 or early 2020 (African Rainbow Minerals Ltd., 2017a, p. 53; 2017b, p. 9; 2018b, p. 45; Buchholz and Foya, 2017, p. 24, 26).

In 2017, Assmang's production of ferromanganese at the Cato Ridge plant was 162,000 t compared with 147,000 t in 2016. Assmang planned to maintain sales of ferromanganese at about 150,000 t/yr through mid-2019 (African Rainbow Minerals Ltd., 2017a, p. 48, 53; 2017b, p. 9; 2018b, p. 45).

BEE company Ntsimbitntle Mining (Pty) Ltd. held a 50.1% share in Tshipi e Ntle Manganese Mining (Pty) Ltd., and Jupiter Mines Ltd. of Australia held a 49.9% share. In the fiscal year starting on March 1, 2016, and ending on February 1, 2017, Jupiter and Ntsimbitntle produced 2.33 Mt of manganese ore at a grade of 37% manganese from the Tshipi Borwa Mine

compared with a revised 1.54 Mt in fiscal year 2016. Between March and August 2017, the mine produced at the rate of 3 Mt/yr. The mine had a capacity of 3.6 Mt/yr and an estimated remaining life of more than 100 years (Buchholz and Foya, 2017, p. 25, 28; Burger, 2017; Jupiter Mines Ltd., 2018, p. 15).

In its fiscal year 2016, United Manganese of Kalahari (Pty) Ltd. (UMK) [Majestic Silver Trading 40 (Pty) Ltd., 51%, and Renova Group of Russia, 49%] produced 1.35 Mt of manganese ore at a grade of 37.5% manganese. UMK produced about 2 Mt in 2017; the company was considering an expansion to 3.8 Mt/yr. The estimated remaining life of the mine was at least 22 years [Buchholz and Foya, 2017, p. 25, 29; SLR Consulting (Africa) (Pty) Ltd., 2017, p. 2.10; Jupiter Mines Ltd., 2018, p. 18].

Manganese ore from the Kalahari deposit was consumed by Transalloys (Pty) Ltd. (a subsidiary of Renova) in the production of silicomanganese. Transalloys had a capacity of 180,000 t/yr. In May 2016, Renova and Majestic announced plans to shut down production in June because of world market conditions. The plant restarted in 2017 (Davies, 2016).

Asia Minerals Ltd. (AML) of Hong Kong operated the Kudumane Mine at Farm York; the mine produced about 1.5 Mt/yr of manganese ore in 2017 at a grade of 37% manganese. In December, the company was engaged in an expansion of its mining operations. AML planned to produce 400,000 t/yr of ore at a grade of 40% manganese at Farm Hotazel; the first shipments of ore were expected to be between April and June 2018 (Buchholz and Foya, 2017, p. 30; Tex Report, The, 2017c, Jupiter Mines Ltd., 2018, p. 18).

Guangxi N&H Metallurgy Development Co. of China operated the Lomoteng Mine, which had a capacity of 600,000 t/yr. The company produced between 360,000 and 540,000 t/yr for export to China. The estimated remaining life of the mine was 128 years (Buchholz and Foya, 2017, p. 25, 29).

Kalagadi Manganese (Pty) Ltd. (ArcelorMittal of Luxembourg, 50%; Kalahari Resources (Pty) Ltd., 40%; and Industrial Development Corp., 10%) planned to start production at a new underground mine at Hotazel in the first quarter of 2017. Output was expected to be 3 Mt/yr of manganese ore at a grade of 38%; Kalagadi completed a plant to beneficiate the mine's output into 2.4 Mt/yr of sintered ore in 2013. The sintering plant, which had a capacity of 3.7 Mt/yr, processed manganese ore from other South African producers. As of yearend, mining had not started (Green, 2014; Projects in Progress, 2014; Jupiter Mines Ltd., 2018, p. 18; Zakhele Mashile, Business Development Manager, Kalagadi Manganese (Pty) Ltd., oral commun., February 8, 2017).

In 2015, Aquila Resources (Pty) Ltd. of Australia completed a feasibility study on a new mine at the Avontuur project. Aquila planned to produce about 1.5 Mt/yr of manganese ore at a grade of 39% manganese from the Gravenhage deposit, of which 1.13 Mt/yr would be lumpy ore for export and 330,000 t/yr would be fine ore sold to local sintering plants. The project subsequently was delayed by a dispute regarding mining rights with Pan African Mineral Development Co., which was owned by the Governments of South Africa, Zambia, and Zimbabwe. In November 2016, the Gauteng division of the High Court of South Africa ruled in favor of Aquila. In November 2017, the Supreme Court of Appeals overturned the lower court's

decision. The dispute was unresolved at yearend (Buchholz and Foya, 2017, p. 30–31; Creamer, 2018a).

Nickel.—The majority of South Africa’s nickel mine production was a coproduct of PGM mining. Amplats produced 26,100 t of refined nickel in 2017 compared with 25,400 t in 2016. About 19,300 t of nickel was mined at the company’s South African PGM mining operations in 2017 compared with a revised 22,700 t in 2016; the Mogalakwena Mine’s production decreased to 16,000 t from 16,900 t. Implats produced 17,100 t of refined nickel in 2017, of which nearly 4,500 t was attributable to the company’s South African PGM mining operations (Impala Platinum Holdings Ltd., 2017a, p. 147, 154, 162; 2018b; Anglo American Platinum Ltd., 2018, p. 39, 40, 44, 46, 48, 50, 52, 54, 56).

ARM and Norilsk produced 15,981 t of nickel at the Nkomati Mine in 2017 compared with 16,665 t in 2016. The companies planned to increase production to 18,500 t/yr by mid-2020. The estimated remaining life of the mine was 11 years (African Rainbow Minerals Ltd., 2017a, p. 5, 7, 41; 2017b, p. 16; 2018b, p. 53).

In November 2016, Lonmin and the Thakadu Group formed a joint venture to build a new nickel sulfate plant at Lonmin’s base metals refinery. The companies completed a feasibility study on the plant in 2017; production was expected to start by the end of 2018. Lonmin and Thakadu planned to produce as much as 25,000 t/yr of high-purity nickel sulfate from Lonmin’s crude nickel sulfate. The plant’s output would be sold to the lithium-ion battery market (Breytenbach, 2017).

Platinum-Group Metals.—In 2017, platinum-group metal (PGM) mine production was 260,264 kg compared with 263,653 kg in 2016 and about 304,000 kg in 2007. Platinum accounted for 50% of PGM mine production by volume in 2017 (Chamber of Mines of South Africa, 2015, p. 33; Mpuleng Galane, Deputy Director of Statistics, Department of Minerals and Energy of the Republic of South Africa, written commun., August 24, 2018).

In 2017, Amplats produced about 155,500 kg of refined PGMs compared with a revised 145,500 kg in 2016. The company’s production of refined platinum was 78,129 kg in 2017; refined palladium, 51,893 kg; refined rhodium, 10,053 kg; and refined iridium and ruthenium, a total of about 15,500 kg. Refined palladium production increased by 14% in 2017; refined platinum, by 8%; and refined rhodium, by 2%. Total refined iridium and ruthenium production decreased by 12% in 2017 (Anglo American Platinum Ltd., 2018, p. 39).

About 102,300 kg of PGMs was produced by the South African mining operations of Amplats and its joint-venture partners in 2017 (not including the Bafokeng Rasimone Platinum, the Bokoni, the Rustenburg, and the Styldrift Mines) compared with 100,100 kg in 2016. Of the PGMs produced, platinum accounted for 48,100 kg in 2017; palladium, 34,400 kg; ruthenium, 10,200 kg; rhodium, 7,130 kg; and iridium, 2,440 kg. Production of mined palladium increased by nearly 5% in 2017, and that of mined platinum, by about 1%. Mined iridium production decreased by 1% and mined rhodium and ruthenium output was nearly unchanged (Anglo American Platinum Ltd., 2018, p. 44, 46, 50, 52, 54, 56).

In 2017, PGM production at Amplats’ Mogalakwena Mine was 32,379 kg; the Amandelbult Mine, 26,516 kg; the Kroondal Platinum Mine, 18,146 kg; the Modikwa Platinum Mine, 10,022 kg; the Union Mine, 9,558 kg; and the Mototolo Platinum Mine, 5,704 kg. Mogalakwena, which accounted for 32% of Amplats’ total mined PGM output, produced 46% of the company’s palladium, 30% of the platinum, 14% of the rhodium, and 9% each of the iridium and ruthenium. Total PGM production increased at Mogalakwena by 12% in 2017; Modikwa, by 10%; Union, by 3%; and Kroondal, by 2%. In 2017, production decreased at Mototolo by 27%, and at Amandelbult, by 3% (Anglo American Platinum Ltd., 2018, p. 44, 46, 50, 52, 54, 56).

In 2018, production at Mogalakwena was expected to be between 31,000 and 34,000 kg of PGMs. Amplats planned to increase production at Amandelbult to between 28,000 and 29,000 kg in 2018 (Anglo American Platinum Ltd., 2018, p. 5–6).

Royal Bafokeng Platinum Ltd. (RBPlat) and joint-venture partner Amplats produced PGMs at the Bafokeng Rasimone Platinum Mine. Production of PGMs (including gold, but not ruthenium or iridium) was about 8,800 kg in 2017 compared with 8,550 kg in 2016. Platinum production increased to 5,690 kg in 2017 from 5,510 kg in 2016. Palladium production at Bafokeng Rasimone was estimated to be between 2,300 and 2,400 kg in 2017. RBPlat produced about 1,400 kg of PGMs at the Styldrift Mine in 2017 compared with 900 kg in 2016. Platinum production increased to 900 kg in 2017 from 590 kg in 2016 (Royal Bafokeng Platinum Ltd., 2018, p. 3, 59).

RBPlat planned to increase total PGM production to between 11,500 and 12,000 kg in 2018. Output of PGMs at the Bafokeng Rasimone Platinum Mine was likely to decrease to 5,000 kg/yr by 2020. The company planned to ramp up production at Styldrift to its full capacity of about 10,000 kg/yr of PGMs by 2020. Platinum would account for 69% of production, and palladium, rhodium, and gold, a total of 31% (Projects in Progress, 2012; Royal Bafokeng Platinum Ltd., 2016, p. 23–24; 2018, p. 59, 66).

Atlatsa Resources Corp. and joint-venture partner Amplats produced platinum at the rate of between 2,200 and 2,300 kg/yr at the Bokoni Mine. In early October 2017, the companies placed Bokoni on care-and-maintenance status (Moumakwa and Rakhudu, 2018).

Implats produced 92,685 kg of refined PGMs in 2017 compared with 95,877 kg in 2016. Platinum accounted for about 46,000 kg in 2017; palladium, 27,000 kg; rhodium, 6,600 kg; and iridium and ruthenium, about 13,100 kg. The company’s South African mining operations accounted for about 42,100 kg of the refined PGMs produced; the remainder was attributable to the Two Rivers joint venture with ARM, the company operations in Zimbabwe, recycling, and toll refining (Impala Platinum Holdings Ltd., 2017a, p. 105, 147, 154, 162; 2017b, p. 2, 12; 2018b).

The Impala Mines near Rustenburg in North West Province produced about 36,500 kg of PGMs (including gold) in 2017 compared with 37,200 kg in 2016. Platinum production was about 18,900 kg in 2017; palladium, 9,920 kg; and rhodium, 2,730 kg. Total gold, iridium, and ruthenium was 4,950 kg in 2017, of which ruthenium and iridium accounted for 70% and 13%, respectively, based on data from Prill splits. Iridium and

ruthenium production decreased by 22% in 2017, and platinum, by 2%. Implats planned to increase platinum production at the Impala Mines to between 21,000 and 22,000 kg in 2018 and to more than 23,000 kg/yr by 2022 (Impala Platinum Holdings Ltd., 2008; 2017a, p. 67, 147; 2017b, p. 2; 2018b).

In 2017, palladium output at the Marula Mine was nearly 2,200 kg; platinum, 2,100 kg; rhodium, 440 kg; and iridium and ruthenium, 820 kg. The company also planned to increase platinum production at Marula to 2,600 kg/yr in 2018 (Impala Platinum Holdings Ltd., 2017a, p. 85, 154; 2017b, p. 4; 2018b).

ARM and Implats operated the Two Rivers Mine; output decreased to 11,252 kg of PGMs in 2017 from a revised 12,746 kg in 2016. Platinum accounted for about 47% of Two Rivers' PGM output; palladium, 27%; ruthenium, 14%; rhodium 8%; iridium, 3%; and gold, 1%. Decreased output was mostly attributable to lower ore grades. The estimated remaining life of the mine was more than 30 years (African Rainbow Minerals Ltd., 2017a, p. 40; 2017b, p. 14; 2018b, p. 51; Moumakwa and Rakhudu, 2018).

In 2017, Lonmin produced 41,904 kg of refined PGMs compared with 42,138 kg in 2016. Lonmin's mining operations produced 38,522 kg of PGMs in 2017, which was nearly unchanged from the amount produced in 2016. Platinum accounted for 20,283 kg of PGM mine production in 2017; palladium, 9,430 kg; ruthenium, 4,881 kg; rhodium, 2,910 kg; and iridium, 1,018 kg. Most of the mine production was from the Marikana Mine. Lonmin planned to sell between 20,000 and 21,000 kg of platinum in 2018 (Lonmin plc, 2017a, p. 13, 189–190; 2017b; 2018b).

In 2016, Sibanye-Stillwater purchased the Rustenburg Mine from Amplats and a 50% share in the Kroondal Platinum Mine from Aquarius Platinum Ltd. The company produced 4,286 kg of PGMs (including gold, but not ruthenium or iridium) at Rustenburg in the last 2 months of 2016; in 2017, production at Rustenburg was 25,179 kg. Sibanye-Stillwater also recovered 591 kg of PGMs from tailings at Platinum Mile in 2017 compared with 426 kg in 2016. The company's total platinum production at Platinum Mile and Rustenburg was about 15,400 kg; palladium, 7,750 kg; and rhodium and gold, a total of about 2,000 kg. Mining at Rustenburg was expected to continue until 2046 (Impala Platinum Holdings Ltd., 2017a, p. 157; 2018b; Anglo American Platinum Ltd., 2018, p. 56; Moumakwa and Rakhudu, 2018; Sibanye-Stillwater Ltd., 2018, p. 14, 44, 46, 48, 52).

