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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 2016, South Africa's estimated share of world mined rhodium production amounted to 79%; mined platinum, 70%; refined rhodium, 65%; refined platinum, 63%; chromium, 49%; vermiculite, 41%; mined palladium, 36%; manganese, 34%; ferrochromium, 32%; refined palladium, 29%; zircon, 27%; industrial garnet, 18%; vanadium, 13%; refined gold, 7%; diamond, 6%; mined gold, 5%; coal, 4%; fluorspar, iron ore, and stainless steel, 3% each; mined cobalt and nickel, 2% each; and aluminum, refined cobalt, and silica sand, 1% each. South Africa also played a globally significant role in the production of ilmenite, kyanite and related minerals, and rutile (BP p.l.c., 2017, p. 38; CPM Group., 2017, p. 6–7, 112–113, 178–179; Merafe Resources Ltd., 2017, p. 10–11; South32 Ltd., 2017; Tex Report, The, 2017a; World Gold Council, 2017; Bedinger, 2018a, b; Bray, 2018; Corathers, 2018; Dolley, 2018; George, 2018; Loferski, 2018; McRae, 2018; Olson, 2018a, b; Polyak, 2018; Shedd, 2018; Singerling, 2018a–c; Tanner, 2018a, b; Tuck, 2018).

In 2016, South Africa's estimated share of the world's coal consumption was 2.3%, and petroleum products, 0.6%. The country also accounted for 89% of total African coal consumption and 14% of total African petroleum products consumption in 2016 (BP p.l.c., 2017, p. 15, 39).

Minerals in the National Economy

The mineral industry accounted for 7% of the gross domestic product (GDP) in 2016 compared with 7.1% in 2015 and 9.8% in 2006. Employment in the mineral industry amounted to 457,698 workers in 2016 compared with 456,337 in 2006. The mineral industry accounted for about 3% of employment in 2015 (the latest year for which data were available). In 2016, PGM mining accounted for 37.7% of the mineral industry's employment; gold, 25.3%; coal, 16.9%; diamond, 3.9%; iron ore, 3.7%; chromite, 3.4%; manganese, 1.6%; and other minerals, 7.6%. In 2006, platinum-group metal (PGM) mining accounted for 36.9% of the mineral industry's employment; gold, 35%; coal, 12.7%; diamond, 4.3%; and chromite, iron ore, and manganese combined, a total of 4.4% (Chamber of Mines of South Africa, 2015, p. 14; 2017, p. 9, 11, 13, 15, 17, 26; 2018, p. 8).

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 communities near their mine sites, 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, Martin, 2010; Chamber of Mines of South Africa, 2018, p. 31).

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 6,000 abandoned mines and numerous tailings piles in the Witwatersrand basin that contained about 6 billion 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 (Crowley, 2014).

In 2016, the Government announced plans to develop a long-term acid mine drainage remediation program with an estimated cost of $780 million.[1] The mining sector would be required to pay 67% of the costs (Inside Mining, 2017).

In 2015, the Government had imposed antidumping duties of between 14% and 77% on cement imported from Pakistan. The Government also imposed antidumping duties on cement imported from China which became effective in 2016 (International Cement Review, 2017).

Production

In 2016, antimony production increased by an estimated 200%; slate, by 147%; shale for brickmaking, by 76%; fluorspar, by an estimated 48%; fire clay, by 31%; vermiculite, by 20%; ilmenite, by an estimated 16%; gypsum and selenium, by 15% each; mined lead and pyrophyllite, by 14% each; stainless steel, by 13% and shale for cement, by 10%. Data on mineral production are in table 1. Increased antimony production was attributable to the restart of the country's only antimony mine in 2015 (Precious Satsha, Administrative Officer, Department of Minerals and Energy of the Republic of South Africa, written commun., April 19, 2017).