Northam Platinum Ltd. operated the Booyensdal North and the Zondereinde Mines. Booyensdal North and Zondereinde's production of platinum was 9,116 kg in 2017; palladium, 4,406 kg; ruthenium, 2,004 kg; rhodium, 1,409 kg; and iridium, 466 kg. In 2016, platinum production was 8,421 kg; palladium, a revised 3,994 kg; and rhodium, a revised 1,338 kg. Northam sold its production to Heraeus South Africa (Pty) Ltd. for refining. Heraeus' production of refined platinum at Port Elizabeth decreased to 8,057 kg in 2017 from 8,238 kg in 2016, and that of refined palladium, to 3,917 kg from 4,011 kg. The company exported iridium, rhodium, and ruthenium to Germany for refining (Northam Platinum Ltd., 2017, p. 11–12; 2018, p. 12–13).

In 2017, Northam was engaged in an expansion of the Booyensdal North Mine. The company planned to increase production to nearly 6,700 kg/yr of PGM (including gold,

but not ruthenium or iridium) in 2018 from 5,000 kg/yr in its fiscal year 2016 by mining ore from the Merensky reef and deepening its UG2 operations (Cornish, 2017; Northam Platinum Ltd., 2017, p. 21).

Northam also planned to produce nearly 6,700 kg/yr of PGMs (including gold, but not ruthenium or iridium) at its new Booyensdal South Mine. The company planned to restart operations at the Everest Mine's processing plant, which was on care-and-maintenance status, by mid-2018. The plant would process ore from the Booyensdal South Mine. Full production at Booyensdal North and Booyensdal South could increase to 14,800 kg/yr by 2022 (Cornish, 2017, 2018b).

ARM and Norilsk produced PGMs at the Nkomati nickel mine. Output increased to 4,412 kg of PGMs in 2017 from 3,637 kg of PGMs in 2016. Based on Prill split data, palladium accounted for about 66% of production; platinum, 28%; and rhodium, 4%. Production was expected to increase in 2018 (Impala Platinum Holdings Ltd., 2008; African Rainbow Minerals Ltd., 2017a, p. 37, 41; 2017b, p. 16; 2018b, p. 53).

Sedibelo Platinum Mines Ltd. produced about 2,500 kg of platinum and 1,500 kg of palladium at the Pilanesberg Mine in 2017 compared with about 3,100 kg of platinum and 1,550 kg of palladium in 2016. The company's platinum production was expected to remain unchanged in 2018. The mine's life was expected to last until at least 2027 (CPM Group, 2018, p. 15, 104; Moumakwa and Rakhudu, 2018).

In fiscal year 2017, Tharisa produced 4,466 kg of PGMs compared with 4,124 kg in fiscal year 2016. Platinum accounted for 55.2% of production by volume in fiscal year 2017; palladium, 16.1%; ruthenium, 14.3%; rhodium, 9.5%; and iridium, 4.7%. The company planned to increase production to 6,200 kg/yr of PGMs by 2020. Sylvania Platinum Ltd. produced about 1,200 kg of platinum and 470 kg of palladium from its chromite tailings retreatment plants in 2017 compared with 1,200 kg of platinum and 560 kg of palladium in 2016 (Tharisa Minerals (Pty) Ltd., 2017, p. 1–2, 13; CPM Group, 2018, p. 15, 104).

Platinum Group Metals Ltd. of Canada opened the Maseve Mine in 2016. The company had planned to mine nearly 8,600 kg/yr of PGMs (including gold, but not ruthenium or iridium), of which platinum would account for 64%; palladium, 27%; rhodium, 5%; and gold, 4%. The estimated life of the mine was more than 20 years. In 2017, Maseve produced platinum at the rate of nearly 470 kg/yr before being placed on care-and-maintenance status (Platinum Group Metals Ltd., 2015, p. 13–14; Lazenby, 2018; Moumakwa and Rakhudu, 2018).

In late 2016, Platinum Group Metals completed a prefeasibility study on a new mine at the Waterberg project. The company had planned to complete a feasibility study on Waterberg, which is located in the Northern Limb of the Bushveld Complex, by the end of 2017. Depending on mining rights and other permits and the results of the study, mining could start by mid-2021. Planned production was 23,100 kg/yr of PGMs (including gold, but not ruthenium or iridium), of which palladium would account for 63%; platinum, 30%; gold, 6%; and rhodium, 1%. The estimated life of the mine was 18 years. As of the end of 2017, the feasibility study had not

been completed (Breytenbach, 2016; Engineering & Mining Journal, 2016; Liedtke, 2018a).

In 2017, Wesizwe Platinum Ltd. was engaged in the development of the Bakubung Mine in North West Province. Wesizwe planned to start mining in the fourth quarter of 2018 and reach the full capacity of 13,000 kg/yr of PGMs (including gold, but not ruthenium or iridium) in 2021. Platinum was expected to account for 62.4% of PGM production; palladium, 28%; rhodium, 7.4%; and gold, 2.2%. The estimated life of the mine was 30 years (Engineering & Mining Journal, 2015; Cornish, 2018b).

In 2017, Ivanhoe Mines Ltd. of Canada completed a feasibility study on the first phase of a new mine at its Platreef project. In the first phase of mining, Ivanhoe would mine about 4 Mt/yr of ore. Production was likely to be 9,500 t/yr of nickel, 5,900 t/yr of copper, and 14,800 kg/yr of PGMs (including gold, but not ruthenium or iridium). In the second phase, ore production could increase to 8 Mt/yr, and in the third phase, to 12 Mt/yr. Mining could start at Platreef, which is located in the northern limb of the Bushveld Complex, in early 2022 (Engineering & Mining Journal, 2017).

Silicon.—Ferroglobe plc of the United Kingdom produced silicon metal at its eMalahleni and Polokwane plants; the company also produced ferrosilicon at eMalahleni. At the end of June 2016, Ferroglobe shut down silicon metal production at eMalahleni and Polokwane because of high power costs and reduced demand in world markets. In August 2017, the National Energy Regulator of South Africa approved Government-owned power company Eskom's application to provide power to the plants at a reduced price. As of November, the plants were still not producing silicon metal (Njobeni, 2017).

Titanium and Zirconium.—Richards Bay Minerals (RBM) (Rio Tinto plc, 74%; Blue Horizon Investments, 24%; and RBM permanent employees, 2%) of the United Kingdom was South Africa's leading producer of ilmenite, rutile, and zircon; the company also produced pig iron and processed ilmenite to titanium slag. About 95% of RBM's total pig iron, rutile, titanium slag, and zircon output was exported (Rio Tinto plc, 2017, p. 8).

RBM mined nearly 1.8 Mt of ilmenite from the Zulti North deposit in 2013. Based on titanium slag production levels, production was estimated to have decreased by more than 35% between 2013 and 2016 because of reduced global demand on world markets. Ilmenite production was estimated to have decreased by between 5% and 10% between 2016 and 2017 (Rio Tinto plc, 2014, p. 28; 2017, p. 12).

Production at Zulti North was expected to decrease after 2019; RBM was engaged in a feasibility study on the development of the Zulti South deposit as of yearend. Depending on the result of the study, the company could start construction at Zulti South in 2018, and mining, in 2020. Based on previous production plans, RBM's total ilmenite production could increase to more than 2.2 Mt/yr. Reserves at Zulti North and Zulti South were expected to be depleted in 2037 and 2044, respectively (Rio Tinto plc, 2014, p. 28; 2017, p. 8; Munyu, 2016; Carnie, 2018).

Titanium slag production by RBM was about 880,000 t in 2012. Production was estimated to have decreased by nearly 35% between 2012 and 2016 because of reduced global demand on world markets. Titanium slag production was estimated to

have increased by 10% between 2016 and 2017 (Rio Tinto plc, 2013, p. 10; 2017, p. 12).

Zircon production by RBM was about 264,000 t in 2012, and rutile production, about 97,000 t. Rutile production was estimated to have decreased by more than 35% between 2012 and 2016 because of reduced global demand on world markets, and zircon production, by nearly 30%. Rutile and zircon production were estimated to have increased by about 10% and 5%, respectively, between 2016 and 2017. RBM's zircon output could increase by 90,000 t/yr after the opening of the Zulti South Mine in 2019 (Rio Tinto plc, 2013, p. 10; 2017, p. 12; Munyu, 2016).

Tronox Ltd. of the United States' (Exxaro Resources Ltd., 44.65%) Namakwa Sands project produced 121,000 t of zircon in 2017 compared with 133,000 t in 2016. Titanium slag production increased to 180,000 t in 2017 from 113,000 t in 2016; rutile production increased to 30,000 t from 26,000 t. The company's ilmenite production was estimated to be about 450,000 t in 2017 compared with 490,000 t in 2016 (Tronox Ltd., 2017, p. 36; 2018, p. 33).

Large-scale mining started at Tronox's Fairbreeze Mine in April 2016. By yearend, the company produced 114,000 t of titanium slag, 31,000 t of zircon, and 12,000 t of rutile. Ilmenite production was estimated to be about 260,000 t in 2016. Titanium slag production was 179,000 t in 2017; zircon, 46,000 t; and rutile, 19,000 t. Ilmenite production was estimated to be 410,000 t in 2017. Fairbreeze had a capacity of 500,000 t/yr of ilmenite, 55,000 t/yr of zircon, and 25,000 t/yr of leucoxene and rutile; the estimated life of the mine was 12 years (Tronox Ltd., 2017, p. 31, 35–36, 38, 41; 2018, p. 33).

Mineral Commodities Ltd. (MCL) of Australia operated the Tormin Mine in Western Cape Province. In 2017, the company produced 138,913 t of ilmenite, 15,624 t of zircon, and 3,914 t of rutile. In 2016, production was a revised 162,123 t of ilmenite, 26,537 t of zircon, and 4,777 t of rutile. Rutile and zircon production decreased in 2017 because of lower ore grades. MCL planned to produce between 100,000 and 130,000 t of ilmenite and a total of between 20,000 and 25,000 t of rutile and zircon in 2018 (Caruso, 2018, p. 12; Mineral Commodities Ltd., 2018, p. 12, 19).

MCL planned to obtain permits in 2018 that could extend Tormin's life by at least 10 years. The company was engaged in a study on a new mineral separation plant that would produce 250,000 t/yr of finished ilmenite and 16,000 t/yr of finished rutile and zircon. The plant also would increase rutile and zircon concentrate capacity by 66,000 t/yr (Caruso, 2018, p. 8, 15).

Most of the titanium slag produced in South Africa was exported before additional processing. In 2017, Nyanza Light Metals Ltd. (Arkein Group of Companies, 80%, and Highveld, 20%) announced plans to build a new TiO₂ pigment plant in the Richards Bay Industrial Development Zone. The company could produce 50,000 t/yr of TiO₂ pigment starting in 2019. Pigment would be produced using titanium-rich wastes from Highveld's iron ore and vanadium mining operations. Africa's consumption of TiO₂ pigment was estimated to be 130,000 t/yr, of which South Africa accounted for 35,000 t/yr (Tshethlanyane, 2017).

Vanadium.—Glencore produced vanadium pentoxide (V_2O_5) and ferrovanadium at the Rhovan Mine and smelter in Brits. In 2017, the production of V_2O_5 at Rhovan was nearly 9,500 t compared with 9,600 t in 2016. The estimated remaining life of the Rhovan Mine was 30 years (Buchholz and Foya, 2017, p. 49; Glencore plc, 2018a, p. 16).

Bushveld Minerals Ltd. of the United Kingdom operated the Vametco Mine and Brits plant. In 2016, Vametco produced at its full capacity of 2,850 t/yr of contained vanadium. In 2017, Bushveld started an expansion at Vametco. The company increased production to nearly 3,040 t/yr of contained vanadium in the third quarter of 2017 and planned to reach 3,750 t/yr by June 2018 and more than 5,000 t/yr by the end of 2019. In December, Bushveld increased its share in Vametco to 59.1% (Buchholz and Foya, 2017, p. 52; Kotze, 2018a).

In 2016, Bushveld completed a prefeasibility study on a new mine at its Mokopane vanadium project. The company could produce about 9,500 t/yr of V_2O_5 from 1 Mt/yr of titaniferous magnetite ore. The estimated life of the mine was at least 30 years. As of the end of 2017, it was unclear when further studies on the mine would proceed (Buchholz and Foya, 2017, p. 52–54; Kotze, 2018a).

Industrial Minerals

Cement.—In 2017, South Africa had six cement producers with a total capacity of 20.5 Mt/yr of cement. Pretoria Portland Cement Co. (Pty) Ltd. (PPC) had a combined cement capacity of 7 Mt/yr; AfriSam Consortium (Pty) Ltd., 4.6 Mt/yr; Lafarge Industries South Africa (Pty) Ltd., 3.2 Mt/yr; Dangote Cement South Africa (Pty) Ltd., 2.9 Mt/yr; Natal Portland Cement Co. (Pty) Ltd., 1.8 Mt/yr; and Mamba Cement Company (Pty) Ltd., 1 Mt/yr. Dangote and Mamba's plants were completed in 2014 and 2015, respectively. Overcapacity in the industry was expected to last for about 10 years (table 2; International Cement Review, 2018).

PPC planned to expand the capacity of its Slurry plant to 2 Mt/yr from 1.5 Mt/yr by the second quarter of 2018. Osho Cement (Pty) Ltd. (Osho Ventures Ltd. of the United Arab Emirates, 60%, and HeidelbergCement AG of Germany, 40%) planned to build two new clinker grinding plants near Port Elizabeth and Richards Bay with a capacity of 600,000 t/yr each of cement. The Port Elizabeth plant was expected to be completed by 2018; it was unclear when the Richards Bay plant would be built (International Cement Review, 2013, 2018; Osho Ventures Ltd., undated).

Clay and Shale.—In 2017, South Africa's sales of brick clay increased to 7.46 Mt from 6.67 Mt in 2016. The production of shale for use in bricks decreased to 1.09 Mt in 2017 from 1.36 Mt in 2016, and shale for use in cement, to 356,000 t from 395,000 t. In early 2016, brick clay and shale were produced at as many as 147 mines (Lourens and DeWater, 2016, p. 61–70, 78–80, 91, 93, 111, 115, 119; Mpuleng Galane, Deputy Director of Statistics, Department of Minerals and Energy of the Republic of South Africa, written commun., August 24, 2018).

Diamond.—In 2017, diamond production was 9.7 million carats compared with a revised 8.31 million carats in 2016 and 15.25 million carats in 2007. Lower production was attributable to decreased production at the Cullinan, the Finsch, and the

Venetia Mine (Chamber of Mines of South Africa, 2015, p. 26; Mpuleng Galane, Deputy Director of Statistics, Department of Minerals and Energy of the Republic of South Africa, written commun., August 24, 2018).

The De Beers Group of Companies accounted for the majority of South Africa's rough diamond production. In 2017, the company's total output increased to 5.21 million carats from 4.23 million carats in 2016. The Venetia Mine's production increased to 4.6 million carats from 3.52 million carats, and the Voorspoed Mine's production decreased to 606,000 carats from 649,000 carats (Anglo American plc, 2018, p. 3).

In 2017, De Beers was engaged in the construction of the Venetia Underground project, which would extend the life of the Venetia Mine from 2023 to 2045 by building a new underground mine. Production from Venetia Underground was expected to start by 2021 and to reach its full capacity of 4.5 million carats per year by 2026 (Cornish, 2018c).

In 2017, diamond production by Petra Diamonds Ltd. at the Finsch Mine remained unchanged at 2.15 million carats. Production increased at the Cullinan Mine to 974,000 carats in 2017 from 778,000 carats in 2016 and decreased at the Koffiefontein Mine to about 48,000 carats from 55,000 carats. The Kimberley Ekapa Mining joint venture produced 965,000 carats in 2017 (Petra Diamonds Ltd., 2017a, p. 11–16; 2018b, p. 14–18).

Petra planned to ramp up production at the Cullinan and the Koffiefontein Mines to 2.2 million carats per year and 85,000 carats per year, respectively, by mid-2019. The company also planned to maintain output at Finsch and Kimberley at 2 million carats per year and 570,000 carats per year, respectively, after mid-2019 (Petra Diamonds Ltd., 2017b).

Fluorspar.—In 2017, South Africa's production of fluorspar was 223,000 t compared with 177,000 t in 2016. Minerale y Productos Derivados SA of Spain held an 85% share in the Vergenoeg Mine, which was South Africa's only active fluorspar mine at the end of 2017. Vergenoeg's production capacity of acid-grade fluorspar was 250,000 t/yr, and its production capacity of metal-grade fluorspar powder and briquette, 30,000 t/yr (table 1; Modiselle, 2017).

About 95% of South Africa's fluorspar sales were exports to Europe and India; only 5% was consumed in South Africa because of a lack of domestic processing facilities. Pelchem SOC (a subsidiary of South African Nuclear Energy Corp.) used fluorspar in the production of hydrofluoric acid (Modiselle, 2017).

Sephaku Fluoride Ltd. (SepFluor) started construction on its Nokeng Mine at Rust de Winter in 2017. The company planned to produce 180,000 t/yr of acid-grade fluorspar and 30,000 t/yr of metallurgical-grade fluorspar from the Outwash Fan and Plattekop deposits. Mining was expected to start in early 2019; the estimated life of the Nokeng Mine was 19 years. In 2016, SepFluor put its plans to build a new fluorochemicals plant that would consume fluorspar from Nokeng on hold because of difficulties in raising funds and unfavorable conditions on world markets (Modiselle, 2017).

Garnet, Industrial.—MCL produced industrial garnet from the Tormin Mine. In 2017, the company produced 211,394 t compared with a revised 254,693 t in 2016 and 284,990 t in 2015. The company was engaged in a study on a new mineral separation

plant that would produce 165,000 t/yr of finished garnet. The plant also would increase garnet concentrate capacity by 210,000 t/yr (Caruso, 2018, p. 12, 15).

Kyanite and Related Materials.—South Africa was the world's leading producer of andalusite. In 2016, national production decreased to an estimated 160,000 t from 190,000 t in 2015. Output decreased because of equipment problems, water shortages, and the closure of domestic steel plants that consumed andalusite for refractories. In 2017, production increased to about 180,000 t in spite of heavy rains at the start of the year (Ghilotti, 2018; Modiselle, 2018).

Imerys South Africa (Pty) Ltd. (a subsidiary of Imerys Group of France) operated the Annesley, the Segorong, and the Thabazimbi Mines. The company increased its production in 2017 with new equipment at Annesley and the reopening of a crushing plant at Thabazimbi. Andalusite Resources (Pty) Ltd. operated the Maroeloesfontein Mine, which had a capacity of more than 70,000 t/yr. In April 2015, the Government's Competition Committee blocked a proposed merger between Imerys and Andalusite Resources. The companies appealed the Competition Committee's decision; the Competition Appeals Court upheld the decision in early March 2017 (table 2; Ghilotti, 2018; Lassetter, 2018; Modiselle, 2018).

Phosphate Rock.—Foskor was South Africa's leading producer of phosphate rock. In 2017, national phosphate rock production increased to 2.08 Mt from 1.7 Mt in 2016. Between October 2016 and March 2017, domestic sales of phosphate rock were at the rate of 2.04 Mt/yr, and export sales, about 450,000 t/yr (table 1; Muravha, 2017).

Foskor consumed phosphate rock in the production of phosphoric acid and fertilizers, including monoammonium phosphate and diammonium phosphate at its plant in Richards Bay. In its 2017 fiscal year (which started on April 1, 2016, and ended on March 31, 2017), the company produced 450,000 t of phosphoric acid compared with 307,000 t in fiscal year 2016. Fertilizer production increased to 324,000 t from 198,000 t. Increased production was attributable to improved equipment. By fiscal year 2018, Foskor planned to increase phosphate rock output to 2.3 Mt/yr; phosphoric acid, to 510,000 t/yr; and fertilizers, to 400,000 t/yr (Foskor (Pty) Ltd., 2017, p. 3, 27, 40).

Kropz Elandsfontein (Pty) Ltd. and African Rainbow Capital (Pty) Ltd. planned to start production at the Elandsfontein Mine, which is located in Western Cape Province, in the first quarter of 2017. The companies planned to produce 1.5 Mt/yr of phosphate rock for domestic and export markets. In August, Kropz announced that the commissioning of the mine was delayed for an undetermined period of time (Kropz Elandsfontein (Pty) Ltd., 2017; Mining Mirror, 2017).

Sand, Construction.—In 2017, South Africa's production of aggregates increased to 52.4 Mt from 51 Mt in 2016. National production of sand for construction decreased to nearly 14.4 Mt in 2017 from 14.6 Mt in 2016. In early 2016, aggregates and construction sand were produced by cement producers and other companies at as many as 595 mines (Lourens and DeWater, 2016, p. 68–69, 71, 78–81, 83–121; Mpuleng Galane, Deputy Director of Statistics, Department of Minerals and Energy of the Republic of South Africa, written commun., August 24, 2018).

Sand, Industrial.—In 2017, South Africa's production of silica sand increased to 2.4 Mt from 1.89 Mt in 2016. In early 2016, silica sand was produced at as many as 25 mines. Silica sand was consumed by Consol Glass (Pty) Ltd., Nampak Glass (Pty) Ltd., and other companies in the production of glass. Consol produced about 850,000 t/yr of glass from four plants (Lourens and DeWater, 2016, p. 76, 83–85, 90; Consol Glass (Pty) Ltd., undated; Mpuleng Galane, Deputy Director of Statistics, Department of Minerals and Energy of the Republic of South Africa, written commun., August 24, 2018).

Stone, Crushed.—In 2017, South Africa's production of limestone increased to nearly 23.8 Mt from 23.4 Mt in 2016. In early 2016, limestone was produced by cement companies and other producers at as many as 43 mines. Limestone sales for use in cement were 14.6 Mt in 2017; metallurgy, 2.08 Mt; agriculture, 1.74 Mt; and other, 1.39 Mt (Lourens and DeWater, 2016, p. 78–80, 100; Mpuleng Galane, Deputy Director of Statistics, Department of Minerals and Energy of the Republic of South Africa, written commun., August 24, 2018).

Stone, Dimension.—In 2017, South Africa's sales of granite dimension stone decreased to 286,147 t from 307,540 t in 2016. About 62% of granite sales were domestic in 2017. Granite accounted for more than 99% of the volume of national dimension stone sales. In early 2016, granite was produced at as many as 57 mines; sandstone, 7 mines; slate, 6 mines; and other dimension stone, 2 mines (Lourens and DeWater, 2016, p. 71–75; Mpuleng Galane, Deputy Director of Statistics, Department of Minerals and Energy of the Republic of South Africa, written commun., August 24, 2018).

Vermiculite.—Palabora Mining was the world's leading producer of vermiculite. The company had planned to increase production at the Palabora Mine to 150,000 t/yr by the end of 2015 and subsequently to its full capacity of 200,000 t/yr. In 2017, production at the Palabora Mine was 166,084 t, which was nearly unchanged from that of 2016. Between October 2016 and March 2017, export sales of vermiculite were at the rate of 43,000 t/yr, and domestic sales, 8,800 t/yr. Agriculture and horticulture accounted for a total of about 80% of domestic consumption, and construction and insulation, about 20% (tables 1, 2; Muravha, 2015; Radipabe, 2017; Mpuleng Galane, Deputy Director of Statistics, Department of Minerals and Energy of the Republic of South Africa, written commun., August 24, 2018).

Mineral Fuels and Related Materials

Coal.—In 2017, coal production was about 252.4 Mt compared with 250.6 Mt in 2016 and 247.7 Mt in 2007. Power generation consumed about 120 Mt/yr of coal; synthetic fuels, about 40 Mt/yr; and the cement, chemical, metals, and other industries, about 22 Mt/yr. About 70 Mt/yr was exported (Chamber of Mines of South Africa, 2015, p. 20; Prevost, 2017; Mpuleng Galane, Deputy Director of Statistics, Department of Minerals and Energy of the Republic of South Africa, written commun., August 24, 2018).

Anglo American's coal production was 49.9 Mt in 2017 compared with 53.8 Mt in 2016. The New Vaal Mine produced 15.1 Mt in 2017; the Zibulo Mine, 6.23 Mt; the Khwezela Mine (which was formed by the merger of the Kleinkopje

and the Landau Mines), 5.71 Mt; the Kriel Mine, 5.39 Mt; the Goedehoop Mine, 4.65 Mt; the Isibonelo Mine, 4.06 Mt; the Greenside Mine, 3.83 Mt; the New Denmark Mine, 3.36 Mt; and the Mafube Mine, 1.56 Mt. In 2017, output increased at New Denmark and Zibulo by 32% and 4%, respectively. Production decreased at Khwezela by 30% in 2017; Kriel, by 15%; Mafube, by 11%; and Isibonelo, by 8%. About 40% of the company's production was exported in 2017 (Anglo American plc, 2018, p. 12–13).

Exxaro's coal production increased to 45 Mt in 2017 from 42.8 Mt in 2016. Output at the Grootegeluk Mine was 22.6 Mt in 2016; the Matla Mine, 7.9 Mt; Exxaro Coal Central (ECC), 3.9 Mt; the Leeuwan Mine, 3.78 Mt; the North Block Complex, 2.86 Mt; and the Mafube Mine, 1.76 Mt. In 2017, production increased at Grootegeluk to 25.5 Mt and decreased at Leeuwan and Mafube to 3.36 Mt and 1.64 Mt, respectively. The North Block Complex was scheduled to be shut down in 2018 (Tex Report, The 2017b; Exxaro Resources Ltd., 2018, p. 77–78).

In 2017, Exxaro and joint-venture partner Anglo American were engaged in the construction of the Mafube Nooitgedacht project. Mining was expected to start in the second quarter of 2018; planned production was 3.1 Mt/yr of thermal coal. Exxaro started construction on the new Belfast Mine and the Leeuwan O/I project in the fourth quarter of 2017. The Leeuwan O/I project and the Belfast Mine were expected to produce 2.7 Mt/yr each of thermal coal, and they were to start production in the third quarter of 2018 and the first half of 2020, respectively. Exxaro also was engaged in the expansion of Grootegeluk's capacity by 1.7 Mt/yr in 2017; the project could be completed by 2020 (Exxaro Resources Ltd., 2018, p. 40–41, 69).

Exxaro planned to obtain financing and finalize power and water agreements for its new Thabametsi Mine by mid-2018. The company planned to start mining at Thabametsi in 2021 and to produce 3.9 Mt/yr of thermal coal to supply a new power station. At yearend, Exxaro was engaged in a legal dispute regarding the environmental authorization for the power station (Exxaro Resources Ltd., 2018, p. 41–42).

In fiscal year 2017 (which started on July 1, 2016, and ended on June 30, 2017), Sasol Ltd.'s coal production decreased to 37.6 Mt from 42.3 Mt in fiscal year 2016. The Syferfontein Mine accounted for 10.9 Mt; the Twistdraai Mine, 7.9 Mt; the Middelbult Mine, 6.5 Mt; the Bosjesspruit Mine, 6.1 Mt; the Brandspruit Mine, 2.8 Mt; the Impumelelo Mine, 2.2 Mt; and the Sigma Mine, 1.2 Mt. Most of Sasol's coal production was consumed in the company's synthetic fuel operations (Sasol Ltd., 2017, p. 36).

Glencore and ARM operated the Goedgevonden Complex, the Impunzi Complex, and the Tweefontein Complex. Output at Goedgevonden decreased to 6.16 Mt in 2017 from 6.81 Mt in 2016 and increased to a total of 17.2 Mt from 15.8 Mt at Impunzi and Tweefontein. Glencore and ARM planned to maintain total sales from Impunzi and Tweefontein at between 17 and 18 Mt/yr through at least mid-2020. The companies also planned to increase sales from Goedgevonden to about 8 Mt/yr by mid-2019 (African Rainbow Minerals, 2017a, p. 57–59; 2017b, p. 19–20; 2018b, p. 56–57).

In late 2017, Glencore started mining at Zonnebloem, which was part of the Impunzi complex. Based on an estimated mine

life of 24 years, production could be as much as 3.3 Mt/yr of salable coal (Glencore plc, 2018b, p. 54, 58).

Izimbiwa Coal (Pty) Ltd. (Phembani Group, 50.01%, and Glencore, 49.99%) operated the Corobrik, the Graspan and the Steelcoal Mines. In 2017, salable coal production at the company's mines was more than 3 Mt compared with about 4 Mt in 2016 (Inside Mining, 2014; Glencore plc, 2017, p. 58; 2018b, p. 58).

Umcebo Mining Ltd. (Glencore, 48.7%) operated the Wonderfontein Mine; production at Wonderfontein was about 3 Mt/yr in 2016 and 2017. The company's joint-venture Wildfontein Mine produced 1.9 Mt of salable coal in 2016 before being depleted (Glencore plc, 2017, p. 55, 57–58; 2018b, p. 59).

South32 produced coal at the Khutala, the Klipspruit, the Middelburg, and the Wolferkrans Mines in Mpumalanga Province. In 2017, the company's output decreased to 27.5 Mt from 30.1 Mt in 2016 because of reduced demand from the Duvha power station. South32 planned to spend about \$300 million to extend the remaining life of Klipspruit by about 20 years (South32 Ltd., 2017, 2018; Tex Report, The, 2017e).

Tegeta Exploration & Resources (Pty) Ltd operated the Brakfontein Mine, the Koornfontein Mines, and the Optimum Complex. The company produced coal at Optimum at the rate of more than 6 Mt/yr between June 2016 and December 2017, of which nearly 4 Mt/yr was supplied to Eskom and more than 2 Mt/yr was exported. Tegeta also had a contract with Eskom to supply 2.4 Mt/yr of coal from Koornfontein between 2016 and 2023. Brakfontein supplied coal to Eskom at the rate of 1.2 Mt/yr in 2016 (Steyn, 2017; Cowan and Skiti, 2018).

Mbuyelo Coal (Pty) Ltd. (Mbuyelo Group, 49% and IchorCoal N.V. of the Netherlands, 45%) operated the Manungu, the Rirhandzu, the Vlakvarkfontein, and the Welgemeend Mines. Welgemeend produced 2.79 Mt in 2016, and Rirhandzu, 1.3 Mt. In October 2016, production at Manungu and Vlakvarkfontein was at the rate of 1.7 Mt/yr and 1.2 Mt/yr, respectively. The company planned to increase its total production to about 10 Mt/yr between late 2019 and late 2021. Output at Manungu was expected to increase to 3 Mt/yr by 2018; Mbuyelo also planned to start mining at Welstand by late 2018. As of October 2016, the remaining life of the Manungu Mine was at least 30 years; the Welgemeend Mine, 15 years; the Rirhandzu Mine, 8 years; and the Vlakvarkfontein Mine, 3.5 years (Solomons, 2016; Revombo and others, 2018, p. 23–24).

Wescoal Holdings Ltd. operated the Elandspruit, the Intibane, and the Khanyisa Mines at the start of 2017. The company purchased Keaton Energy Holdings Ltd., which operated the Vanggatfontein Mine in Mpumalanga Province, in the third quarter of 2017. Total sales from the mines were at the rate of 4.8 Mt/yr between April and September. In December, run-of-mine production from Vanggatfontein was at the rate of 2.5 Mt/yr; Elandspruit, about 2 Mt/yr; Khanyisa, 1.2 Mt/yr; and Intibane, about 1 Mt/yr. Wescoal planned to make an investment decision on the Moabsvelden project, which could produce between 1.5 and 2 Mt/yr of run-of-mine coal, after January 2018 (Kotze, 2017c).

In the second half of 2017, Universal Coal plc of the United Kingdom's sales from the Kangala Mine and the New Clydesdale Colliery (NCC) in Mpumalanga Province were

4.7 Mt/yr compared with nearly 2.5 Mt/yr in the second half of 2016. Increased production was attributable to the reopening of NCC, which had been on care-and-maintenance status, in September 2016. Universal planned to supply 1.2 Mt/yr of thermal coal from NCC to Eskom for 7 years and 650,000 t/yr of thermal coal to export markets for 5 years (Tex Report, The, 2017d, g; 2018).

Menar Holding (Pty) Ltd. of Luxembourg held controlling interests in Canyon Coal (Pty) Ltd., which operated the Hakhano, the Phalanndwa, and the Singani Mines, and in Zululand Anthracite Colliery (Pty) Ltd. In 2016, total production at Menar's mines was 3.06 Mt compared with 3.42 Mt in 2015. In October 2017, Canyon was producing at the rate of 3.6 Mt/yr at Hakhano, Phalanndwa, and Singani compared with 2.4 Mt/yr in 2016. Canyon planned to increase its production to 10 Mt/yr by 2020 by opening the new Khanye, Springfield, and Ukufisa Mines (Solomons, 2017a; Revombo and others, 2018, p. 35–36).

Hosken Consolidated Coal (Pty) Ltd. produced a total of 4.22 Mt at the Mbali and the Palesa Mines in 2016 compared with 4.15 Mt in 2015. Eyethu Coal (Pty) Ltd. produced a total of 2.7 Mt at the Klipfontein, the Leeuwpoort, and the TNDB Mines in 2016 compared with 2.37 Mt in 2015. IchorCoal's production at the Vunene Mine decreased to 1.45 Mt in 2016 from 1.87 Mt in 2015. The company also planned to restart the Usutu Mine; production was expected to reach 1.6 Mt/yr by the fourth quarter of 2018 (Andrews, 2017a; Revombo and others, 2018, p. 21–22, 33–34, 40–41).

Resource Generation Ltd. (Resgen) of Australia planned to build the new Boikarabelo Mine in the Waterberg coalfield. The company hoped to obtain financing by the second quarter of 2018 and to start mining by the third quarter of 2020. Resgen planned to produce 15 Mt/yr of run-of-mine coal at Boikarabelo, of which 6.5 Mt/yr would be salable (Resource Generation Ltd., 2017, p. 5, 7, 20).

Coal of Africa Ltd. planned to start mining at the Makhado project at the Southpansberg coalfield in Limpopo Province in 2019. The company planned to produce 4 Mt/yr of run-of-mine coal, of which between 1.6 and 1.8 Mt/yr would be salable, during the estimated 29-year life of the mine. Thermal coal was expected to account for between 900,000 t/yr and 1 Mt/yr, and coking coal, between 700,000 and 800,000 t/yr. In December 2017, Coal of Africa changed its name to MC Mining Ltd. (Tex Report, The, 2017a).

Uranium.—AngloGold Ashanti mined uranium as a coproduct of gold. The company's production of uranium oxide (U_3O_8) from its Kopanang and Moab Khotsong Mines was about 360 t/yr in 2016 and 2017 (AngloGold Ashanti Ltd., 2018, p. 23).

In 2016, Sibanye-Stillwater produced 66 t of U_3O_8 from the Cooke Operations as a coproduct of gold. The company planned to recover uranium from tailings at WRTRP starting in 2018. Production could be as much as 910 t/yr of U_3O_8 between 2018 and 2039. In November 2017, the company proposed to sell its WRTRP assets to DRDGold in return for a 38% share in DRDGold (Sibanye Gold Ltd., 2017, p. 53; Pretorius and others, 2018, p. 2, 23; Sibanye-Stillwater Ltd., 2018, p. 26, 67).

In 2013, Peninsula Energy Ltd. of Australia completed a scoping study with favorable results of a new mine at its Karoo project. Planned production in the study was nearly 1,400 t/yr

of U_3O_8 . The company was engaged in a prefeasibility study in 2016. Contained resources at Karoo were estimated to be 25,800 t of U_3O_8 . In October 2017, the company announced plans to divest its interest in the project because of its plans to focus on mining uranium in the United States (Andrews, 2015b, 2016; Peninsula Energy Ltd., 2017).

MINERAL INDUSTRY HIGHLIGHTS IN 2018

In 2018, the GDP was about \$237 billion.¹ The mining and quarrying sector accounted for 7.2% of the GDP. The principal mineral exports were coal, ferrochromium, gold, iron ore, manganese ore, and PGMs (Minerals Council South Africa, 2019, p. 8, 22, 26, 28, 30, 32).

Production

In 2018, silicon metal production increased by an estimated 920%; slate, by an estimated 136%; ferrosilicon, by an estimated 104%; pyrophyllite, by 78%; mica, by 52%; tellurium, by an estimated 45%; industrial garnet, by 32%; fire clay, by 22%; selenium, by an estimated 17%; anthracite, by 15%; mined ruthenium, by 14%; magnesite, by an estimated 13%; and andalusite and metallurgical coal, by an estimated 11% each. Plastic clay production restarted in 2018. Flint clay production decreased by 56% in 2018; granite, by 47%; uranium, by an estimated 37%; feldspar, by 34%; refined copper, by 28%; mined copper and mined lead, by 27% each; silver, by 26%; brick clay, kaolin, and natural gas liquids, by 24% each; sodium sulfate, by 23%; shale for use in brick, 22%; natural gas, by 17%; mined gold and vermiculite, by 15% each; shale for use in cement, 14%; mined nickel and nickel matte, by 11% each; and titaniferous slag, by an estimated 10% (table 1; Galane, 2018; Precious Satsha, Administrative Officer, Department of Minerals and Energy of the Republic of South Africa, written commun., May 14, 2019).

Commodity Review

Metals

Chromium.—Glencore and Merafe mined 4 Mt of chromite in 2018 compared with 3.8 Mt in 2017. Total production at Glencore and Merafe's ferrochromium plants increased to 1.99 Mt in 2018 from 1.93 Mt in 2017 (Glencore plc, 2019, p. 15; Merafe Resources Ltd., 2019, p. 5).

In fiscal year 2018, Tharisa produced about 1.45 Mt of chromite at the Tharisa Mine compared with 1.33 Mt in fiscal year 2017. Northam produced 650,000 t of chromite in its fiscal year 2018 compared with 581,000 t in fiscal year 2017. The company planned to increase production to more than 1 Mt/yr by 2020. Lonmin's sales of chromite from UG2 ore increased to 1.7 Mt in 2018 from 1.37 Mt in 2017. Amplats produced 859,000 t of chromite from UG2 ore in 2018 compared with 978,800 t in 2017 (James, 2018; Lonmin plc, 2018a, p. 183; 2018b; 2019; Tharisa Minerals (Pty) Ltd., 2018, p. 3; Anglo American Platinum Ltd., 2019, p. 45).

¹Where necessary, values have been converted from South African rand (R) to U.S. dollars (US\$) at an annual average exchange rate of R13.258=US\$1.00 for 2018.

Gold.—Sibanye-Stillwater produced a total of 34,756 kg of gold at the Beatrix, the Driefontein, and the Kloof Mines and the Cooke Operations in 2018 compared with 43,634 kg in 2017. Most of the decrease was attributable to decreased production at the Driefontein Mine. The reopening of the Burnstone Mine was delayed until 2021 (Sibanye-Stillwater Ltd., 2019, p. 68–69, 71).

AngloGold Ashanti produced more than 8,200 kg of gold at the Mponeng Mine and 5,300 kg at its surface operations in 2018. In January and February 2018, mining at the Kopanang and the Moab Khotsong Mines was at the rate of 2,200 kg/yr and 7,300 kg/yr, respectively. AngloGold Ashanti sold the Moab Khotsong Mine to Harmony and the Kopanang Mine to Heaven-Sent at the end of February (AngloGold Ashanti Ltd., 2019, p. 93).

Gold Fields produced nearly 4,900 kg of gold at the South Deep Mine in 2018 compared with 8,700 kg in 2017; the production target for 2018 was 7,600 kg. The company planned to produce 6,000 kg at South Deep in 2019 (Seccombe, 2019).

Lead and Zinc.—South Africa's mined lead production decreased to about 35,000 t in 2018 from 48,150 t in 2017, and mined zinc, to 28,129 t from 30,778 t. Vedanta started zinc production at the Gamsberg Mine in November 2018. In May, the company started a feasibility study on a new smelter and refinery near the mine site that would produce 250,000 t/yr of zinc in the first phase of the mine's production and subsequently expand at the same time as the mine to 450,000 t/yr (table 1; Kotze, 2018b; Vedanta Resources Ltd, 2019).

Manganese.—In 2018, ARM produced 3.59 Mt of manganese ore at the Gloria and the Nchwaning Mines compared with 3.62 Mt in 2017. The company's ferromanganese production decreased to 151,000 t in 2018 from 162,000 t in 2017. ARM planned to increase the total (combined) capacity at Gloria and Nchwaning to 5 Mt/yr; the rampup to full capacity was unlikely to be completed until after 2023 (African Rainbow Minerals Ltd., 2018a, p. 14, 78, 87; 2019, p. 52).

Samancor Manganese produced 3.49 Mt of manganese ore at the Mamatwan and the Wessels Mines compared with 3.72 Mt in 2017. The company's output of manganese alloys increased to 127,000 t in 2018 from 120,000 t in 2017 (South32 Ltd., 2018, 2019).

Jupiter and Ntsimbitntle produced manganese ore from the Tshipi Borwa Mine at the rate of about 3.5 Mt/yr in 2018 compared with 3 Mt/yr between March and August 2017. UMK's production at the Kalahari deposit increased to about 2.7 Mt in 2018 from 2 Mt in 2017 and AML's production at Kudumane, to 1.6 Mt from 1.5 Mt (Burger, 2017; Jupiter Mines Ltd., 2018, p. 18; 2019, p. 10)

Nickel.—Amplats produced 23,100 t of refined nickel in 2018 compared with 26,100 t in 2017. More than 19,000 t of nickel was mined at company's South African PGM mining operations in 2018, which was nearly unchanged from that of 2017. Implats produced 16,400 t of refined nickel in 2018 compared with 17,100 t in 2017. ARM's nickel output at Nkomati decreased to 13,193 t in 2018 from 15,981 t in 2017 (African Rainbow Minerals, 2018b, p. 58; 2019, p. 68; Impala Platinum Holdings Ltd., 2018a, p. 57, 68; 2019, p. 65, 75; Anglo American Platinum Ltd., 2019, p. 45).

Platinum-Group Metals.—In 2018, Amplats produced about 145,500 kg of refined PGMs compared with 155,500 kg in 2017. Refined platinum production was 74,723 kg in 2018; refined palladium, 46,711 kg; refined rhodium, 9,107 kg; and refined iridium and ruthenium, a total of about 15,000 kg. At the start of February 2018, Amplats sold its interest in the Union Mine to Siyanda Resources (Pty) Ltd. Amplats increased its share in the Mototolo Platinum Mine to 100% at the end of October (Anglo American Platinum Ltd., 2019, p. 45, 56, 60).

Implats produced 95,799 kg of refined PGMs in 2018 compared with 92,685 kg in 2017. Platinum accounted for about 50,300 kg in 2018; palladium, 28,200 kg; rhodium, 6,400 kg; and iridium and ruthenium, a total of about 10,800 kg. ARM and Implats produced 10,285 kg at the Two Rivers Mine in 2018 compared with 11,252 kg in 2017 (African Rainbow Minerals, 2018b, p. 55; 2019, p. 66; Impala Platinum Holdings Ltd., 2018a, p. 57, 68; 2019, p. 65, 75).

In 2018, Lonmin produced 38,475 kg of refined PGMs compared with a revised 41,883 kg in 2017. Lonmin's mining operations produced 36,527 kg in 2018 compared with 38,522 kg in 2017. Platinum accounted for 19,156 kg of PGM mine production in 2018; palladium, 8,961 kg; ruthenium, 4,676 kg; rhodium, 2,757 kg; and iridium, 977 kg (Lonmin Plc, 2018a, p. 182–183; 2018b; 2019).

At the end of 2018, Wesizwe had not started mining at Bakubung. As of November, Platinum Group Metals had not completed its feasibility study on the Waterberg project (Bulbulia, 2019).

Silicon.—In March 2018, Eskom implemented its agreement to supply Ferroglobe's eMalahleni and Polokwane plants with power at a reduced rate. By late May, the plants were operating at full capacity (Slabbert, 2018).

Titanium and Zirconium.—In 2018, RBM's production of ilmenite and titanium slag decreased by nearly 20%. The company's operations were shut down during March and April and again in July because of a dispute with contractors (Holman, 2018).

Tronox produced 119,000 t of zircon at Namakwa Sands in 2018 compared with 121,000 t in 2017. Titanium slag production remained nearly unchanged at 180,000 t in 2018; rutile production increased to 32,000 t in 2018 from 30,000 t in 2017. The company's ilmenite production was estimated to be about 440,000 t in 2018 compared with 450,000 t in 2017 (Tronox Ltd., 2018, p. 33; 2019, p. 37).

Titanium slag production at Tronox's Fairbreeze Mine increased to 194,000 t in 2018 from 179,000 t in 2017; zircon, to 53,000 t from 46,000 t; and rutile, to 22,000 t from 19,000 t. Ilmenite production was estimated to be 480,000 t in 2018 compared with 410,000 t in 2017 (Tronox Ltd., 2018, p. 33; 2019, p. 37).

Vanadium.—In 2018, Glencore's production of V₂O₅ at Rhovan was nearly 9,200 t compared with 9,500 t in 2017. Bushveld produced 2,560 t of contained vanadium at Vametco in 2018; the company completed the expansion of its capacity to 3,750 t/yr in June. Bushveld planned to start construction of a further expansion to 5,000 t/yr in 2020. The company increased its share in Vametco to 74% in 2018 (Bushveld Minerals Ltd., 2019; Glencore plc, 2019, p. 5).

Industrial Minerals

Diamond.—De Beers mined a total of 4.68 million carats of diamond at Venetia and Voorspoed in 2018 compared with 5.21 million carats in 2017. Decreased production at Venetia was attributable to a safety stoppage and lower ore grades. Voorspoed was placed on care-and-maintenance status in the fourth quarter of 2018 (De Beers Group, 2019).

In 2018, Petra's production at the Finsch Mine decreased to 1.98 million carats from 2.15 million carats. Production increased at the Cullinan Mine to 1.59 million carats in 2018 from 974,000 carats in 2017 and decreased at the Koffiefontein Mine to about 53,000 carats from 55,000 carats. The Kimberley Ekapa Mining joint venture produced at the rate of nearly 1.1 million carats per year in the first half of 2018; Petra sold its share in the mine to joint-venture partner Ekapa Mining (Pty) Ltd. (Petra Diamonds Ltd., 2018a, p. 42; 2018b, p. 14–18; 2019, p. 12–14).

Garnet, Industrial.—In 2018, MCL produced 278,205 t of industrial garnet at the Tormin Mine compared with 211,394 t in 2017. The company planned to produce between 270,000 and 300,000 t in 2019 (Mineral Commodities Ltd., 2019, p. 15, 25).

Vermiculite.—In 2018, vermiculite production at the Palabora Mine decreased to 141,346 t from 166,084 t in 2017. Mining was expected to continue at Palabora until 2045 (Golder Associates Inc., 2019, p. 20).

Mineral Fuels

Coal.—At the start of March 2018, Anglo American sold its Kriel, New Denmark, and New Vaal Mines to Seriti Coal (Pty) Ltd. Total production at Kriel, New Denmark, and New Vaal was at the rate of 17 Mt/yr in January and February. Anglo American produced 29.2 Mt at its other South African coal operations in 2018 (Anglo American plc, 2019, p. 12).

Exxaro's coal production increased to 44.4 Mt in 2018 from 42.8 Mt in 2017. The company started production at the Leeuwan Life Expansion project, which would increase output of thermal coal by 2.7 Mt/yr, in the second half of 2018 (Exxaro Resources Ltd., 2019, p. 67, 80).

Outlook

Numerous producers are planning new mines and plants and capacity expansions of existing operations for cement, chromite, coal, copper, diamond, ferrovandium, fluorspar, gold, ilmenite, manganese ore, nickel, pig iron, PGMs, phosphate fertilizers, phosphate rock, rare-earths, rutile, uranium, vanadium, zinc, and zircon. Challenges to the industry included aging mines, decreasing ore grades, increasing costs, labor disputes, and low levels of exploration activity. Power costs increased by 17% per year between 2010 and 2016, and the costs of materials increased by more than 10% per year between 2012 and 2016 (Louw, 2017).

Increases in coal, iron ore, and manganese exports depend upon increased rail network capacity. Government-owned Transnet SOC Ltd. planned to increase the capacity of railways for coal export to 81 Mt/yr from 70 Mt/yr by 2019; capacity was expected to increase to 110 Mt/yr by 2023 and 125 Mt/yr by 2025. The capacity of the iron ore railways was expected

to increase to 71 Mt/yr from 60 Mt/yr by 2037. Transnet also planned to increase the capacity of the manganese railways to 16 Mt/yr from 6 Mt/yr by 2020. Manganese exports were expected to increase to more than 13 Mt/yr by 2030 (Transnet SOC Ltd., 2018, p. 52–54, 117).

Increased coal production also depended on the construction of new mines in the Waterberg coal field. Development of new mines could be constrained by the lack of infrastructure and water, the distances from domestic consumers and export terminals, the greater mine depths, and the relatively low quality of the coal. Reserves in the Central Basin, which produced most of South Africa's coal, could be depleted in 20 years (Prevost, 2017).

The long-term future of the domestic gold and PGM subsectors depended upon the adoption of mechanized mining methods. Increased mechanization could lead to an additional 590,000 kg of gold and 360,000 kg of platinum being mined (along with other PGMs as coproducts). In 2016, the Government budgeted \$10 million for the development of new mining technologies (Chamber of Mines of South Africa, 2018, p. 34).

In the PGM mining subsector, production could continue to shift away from platinum and towards other PGMs. Many PGM mining companies are producing less ore from the platinum-rich Merensky layer and more from the UG2 layer, which is rich in other PGMs. Production also has shifted towards the deposits in the Platreef, which are more palladium-rich.

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TABLE 1
SOUTH AFRICA: PRODUCTION OF MINERAL COMMODITIES¹

(Metric tons, gross weight, unless otherwise specified)

Commodity	2014	2015	2016	2017	2018
METALS					
Aluminum, metal, primary	745,000	695,000	701,000	716,000	714,000
Antimony, mine, concentrate, Sb content	815	302 ^r	350 ^r	--	--
Chromium, mine, chromite:					
44% to 48% Cr ₂ O ₃ thousand metric tons	2,043	2,127 ^r	1,935	2,010	1,101
Less than 44% Cr ₂ O ₃ do	11,995	13,528	12,772 ^r	14,538	16,516
Total do	14,000	15,700	14,700	16,500	17,600
Cobalt:					
Mine, Co content, recoverable ^c	3,000	2,900	2,300 ^r	2,300	2,300
Refinery, metal powder and sulfate	1,332	1,300	1,101	1,062	1,089
Copper:					
Mine, concentrate, Cu content	78,700 ^r	77,400	65,300 ^r	65,500	48,100
Smelter, primary	71,700 ^r	71,800	68,700 ^r	70,000	70,000
Refinery, primary	78,697	77,360	65,257 ^r	65,503	46,900
Ferroalloys:					
Ferrochromium thousand metric tons	3,719	3,685	3,596	3,700 ^c	3,900 ^c
Ferromanganese do.	787 ^r	512	335	257	236
Ferrosilicon do.	88	92 ^r	73 ^r	48	98 ^c
Ferrovaniadium ^c do.	19	15	7	7	7
Silicomanganese ² do.	228	210	144	160	164
Gold:					
Mine, Au content kilograms	151,622	144,504	142,202 ^r	137,133	117,150
Refinery ^{c,3,4} do.	370,000	340,000	300,000	300,000	300,000
Iron ore, mine:					
Gross weight thousand metric tons	80,759	72,806	66,456	74,857	74,264
Fe content do.	51,500	46,000	43,000 ^r	47,600	47,200
Iron and steel:					
Direct-reduced iron do.	1,612	1,125	702	925	835
Pig iron do.	4,402	4,464	4,311	4,352	4,611
Steel:					
Raw steel do.	6,412	6,417	6,141	6,301	6,327
Products, stainless do.	473	515	582	591	550
Lead:					
Mine, concentrate, Pb content	29,348	34,573	39,344	48,150	35,000 ^c
Refinery, secondary ^c	52,000	52,000	54,000	54,000	56,000
Manganese:					
Mine, metallurgical grade:					
Gross weight:					
30% to 40% Mn thousand metric tons	9,776	7,340 ^r	8,290 ^r	9,932	10,510
40% to 45% Mn do.	1,703	2,499	1,082	2,884	2,189
45% to 48% Mn do.	2,572	1,194	1,434	1,209	2,219
More than 48% Mn do.	--	--	--	119	--
Total	14,100	11,000 ^r	10,800 ^r	14,100	14,900
Mn content ^c do.	5,500 ^r	4,300 ^r	4,200 ^r	5,500	5,800
Refinery, metal, electrolytic ^c do.	30	30	30	30	30
Nickel:					
Mine, Ni content	54,956	56,689	48,994	48,383	43,236
Smelter, matte, for domestic use ^c	38,000 ^r	39,000 ^r	38,000 ^r	38,000	34,000
Refinery, metal, electrolytic	39,356 ^r	41,910 ^r	42,332 ^r	42,362	39,500
Products, chemicals	3,500 ^c	5,300 ^c	4,743 ^r	4,966	5,281

See footnotes at end of table.

TABLE 1—Continued
SOUTH AFRICA: PRODUCTION OF MINERAL COMMODITIES¹

(Metric tons, gross weight, unless otherwise specified)

Commodity	2014	2015	2016	2017	2018
METALS—Continued					
Platinum-group metals:					
Mine, elemental content:					
Iridium kilograms	4,231	6,230	6,624	5,973	6,357
Palladium do.	58,410	82,691	76,273	80,132	80,629
Platinum do.	93,991	139,125	133,241	131,242	137,053
Rhodium do.	12,916	18,722	19,237	18,431	18,608
Ruthenium do.	18,896	28,747	28,278	24,486	27,999
Total do.	188,000	276,000	264,000	260,000	271,000
Refinery:					
Palladium do.	67,646 ^r	89,815 ^r	88,719 ^r	93,126	89,299
Platinum do.	109,883 ^{5,r}	151,156 ^r	150,300 ^r	154,295	155,915
Rhodium do.	13,940 ^r	18,220 ^r	19,360 ^r	19,830	18,550
Other ⁶ do.	25,670 ^r	34,800 ^r	37,450 ^r	34,840	31,800
Total do.	217,000 ^r	294,000 ^r	296,000 ^r	302,000	296,000
Selenium, anode slimes, Se content ^c do.	13,000 ^r	14,000 ^r	14,000 ^r	12,000	14,000
Silicon, metal thousand metric tons	47	46 ^r	27 ^r	5	51 ^c
Silver, mine, Ag content kilograms	49,220	51,861	55,622 ^r	62,536	46,467
Tellurium, refinery, Te content, anode slimes ^c	5,900 ^r	6,600 ^r	6,700 ^r	5,300	7,700
Titanium:					
Mineral concentrates:					
Ilmenite and leucoxene ^c thousand metric tons	2,300 ^r	1,700 ^r	2,000 ^r	2,200	2,000
Rutile ^c do.	100 ^r	95 ^r	100	120	110
Total do.	2,400 ^r	1,800 ^r	2,100 ^r	2,320	2,110
Titaniferous slag ^c do.	1,100 ^r	940 ^r	820 ^r	1,000	900
Vanadium, V content	21,582	17,788	8,163 ^r	7,959	7,700
Zinc, mine, concentrate, Zn content	26,141	29,040	26,695	30,778	28,129
Zirconium, baddeleyite and zircon concentrate	398,101	377,767 ^r	377,430 ^r	361,813	350,000 ^c
INDUSTRIAL MINERALS					
Cement, hydraulic ⁷ thousand metric tons	12,068	12,992	13,000 ^c	14,000 ^c	15,000 ^c
Clay:					
Bentonite	171,119	165,535	148,742	165,141	173,486
Brick clay ⁷ thousand metric tons	6,687	6,945 ^r	6,668 ^r	7,460	5,661
Fire clay	239,906	751,711	985,333	430,650	525,853
Flint, raw and calcined	26,891	19,785	10,203	10,064	4,421
Fuller's earth, attapulgite	17,668	17,627	16,374	18,333	17,121
Kaolin	27,258	20,126 ^r	21,141	31,295	23,724
Plastic clay	268	4,554	--	--	2,092
Diamond, gem and industrial thousands carats	8,059	8,233	8,306 ^r	9,698	9,911
Feldspar, mine	102,541	130,184	127,872 ^r	116,705	76,803
Fluorspar, mine: ^c					
Acid grade	150,000	110,000	146,000 ^r	209,000	220,000
Metallurgical grade	14,000	11,000 ^r	31,000 ^r	14,000	22,000
Total	164,000	121,000 ^r	177,000	223,000	242,000
Garnet, industrial	254,816	284,990	254,693 ^r	211,394	278,205
Gypsum, mine	376,223	231,688	262,457 ^r	320,685	313,909
Kyanite and related minerals, andalusite	172,657	190,000 ^c	160,000 ^{r,c}	180,000 ^c	200,000 ^c
Lime ⁷ thousand metric tons	1,260 ^r	1,119 ^r	1,131 ^r	1,221	1,311
Magnesite, mine	12,335	40,000 ^{r,c}	60,000 ^{r,c}	80,000 ^c	90,000 ^c
Mica, ground and scrap	83	29	8	21	32
Nitrogen, ammonia, N content ^c	620,000	620,000	620,000	620,000	620,000
Perlite	1,100	1,000 ^c	1,000 ^c	1,000 ^c	1,000 ^c

See footnotes at end of table.

TABLE 1—Continued
SOUTH AFRICA: PRODUCTION OF MINERAL COMMODITIES¹

(Metric tons, gross weight, unless otherwise specified)

Commodity	2014	2015	2016	2017	2018	
INDUSTRIAL MINERALS—Continued						
Phosphate rock:						
Gross weight	thousand metric tons	2,011	1,852	1,697	2,079	2,058
P ₂ O ₅ content	do.	743	685	636 ^r	769	761
Salt		493,798	517,159	473,339 ^r	492,844	476,107
Sand and gravel, industrial, unspecified	thousand metric tons	2,605	2,278 ^r	1,886 ^r	2,401	2,287
Sodium, compounds, sodium sulfate, mine		51,751	38,374	26,248	57,493	44,008
Stone, sand, and gravel, construction:						
Sand and gravel: ⁷						
Aggregate	thousand metric tons	47,972	48,991 ^r	51,035 ^r	52,415	47,819
Sand	do.	14,220	14,788 ^r	14,594 ^r	14,357	13,546
Stone:						
Crushed:						
Limestone, including dolomite	do.	21,776	22,927 ^r	23,355 ^r	23,765	22,802
Shale: ⁷						
For brickmaking	do.	785	963 ^r	1,363 ^r	1,090	849
For cement	do.	404	354	395 ^r	356	305
Dimension:						
Granite, including norite ⁷		233,420	263,333 ^r	307,540 ^r	286,147	151,443
Slate		19,051	6,497 ^r	60 ^r	848	2,000 ^e
Sulfur, byproduct, S content:						
Metallurgy		102,438	108,579 ^r	85,114 ^r	62,824	58,000 ^e
Petroleum		174,580	169,051 ^r	195,716 ^r	193,786	181,000 ^e
Total		277,000	278,000 ^r	281,000	257,000	239,000
Talc and pyrophyllite:						
Pyrophyllite, wonderstone		22,500	17,352 ^r	19,114	55,048	98,245
Talc		4,827	4,497	4,462	3,728	3,897
Vermiculite		143,007	138,290	166,483	166,084	141,346
Wollastonite ^c		1,100 ^r	1,100 ^r	1,100 ^r	1,100	1,100
MINERAL FUELS AND RELATED MATERIALS						
Coal, marketable:						
Anthracite	thousand metric tons	3,517	3,395	2,635 ^r	2,886	3,317
Bituminous ^c	do.	255,000	246,000 ^r	244,000 ^r	246,000	246,000
Metallurgical ^c	do.	3,400	2,700 ^r	4,000 ^r	3,500	3,900
Coke, metallurgical, marketable	do.	1,981 ^r	2,009 ^r	1,940 ^r	1,900 ^e	1,900 ^e
Natural gas	million cubic meters	1,184 ^r	1,464 ^r	901 ^r	822	685
Petroleum:						
Natural gas liquids	thousand 42-gallon barrels	924	738	403 ^r	324	247
Refinery:						
Distillate fuel oil	do.	51,974 ^r	46,483 ^r	56,547 ^r	57,000 ^e	57,000 ^e
Gasoline	do.	49,440 ^r	47,623 ^r	54,797 ^r	55,000 ^e	55,000 ^e
Jet fuel	do.	12,886 ^r	18,168 ^r	17,533 ^r	18,000 ^e	18,000 ^e
Kerosene	do.	3,448	3,548 ^r	3,602 ^r	3,600 ^e	3,600 ^e
Liquefied petroleum gas	do.	2,494	3,689 ^r	3,526 ^r	3,500 ^e	3,500 ^e
Residual fuel oil	do.	20,806	25,248 ^r	24,009 ^r	24,000 ^e	24,000 ^e
Other, including lubricants and greases	do.	4,023 ^r	3,636 ^r	4,401 ^r	4,400 ^e	4,400 ^e
Total	do.	145,000 ^r	148,000 ^r	164,000 ^r	166,000 ^e	166,000 ^e
Uranium, mine, U content		566	448	382	310 ^e	196

^eEstimated. ^rRevised. do. Ditto. -- Zero.

¹Table includes data available through December 16, 2019. All data are reported unless otherwise noted. Totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²Reported by the International Manganese Institute.

³Data are for the Rand Refinery (Pty) Ltd.

⁴Production is based on fiscal year, with a starting date of October 1 of the year shown.

⁵Includes sales.

⁶May include small amounts of gold.

⁷Sales.

TABLE 2
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 2018

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Aggregates	AfriSam Consortium (Pty) Ltd.	18 mines in Gauteng, KwaZulu-Natal, Mpumalanga, and Western Cape Provinces	10,000.
Do.	Lafarge Mining South Africa (Pty) Ltd. (LafargeHolcim Ltd., 76.3%)	21 mines in Eastern Cape, Free State, KwaZulu-Natal, Limpopo, Mpumalanga, and Western Cape Provinces	6,000. ^e
Do.	Pretoria Portland Cement Co. (Pty) Ltd. (Barloworld Trust Co. Ltd., 68%)	Mines at Francistown, Kgale, Laezonia, and Mooiplaas	3,000.
Aluminum	South32 Ltd.	Hillside smelter at Richards Bay	726.
Andalusite	Imerys South Africa (Pty) Ltd. (Imerys Group)	Annesley and Segorong Mines at Penge, and Thabazimbi Mine near Thabazimbi	250. ^e
Do.	Andalusite Resources (Pty) Ltd. [African Mineral Trading and Exploration (Pty) Ltd.]	Maroeloesfontein Mine, near Thabazimbi, Northern Cape Province	70.
Antimony	metric tons Stibium Mining (Pty) Ltd.	Cons Murch Mine near Gravelotte ¹	7,000.
Cement	Pretoria Portland Cement Co. (Pty) Ltd. (Barloworld Trust Co. Ltd., 68%)	De Hoek, Dwaalboom, Hercules, Jupiter, Riebeeck, and Slurry plants	7,000.
Do.	AfriSam Consortium (Pty) Ltd.	Dudfield, Roodepoort, and Ulco plants	4,600.
Do.	Lafarge Industries South Africa (Pty) Ltd. (LafargeHolcim Ltd., 76.3%)	Lichtenburg plant in North West Province	3,200.
Do.	Dangote Cement South Africa (Pty) Ltd. (Dangote Industries Ltd., 64%)	Plants near Delmas in Mpumalanga Province and at Lichtenburg	2,900.
Do.	Natal Portland Cement Co. (Pty) Ltd. (Cimentos de Portugal SGPS, S.A., 98%)	Simuma plant in KwaZulu-Natal Province	1,800.
Do.	Mamba Cement Company (Pty) Ltd	Plant near Northam	1,000.
Chromite	Glencore plc, 79.5%, and Merafe Resources Ltd., 20.5%	Magareng Mine in Mpumalanga Province	1,200.
Do.	do.	Thorncliffe Mine at Steelpoort	995.
Do.	do.	Kroondal Mine at Rustenburg	850.
Do.	do.	Helena Mine at Steelpoort	825.
Do.	do.	Waterval Mine in North West Province	650.
Do.	do.	Boshoek Mine in North West Province	NA.
Do.	Samancor Chrome (Pty) Ltd. (International Mineral Resources BV, 70%)	Eastern Chrome Mines in Steelpoort Valley, Mpumalanga Province	2,000.
Do.	do.	Western Chrome Mines in North West Province	1,500.
Do.	Tharisa Minerals (Pty) Ltd.	Tharisa Mine in North West Province	1,920.
Do.	Hernic Ferrochrome (Pty) Ltd. (Mitsubishi Corp., 51%)	Bokone and Morula Mines near Brits	1,500.
Do.	Lonmin plc	Marikana Mines (Eastern Platinum, Karee, and Western Platinum) and Pandora Mine	1,500. ^e
Do.	Assore Ltd.	Dwarsrivier Mine in Mpumalanga Province	1,400.
Do.	Nkomati Joint Venture (African Rainbow Minerals Ltd., 50%, and MMC Norilsk Nickel, 50%)	Nkomati Mine in Mpumalanga Province	900.
Do.	Two Rivers Platinum Mine (Pty) Ltd. (African Rainbow Minerals Ltd., 55%, and Impala Platinum Holdings Ltd., 45%)	Two Rivers Platinum Mine near Steelpoort	320. ^e
Do.	Anglo American Platinum Ltd. (Amplats) (Anglo American plc, 74.1%)	Plant at Amandelbult Mine near Northam	700.
Do.	Anglo American Platinum Ltd. (Amplats) and Siyanda Resources	Masa Plant at Union Mine near Northam	330.
Do.	Sibanye-Stillwater Ltd.	Waterval Plant near Rustenburg Mine	820. ^e
Do.	ASA Metals (Pty) Ltd. (Sinosteel Corp., 60%, and Limpopo Economic Development Enterprise, 40%)	Dilokong Mine, near Burgersfort in Mpumalanga Province ¹	800.

See footnotes at end of table.

TABLE 2—Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 2018

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Chromite—Continued	Northam Platinum Ltd.	Booysendal North and Zondereinde Mines	660. ^c
Do.	Afarak Group Oyj	Mecklenburg, Stellite, and Vlakpoort Mines	500. ^c
Do.	Bayer (Pty) Ltd.	Rustenburg Chrome Mine	450.
Do.	Impala Chrome (Pty) Ltd. [Impala Platinum Holdings Ltd. (Implats), 65%]	Impala Mines near Rustenburg	220. ^c
Coal	Exxaro Resources Ltd. (BEE Holdco, 52.3%)	Grootegeluk Mine in Limpopo Province	33,400.
Do.	do.	Matla Mine in Mpumalanga Province	14,000.
Do.	do.	Arnot Mine in Mpumalanga Province ¹	5,000.
Do.	do.	Exxaro Coal Central in Mpumalanga Province	4,500. ^c
Do.	do.	Leeuwpan Mine in Mpumalanga Province	4,200. ^c
Do.	do.	North Block Complex in Mpumalanga Province	3,300.
Do.	Exxaro Resources Ltd., 50%, and Anglo American plc, 50%	Mafube Mine near Sasolburg	4,200.
Do.	Sasol Ltd.	Syferfontein Mine near Secunda	11,300.
Do.	do.	Twistdraai Mine near Secunda	8,900.
Do.	do.	Middelbult Mine near Secunda	7,900.
Do.	do.	Bosjesspruit Mine near Secunda	7,100.
Do.	do.	Impumelelo Mine near Secunda	3,600.
Do.	do.	Brandspruit Mine near Secunda	3,300.
Do.	do.	Sigma Mine near Sasolburg	1,900.
Do.	South32 Ltd.	Middelburg and Wolverkrans Mines in Mpumalanga Province	17,000.
Do.	do.	Khutala Mine in Mpumalanga Province	12,000.
Do.	do.	Klipspruit Mine in Mpumalanga Province	7,000.
Do.	Anglo Coal Ltd. (Anglo American plc, 100%)	Khwezela Mine near Witbank	8,700.
Do.	do.	Zibulo Mine in Mpumalanga Province	8,000.
Do.	do.	Goedehoop Mine in Mpumalanga Province	7,500.
Do.	do.	Isibonelo Mine in Mpumalanga Province	5,000.
Do.	do.	Greenside Mine near Witbank	5,000. ^c
Do.	Glencore plc, 79.8%, and African Rainbow Minerals Ltd., 20.2%	Impunzi Complex and Tweefontein Complex at Witbank	18,000. ^c
Do.	do.	Goedevonden Complex at Witbank	7,700.
Do.	Izimpiwa Coal (Pty) Ltd. (Phembani Group, 50.01%, and Glencore plc, 49.99%)	Corobrik, Graspan, and Springlake Mines	4,500. ^c
Do.	Umcebo Mining Ltd. (Glencore plc, 48.7%)	Wonderfontein Mine near Belfast	3,500. ^c
Do.	Seriti Coal (Pty) Ltd.	New Vaal Mine near Vanderbijlpark	18,000.
Do.	do.	Kriel Mine in Mpumalanga Province	10,000.
Do.	do.	New Denmark Mine in Mpumalanga Province	5,000.
Do.	Optimum Coal Mine (Pty) Ltd. [Tegeta Exploration & Resources (Pty) Ltd., 67.6%]	Optimum Complex in Mpumalanga Province ¹	11,000.
Do.	do.	Koornfontein Mine in Mpumalanga Province ¹	3,000. ^c
Do.	Tegeta Exploration & Resources (Pty) Ltd.	Brakfonten Mine in Mpumalanga Province ¹	1,400. ^c
Do.	Mbuyelo Coal (Pty) Ltd. (Mbuyelo Group, 49%, and IchorCoal N.V., 45%)	Welgemeend Mine in Mpumalanga Province	3,100. ^c
Do.	do.	Manungu Mine in Mpumalanga Province	1,900. ^c
Do.	do.	Rirhandzu Mine in Mpumalanga Province	1,500. ^c
Do.	do.	Vlakovarkfontein Mine near Kendal	1,400. ^c
Do.	Wescoal Holdings Ltd.	Vanggatfontein Mine in Mpumalanga Province	2,640.
Do.	do.	Elandspruit Mine in Mpumalanga Province	2,000.
Do.	do.	Khanyisa Mine in Mpumalanga Province	1,000.
Do.	do.	Intibane Mine in Mpumalanga Province	1,000.
Do.	Burgh Group Holdings	Leeuwpoort, Mooifontein, and other mines	5,000. ^c

See footnotes at end of table.

TABLE 2—Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 2018

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners		Location of main facilities	Annual capacity
Coal—Continued	Universal Coal plc		Kangala Mine in Mpumalanga Province	2,900. ^e
Do.	do.		New Clydesdale Colliery in Mpumalanga Province	2,100. ^e
Do.	Canyon Coal (Pty) Ltd. [Menar Holding (Pty) Ltd.]		Hakhano, Phalannndwa, and Singani Mines in Mpumalanga Province	4,000. ^e
Do.	Zululand Anthracite Colliery (Pty) Ltd. [Menar Holding (Pty) Ltd., 76%]		Mine near Emakhalathini	870. ^e
Do.	Hosken Consolidated Coal (Pty) Ltd.		Palesa Mine in Mpumalanga Province	3,300. ^e
Do.	do.		Mbali Mine in Mpumalanga Province	1,500. ^e
Do.	Vunene Mining (Pty) Ltd. (IchorCoal N.V., 76%)		Vunene Mine in Mpumalanga Province	2,100. ^e
Do.	do.		Mbali Mine in Mpumalanga Province	1,600.
Do.	Eyethu Coal (Pty) Ltd.		Klipfontein, Leeuwoort, and TNDB Mines in Mpumalanga Province	3,100. ^e
Do.	Kangra Group Pty. Ltd. (Shanduka Resources (Pty) Ltd., 30%)		Savmore Mine in Mpumalanga Province	3,000.
Do.	Imbawula Group		Mpumalanga Division (Spitzkop and Tselentis Mines) at Breyten and Ermelo	2,800.
Do.	Kuyasa Mining (Pty) Ltd.		Delmas Mine	2,000.
Cobalt:				
Mine	metric tons	Nkomati Joint Venture	Nkomati Mine in Mpumalanga Province	1,200. ^e
Do.	do.	Anglo American Platinum Ltd. (Amplats) (Anglo American plc, 78%)	Amandelbult, Mogalakwena, Union, and other mines in Bushveld Complex	500. ^e
Refined	do.	Anglo American Platinum Ltd. (Amplats)	Rustenburg Base Metal Refiners	700. ^e
Do.		Impala Platinum Holdings Ltd. (Implats)	Base metals refinery	NA.
Copper:				
Mine		Palabora Mining Co. Ltd.	Palabora Mine at Phalaborwa	65. ²
Do.		Anglo American Platinum Ltd. (Amplats)	Amandelbult, Mogalakwena, Union, and other mines in Bushveld Complex	13. ²
Do.		Nkomati Joint Venture	Nkomati Mine in Mpumalanga Province	10
Do.		Impala Platinum Holdings Ltd. (Implats)	Impala Rustenburg Mine near Phokeng	7. ²
Do.		Black Mountain Mineral Development Co. (Pty) Ltd. (Vedanta Resources plc, 74%)	Black Mountain Mine near Aggeneys in Northern Cape Province	6. ²
Smelter		Palabora Mining Co. Ltd.	Smelter at Phalaborwa	110. ²
Do.		Anglo American Platinum Ltd. (Amplats)	Rustenburg Smelter	11. ²
Do.		Impala Platinum Ltd. (Implats)	Smelter near Phokeng	7. ²
Refined		Palabora Mining Co. Ltd.	Refinery at Phalaborwa	140. ²
Do.		Anglo American Platinum Ltd. (Amplats)	Rustenburg Base Metal Refiners	13. ²
Do.		Lonmin plc	Base metals refinery and scrap plant	9. ²
Do.		Impala Platinum Holdings Ltd. (Implats)	Base metals refinery	7. ²
Diamond	thousand carats	De Beers Consolidated Mines Ltd. (DeBeers Group of Companies, 76%)	Venetia Mine in Northern Cape Province	7,500.
Do.	do.	do.	Voorspoed Mine in Free State Province	800.
Do.	do.	Petra Diamonds Ltd.	Finsch Mine in Northern Cape Province	2,000.
Do.	do.	do.	Cullinan Mine in Gauteng Province	1,100. ^e
Do.	do.	do.	Koffiefontein Mine in Free State Province	60. ^e
Do.	do.	Ekapa Mining (Pty) Ltd.	Kimberley Mine in Northern Cape Province	800.
Do.	do.	DiamondCorp plc	Lace Mine ¹ near Kroonstad	500.
Do.	do.	Jagersfontein Developments (Pty) Ltd.	Jagersfontein Mine in Free State Province	250. ^e
Do.	do.	Trans Hex Group	Namaqualand Mine	130. ^e
Do.	do.	do.	Baken and other mines	60. ^e
Do.	do.	Batla Minerals SA	Superkolong Diamond operations	130. ^e
Fluorspar		Vergenoeg Mining Corp. (Pty) Ltd. (Minerales Y Productos Derivados SA, 85%)	Vergenoeg Mine at Rust de Winter	250.

See footnotes at end of table.

TABLE 2—Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 2018

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners		Location of main facilities	Annual capacity
Gamet, industrial	Mineral Commodities Ltd. (MCL)		Tormin Mine in Western Cape Province	300.
Gold:				
Mine	kilograms	Sibanye-Stillwater Ltd.	Driefontein Mine in Gauteng Province	18,000. ^c
Do.	do.	do.	Kloof Mine in Gauteng Province	18,000. ^c
Do.	do.	do.	Beatrix Mine in Free State Province	11,000. ^c
Do.	do.	do.	Cooke Operations in Gauteng Province	7,500. ^c
Do.	do.	do.	Burnstone Mine ¹ in Mpumalanga Province	3,100.
Do.	do.	Harmony Gold Mining Company Ltd.	Tshepong Mine in Free State Province	9,400.
Do.	do.	do.	Great Noligwa and Moab Khotsoeng Mines	8,500. ^c
Do.	do.	do.	Kusasaletu Mine in Gauteng Province	4,400.
Do.	do.	do.	Kalgold, Phoenix, and other surface operations	3,000.
Do.	do.	do.	Doornkop Mine in Gauteng Province	2,900.
Do.	do.	do.	Target 1 Mine in Free State Province	2,900.
Do.	do.	do.	Bambanani Mine in Free State Province	2,600.
Do.	do.	do.	Masimong Mine in Free State Province	2,200.
Do.	do.	do.	Joel Mine in Free State Province	2,100.
Do.	do.	do.	Unisel Mine in Free State Province	1,800.
Do.	do.	AngloGold Ashanti Ltd. (Anglo American plc, 41.8%)	Mponeng Mine in Gauteng Province	10,000.
Do.	do.	do.	Tau Tona Mine ¹ in Gauteng Province	8,100.
Do.	do.	do.	Surface Operations in North West Province	7,000. ^c
Do.	do.	Gold Fields Ltd.	South Deep Mine in Gauteng Province	15,500.
Do.	do.	Heaven-Sent SA Sunshine Investment Company Ltd.	Kopanang Mine in Free State Province	9,000.
Do.	do.	Pan African Resources plc	Barberton Mine in Mpumalanga Province	3,000.
Do.	do.	do.	Evander Mine in Mpumalanga Province	3,000.
Do.	do.	do.	Barberton Tailings Retreatment Project	930.
Do.	do.	do.	Evander Tailings Retreatment Project	930.
Do.	do.	DRDGold Ltd.	Ergo operations near Johannesburg	5,000. ^c
Do.	do.	Gold One International Ltd.	Modder East Mine in Gauteng Province	4,700.
Do.	do.	Village Main Reef Ltd.	Tau Lekoa Mine	3,200. ^c
Do.	do.	Anglo American Platinum Ltd. (Amplats)	Amandelbult, Mogalakwena, Union, and other mines in Bushveld Complex	3,000. ^c
Refined	metric tons	Rand Refinery (Pty) Ltd. (AngloGold Ashanti Ltd., 53%, and Gold Fields Ltd., 33%)	Germiston, Gauteng Province	600.
Iron and steel:				
Iron ore	Kumba Iron Ore Ltd.		Sishen Mine at Sishen	38,000.
Do.	do.	do.	Kolomela Mine in Northern Cape Province	14,000.
Do.	Assmang (Pty) Ltd.		Khumani Mine in Northern Cape Province	16,000.
Do.	do.	do.	Beeshoek Mine near Postmasburg	4,000.
Do.	Palabora Mining Co. Ltd.		Palabora Mines at Phalaborwa	10,000.
Do.	Evraz Highveld Steel and Vanadium Corp. Ltd. (Evraz Group S.A., 79%)		Mapochs Mine at Roossenekal ¹	2,700.
Do.	Sedibeng Iron Ore (Pty) Ltd. [Black Ginger (Pty) Ltd., 64%]		Mine at Postmasburg in Northern Cape Province	2,000
Do.	Afrimat Ltd.		Diro Mine in Northern Cape Province	1,000.
Pig iron	Richards Bay Minerals (RBM) (Rio Tinto plc, 74%, and Blue Horizon Investments, 24%)		Smelter at Richards Bay	550.
Ferroalloys	Glencore plc, 79.5%, and Merafe Resources Ltd., 20.5%		Lion plant at Steelpoort	720 ferrochromium.
Do.	do.	do.	Wonderkop plant at Marikana	553 ferrochromium.
Do.	do.	do.	Rustenburg plant at Rustenburg	430 ferrochromium.
Do.	do.	do.	Lydenburg plant at Lydenburg	396 ferrochromium.
Do.	do.	do.	Boshhoek plant at Boshhoek	240 ferrochromium.

See footnotes at end of table.

TABLE 2—Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 2018

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Iron and steel:—Continued			
Ferroalloys—Continued	Samancor Chrome (Pty) Ltd.	Plants at Middelburg, Steelpoort, and Witbank	1,200 ferrochromium.
Do.	do.	Buffelsfontein plant in North West Province	267 ferrochromium.
Do.	Samancor Chrome (Pty) Ltd. and Sinosteel Corp.	Plant near Pietersburg, Northern Cape Province ¹	400 ferrochromium.
Do.	Heric Ferrochrome (Pty) Ltd.	Plant at Brits	420 ferrochromium.
Do.	Traxys Group	Plant at Richards Bay ¹	150 ferrochromium.
Do.	Assmang (Pty) Ltd.	Cato Ridge plant in KwaZulu-Natal Province	300 ferromanganese.
Do.	do.	Machadodorp plant in Mpumalanga Province ¹	290 ferromanganese
Do.	Samancor Manganese (Pty) Ltd. (South32 Ltd., 60%)	Plant at Meyerton	500 ferromanganese.
Do.	Transalloys (Pty) Ltd. (Renova Group)	Plant at Witbank	180 silicomanganese.
Do.	Ferroglobe plc	New Castle plant at Ballengeich ¹	45 ferrosilicon.
Do.	do.	eMalahleni plant	40 ferrosilicon.
Do.	metric tons Vanchem Vanadium Products (Pty) Ltd. (Duferco Group)	Plant at Witbank ¹	12,500 ferrovanadium.
Do.	do. Glencore plc	Rhovan plant at Brits	6,000 ferrovanadium.
Do.	Afarak Group Oyj	Mogale plant	110 ferroalloys.
Steel	ArcelorMittal South Africa Ltd.	Plant at Vanderbijlpark	2,900 crude steel.
Do.	do.	Plants at Newcastle and Vereeniging	1,900 crude steel.
Do.	do.	Plant at Saldanha	1,300 crude steel.
Do.	Evraz Highveld Steel and Vanadium Ltd.	Plant at Witbank ¹	815 crude steel.
Do.	Columbus Stainless (Pty) Ltd. (Acerinox S.A., 76%)	Stainless steel plant at Middelburg	750 crude steel.
Do.	Scaw Metals Group	Germiston plant, Johannesburg	600 crude steel.
Do.	Davsteel Division (Cape Gate Pty. Ltd.)	Vanderbijlpark plant, Gauteng	485 crude steel; 460 rolled steel.
Do.	Cape Town Iron & Steel Works (Pty) Ltd. (Cisico)	Kuils River plant, Cape Town ¹	300 crude steel; 300 billet.
Do.	Duferco Steel Processing Ltd.	Cold-rolled slab steel plant at Saldanha Bay	240 rolled steel.
Lead, mine	Vedanta Resources plc	Black Mountain Mine near Aggeneys in Northern Cape Province	55.
Lime	PPC Lime Ltd. (Pretoria Portland Cement Company Ltd.)	Plant at Lime Acres	1,200.
Do.	Idwala Lime (Idwala Industrial Holdings)	Plant at Danielskuil	1,000.
Do.	Inca Lime (Pty) Ltd. (Inca Mining (Pty) Ltd.)	Plant at Immerpan, Limpopo Province	100.
Magnesite	Chamotte Holdings	Strathmore Magnesite Mine	100. ^e
Manganese	Hotazel Manganese Mines (Pty) Ltd. (South32 Ltd., 60%)	Mamatwan Mine near Hotazel	3,500 ore.
Do.	do.	Wessels Mine near Hotazel	1,000 ore.
Do.	United Manganese of Kalahari (Pty) Ltd. (UMK) (Majestic Silver Trading 40 (Pty) Ltd., 51%, and Renova Group, 49%)	Russik Mine in Northern Cape Province	4,000 ore.
Do.	Assmang (Pty) Ltd.	Nchwaning Mine near Black Rock	3,200 ore.
Do.	do.	Gloria Mine near Black Rock	600 ore.
Do.	Tshipi e Ntle Manganese Mining (Pty) Ltd. (Ntsimbitntle Mining (Pty) Ltd., 50.1%, and Jupiter Mines Ltd., 49.9%)	Tshipi Borwa Mine in Northern Cape Province	3,600 ore.
Do.	Asia Minerals Ltd. (AML)	Kudumane Mine at Fort York	1,500 ore.
Do.	Guangxi N&H Metallurgy Development Co.	Lomoteng Mine	600 ore.
Do.	Manganese Metal Co. Pty. Ltd. [Samancor Manganese (Pty) Ltd., 51%]	Electrolytic plant at Nelspruit	30 manganese metal.

See footnotes at end of table.

TABLE 2—Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 2018

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners		Location of main facilities	Annual capacity
Nickel	Anglo American Platinum Ltd. (Amplats)		Amandelbult, Mogalakwena, Union, and other mines in Bushveld Complex	33 mine. ^c
Do.	do.		Rustenburg Base Metal Refiners	33 refined.
Do.	Nkomati Joint Venture		Nkomati Mine in Mpumalanga Province	21 mine.
Do.	Impala Platinum Ltd.		Impala Rustenburg Mine near Phokeng	6 mine. ^c
Do.	do.		Base metals refinery	16 refined. ^c
Do.	Lonmin plc		Marikana and Pandora Mines near Marikana	4 mine. ^c
Do.	do.		Base metals refinery	5 sulfate. ^c
Nitrogen, ammonia	Sasol Ltd.		Plants at Sasolburg and Secunda	660.
Petroleum:				
Crude	thousand 42-gallon barrels	Petroleum Oil and Gas Corporation of South Africa (Government, 100%)	Oribi and Oryx fields ¹	730.
Refined	do.	South African Petroleum Refineries (Shell SA Energy, 50%, and BP Southern Africa, 50%)	Sapref refinery in Durban	65,700.
Do.	do.	Engen Ltd. (62%)	Enref refinery in Durban	43,800.
Do.	do.	National Petroleum Refiners of South Africa Pty. Ltd. (Sasol Ltd., 63.6%)	Natref refinery in Sasolburg	39,400.
Do.	do.	Caltex Oil SA (Pty) Ltd.	Chevref refinery in Cape Town	36,500.
Phosphate rock	Phosphate Development Corp. Ltd. [Foskor (Pty) Ltd.]		Foskor Mine and plant at Phalaborwa	2,800 phosphate rock.
Phosphoric acid	do.		Plant at Phalaborwa	720.
Platinum-group metals:				
Mine	kilograms	Anglo American Platinum Ltd. (Amplats)	Mogalakwena Mine at Ga-Masanya	15,000 platinum; 17,000 palladium; 1,100 rhodium; 960 ruthenium; 220 iridium.
Do.	do.	do.	Amandelbult Mine near Northam	16,000 platinum; 7,300 palladium; 2,400 rhodium; 4,200 iridium and ruthenium.
Do.	do.	do.	Mototolo Mine at Steelpoort ¹	3,300 platinum; 2,100 palladium; 990 ruthenium; 570 rhodium; 220 iridium
Do.	do.	Siyanda Resources (Pty) Ltd.	Union Mine at Swartklip	10,700 platinum; 4,600 palladium; 1,800 rhodium; 3,100 iridium and ruthenium.
Do.	do.	Kroondal Platinum Mines [Anglo American Platinum Ltd. (Amplats), 50%, and Sibanye-Stillwater Ltd., 50%]	Kroondal Platinum Mine near Rustenburg	11,000 platinum; 6,000 palladium; 3,500 ruthenium; 2,200 rhodium; 800 iridium.
Do.	do.	Modikwa Platinum Mine [Anglo American Platinum Ltd. (Amplats), 50%, and African Rainbow Minerals, 50%]	Modikwa Mine at Makgemeng	4,200 platinum; 4,000 palladium; 1,200 ruthenium; 820 rhodium; 310 iridium.

See footnotes at end of table.

TABLE 2—Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 2018

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners		Location of main facilities	Annual capacity
Platinum-group metals:—Continued				
Mine— Continued	kilograms	Royal Bafokeng Platinum Ltd. (RBPlat) [Royal Bafokeng Nation, 67%, and Anglo American Platinum Ltd., 33%]	Styldrift Mine near Phokeng	6,900 platinum; 3,100 palladium, rhodium, and gold.
Do.	do.	Royal Bafokeng Platinum Ltd. (RBPlat) [Royal Bafokeng Nation, 67%, and Anglo American Platinum Ltd., 33%]	Bafokeng Rasimone Platinum Mine near Phokeng	5,900 platinum; 2,400 palladium; 790 ruthenium; 460 rhodium; 150 iridium.
Do.	do.	Atlatsa Resources Corp., 51%, and Anglo American Platinum Ltd., 49%	Bokoni Mine at Sefateng ¹	4,100 platinum; 2,700 palladium; 470 rhodium.
Do.	do.	Impala Platinum Holdings Ltd. (Implats)	Impala Mines, near Phokeng in North West Province	29,500 platinum; 16,000 palladium; 6,600 ruthenium; 4,000 rhodium; 1,600 iridium.
Do.	do.	do.	Marula Mine at Bothashoek	2,200 platinum; 2,300 palladium; 630 ruthenium; 460 rhodium; 180 iridium.
Do.	do.	Two Rivers Platinum Mine (Pty) Ltd.	Two Rivers platinum mine near Steelpoort	5,500 platinum; 3,200 palladium; 1,600 ruthenium; 930 rhodium; 350 iridium.
Do.	do.	Lonmin plc	Marikana and Pandora Mines near Marikana	24,900 platinum; 11,600 palladium; 5,300 ruthenium; 3,400 rhodium; 1,100 iridium.
Do.	do.	Sibanye-Stillwater Ltd.	Rustenburg Mine	24,000 platinum; 11,900 palladium; 3,100 rhodium; 5,500 iridium and ruthenium.
Do.	do.	Northam Platinum Ltd. [Anglo American Platinum Ltd. (Amplats), 22.5%, and Mvelaphanda Resources Ltd., 21.9%]	Zondereinde Mine near Northam	9,400 platinum; 4,600 palladium; 1,100 rhodium.
Do.	do.	do.	Booyendal North Mine	2,900 platinum; 1,600 palladium; 470 rhodium.
Do.	do.	Platinum Group Metals Ltd.	Maseve Mine ¹	5,500 platinum; 2,300 palladium; 430 rhodium.
Do.	do.	Sedibelo Platinum Mines Ltd.	Pilanesberg Mine in North West Province	5,400 platinum; 1,700 palladium; 490 rhodium.

See footnotes at end of table.

TABLE 2—Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 2018

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Platinum-group metals:—Continued				
Mine— Continued	kilograms	Tharisa Minerals (Pty) Ltd.	Tharisa Mine in North West Province	2,700 platinum; 710 palladium; 530 ruthenium; 360 rhodium; 170 iridium.
Do.	do.	Nkomati Joint Venture	Nkomati Mine in Mpumalanga Province	4,300 platinum-group metals.
Do.	do.	Sylvania Platinum Ltd.	Sylvania Dump Operations	1,100 ^e platinum; 520 ^e palladium; 290 ^e rhodium.
Smelted	do.	Anglo American Platinum Ltd. (Amplats)	Polokwane smelter at Polokwane, Mortimer smelter at Swartklip, and Waterval smelter	85,000 platinum; 55,000 palladium; 12,000 rhodium.
Do.	do.	Impala Platinum Holdings Ltd. (Implats)	Smelter near Phokeng	81,000 platinum; 52,600 palladium; 11,600 rhodium; 17,000 gold, iridium, and ruthenium.
Refined	do.	Anglo American Platinum Ltd. (Amplats)	Precious metals refinery near Rustenburg	81,000 platinum; 54,000 palladium; 11,000 rhodium; 18,800 iridium and ruthenium.
Do.	do.	Impala Platinum Holdings Ltd. (Implats)	Precious metals refinery near Springs in Gauteng Province	71,500 platinum metal; 46,400 palladium metal; 10,200 rhodium metal; 15,000 gold, iridium, and ruthenium.
Do.	do.	Lonmin plc	Refinery at Brakpan	31,000 platinum metal; 14,600 palladium metal; 7,000 ruthenium metal; 4,300 rhodium metal; 1,400 iridium metal.
Do.	do.	Heraeus South Africa (Pty) Ltd.	Refinery at Port Elizabeth	9,200 ^e platinum metal; 4,400 ^e platinum metal;
Pyrophyllite		Idwala Industrial Minerals (Benoni)	Ottsdal Mine in North West Province	15.
Do.		Wonderstone Ltd. (The Associated Ore & Metals Corp. Ltd.)	Pyrophyllite (wonderstone) mine, North West Province	NA.
Do.		G&W Base and Industrial Minerals Pty. Ltd. [Zimco Group (Pty) Ltd.]	Piet Retief Mine	NA.
Selenium	kilograms	Impala Platinum Ltd. (Implats)	Impala and Marula Mines	12,000. ^e
Do.	do.	Palabora Mining Co. Ltd.	Palabora Mine and plant at Phalaborwa	10,000. ^e
Silicon		Ferroglobe plc	Polokwane plant, near Pietersburg	55 silicon metal.
Do.	do.	do.	eMalahleni plant	12 silicon metal.
Silver:				
Mine	metric tons	Vedanta Resources plc	Black Mountain Mine near Aggeneys in Northern Cape Province	50 mined silver.
Refined	do.	Rand Refinery Ltd.	Germiston, Gauteng Province	200 refined silver.

See footnotes at end of table.

TABLE 2—Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 2018

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Sulfur		Sasol Synthetic Fuels (Pty) Ltd.	Plant at Secunda	180.
Do.		South African Petroleum Refineries	Plant at Durban	63.
Do.		Engen Petroleum Ltd.	do.	47.
Do.		National Petroleum Refiners of South Africa (Pty) Ltd.	Plant at Sasolburg	44.
Do.		Caltex Oil SA (Pty) Ltd.	Plant at Cape Town	30.
Synthetic fuels	thousand 42-gallon barrels	Sasol Synthetic Fuels (Pty) Ltd.	Coal to oil plant at Secunda	58,400.
Do.	do.	Petroleum Oil and Gas Corporation of South Africa	Natural gas to petroleum products plant at Mossel Bay	16,400.
Tellurium	kilograms	Impala Platinum Ltd. (Implats)	Impala and Marula Mines	5,000. ^c
Do.	do.	Palabora Mining Co. Ltd.	Palabora Mine and plant at Phalaborwa	5,300. ^c
Titanium:				
Titanium concentrates		Richards Bay Minerals (RBM) (Rio Tinto plc, 74%, and Blue Horizon Investments, 24%)	Open cast operations, near Richards Bay	2,000 ilmenite; ^c 100 rutile. ^c
Do.		Tronox Ltd., 74% (Exxaro Resources Ltd., 44.65%)	Namakwa Sands near Brand-se-Baai and mineral separation plant at Koekenaap	540 ilmenite; 31 rutile.
Do.		do.	Fairbreeze Mine in KwaZulu-Natal Province	500 ilmenite; 25 rutile.
Do.		Mineral Commodities Ltd. (MCL)	Tormin Mine in Western Cape Province	180 ^c ilmenite; 5.5 rutile.
Titanium slag		Richards Bay Minerals (RBM)	Smelter at Richards Bay	1,050.
Do.		Tronox Ltd., 74%	Empangeni smelter near Richards Bay	220.
Do.		do.	Smelter at Vredenberg, Saldanha Bay area	190.
Uranium oxide	metric tons	AngloGold Ashanti Ltd.	Kopanang and Moab Khotsong Mines and Mine Waste Solutions (MWS) project	650. ^c
Do.	do.	Sibanye-Stillwater Ltd.	Cooke Operations in Gauteng Province	120. ^c
Do.	do.	Shiva Uranium Ltd.	Mine in North West Province ¹	NA
Vanadium pentoxide	do.	Evraz Highveld Steel and Vanadium Ltd. (Evraz Group S.A., 79%)	Mapochs Mine near Lydenburg ¹	17,500.
Do.	do.	do.	Plant at Witbank ¹	10,800.
Do.	do.	Glencore plc, 74%	Rhovon Mine and smelter at Brits	10,000.
Do.	do.	Vanchem Vanadium Products (Pty) Ltd. (Duferco Group)	Plant at Witbank ¹	5,000. ^c
Do.	do.	Vametco Minerals Corp. (Bushveld Minerals Ltd., 100%)	Vametco Mine and Brits plant	3,750 vanadium.
Vermiculite		Palabora Mining Co. Ltd.	Palabora Mine and plant at Phalaborwa	200.
Wollastonite	metric tons	Incubex Minerals Ltd.	Mine near Garies	1,100. ^c
Zinc, mine		Vedanta Resources Ltd.	Gamsberg Mine in Northern Cape Province	250.
Do.		Black Mountain Mineral Development Co. (Pty) Ltd.	Black Mountain Mine near Aggeneys in Northern Cape Province	40.
Zirconium		Richards Bay Minerals (RBM)	Open cast mines near Richards Bay	300 zircon in concentrate.
Do.		Tronox Ltd., 74%	Namakwa Sands near Brand-se-Baai and mineral separation plant at Koekenaap	135 zircon in concentrate.
Do.		do.	Fairbreeze Mine in KwaZulu-Natal Province	55 zircon in concentrate.
Do.		Mineral Commodities Ltd. (MCL)	Tormin Mine in Western Cape Province	38 zircon in concentrate.

^cEstimated. Do., do. Ditto. NA Not available.

¹Not operating at the end of 2018.

²Data from International Copper Study Group.

TABLE 3
SOUTH AFRICA: RESERVE BASE OF MAJOR MINERALS IN 2018¹

(Million metric tons unless otherwise specified)

Commodity	Reserves
Alumino-silicates ²	96
Antimony	thousand metric tons 27
Chromite ore	3,100
Coal, recoverable	66,700
Fluorspar	41
Gold	thousand metric tons 6
Iron ore	770
Manganese, ore	200
Nickel	thousand metric tons 3,700
Phosphate rock	1,500
Platinum-group metals	thousand metric tons 63
Titanium minerals	71
Vanadium	thousand metric tons 3,500
Vermiculite	14
Zirconium	14

¹Metallic minerals are contained metal.

²Includes aluminosilicate and sillimanite.

Source: Mokwena, E., Malemetja, E., Madzuhe, V., and Masetlana, T.R., 2018, General review, *in* South Africa's Mineral Industry 2017/2018: Pretoria, South Africa, Department of Mineral Resources of the Republic of South Africa, p. 1–27.