In 2016, mica production decreased by 72%; ferrovanadium, by an estimated 53%; ferrosilicon and silicon metal, by an estimated 51% each; flint clay, by 48%; natural gas liquids, by 45%;

[1]Where necessary, values have been converted from South African Rand (ZAR) to U.S. dollars (US$) at an annual average exchange rate of R15.319=US$1.00 for 2016.

vanadium, by an estimated 44%; direct-reduced iron and natural gas, by 38% each; ferromanganese, by 35%; sodium sulfate, by 32%; silicomanganese, by 31%; anthracite, by 23%; mined copper, by 20%; titaniferous slag, by an estimated 19%; industrial sand, by 17%; refined cobalt and uranium, by 15% each; mined cobalt, refined copper, manganese ore, and mined nickel, by 14% each; refined gold, by an estimated 12%; metallurgical coal and nickel chemicals, by an estimated 11% each; and bentonite, by 10%. Production of plastic clay ceased in 2015. The decreases in ferrovanadium, silicon metal, and silicomanganese production were attributable to plant closings (table 1; Precious Satsha, Administrative Officer, Department of Minerals and Energy of the Republic of South Africa, written commun., April 19, 2017).

Structure of the Mineral Industry

Most of the South African mineral industry was privately owned, although 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 sharply by mineral commodity. Antimony, fluorspar, industrial garnet, mined lead, vermiculite, and mined zinc were produced by only one domestic company each. The leading producer of uranium accounted for about 80% of national production; that of iron ore, 62%; diamond, 50%; nickel, 42%; gold, 33%; and coal, 21%. Table 2 is a list of major mineral industry facilities.

The mining industry was regulated by the Department of Mineral Resources. Exploration and production of natural gas and petroleum was 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.

Mineral Trade

Crude mineral products accounted for 25% of the value of total exports of $77 billion in 2016. About 70% of crude mineral products, by value, were exported in 2016. South Africa's exports of gold amounted to $3.95 billion in 2016; platinum, $3.83 billion; coal, $3.29 billion; iron ore; $2.57 billion; manganese ore, $1.23 billion; palladium, $1.21 billion; diamond, $793 million; chromite, $623 million; nickel, $379 million; rhodium, $355 million; iridium, $138 million; ruthenium, $33 million; and other crude mineral products, which included ilmenite, lead, rutile, and zircon, $840 million. Processed mineral products, which included aluminum, antimony trioxide, ferrochromium, manganese alloys, phosphoric acid, silicon metal and alloys, titanium slag, and vanadium alloys and other vanadium products accounted for an additional 15% of total exports (Creamer, 2017b; Precious Satsha, Administrative Officer, Department of Minerals and Energy of the Republic of South Africa, written commun., April 19, 2017).

The percentage of domestic consumption of mineral commodities produced in South Africa varied sharply by commodity. In 2016, silver exports, by volume, amounted to 94% of total sales; iron ore, 90%; PGMs, 89%; diamond, 84%; nickel, 81%; gold, 80%; copper, 51%; granite, 35%; coal, 28%; flint clay, 3%; and lime and silica, less than 1% each. Between April and September 2016, zircon exports accounted for 99% of total sales. In the first half of 2016, vermiculite exports accounted for 84% of total sales. Between October 2015 and March 2016, phosphate rock exports accounted for 35% of total sales. Between October 2014 and March 2015 (the latest period for which data were available), andalusite exports accounted for 57% of total sales (Motsie, 2015; Munyu, 2016; Muravha, 2016; Singo, 2016; Precious Satsha, Administrative Officer, Department of Minerals and Energy of the Republic of South Africa, written commun., April 19, 2017).

In 2016, South Africa's imports were reported to be about $74.7 billion. Petroleum and petroleum products accounted for 12.2% of imports in 2016 (World Bank Group, undated).

Commodity Review

Metals

Aluminum.—South Africa produced primary aluminum from alumina imported from Australia. South32 Ltd. of Australia operated the Hillside primary aluminum smelter at Richards Bay; production at Hillside increased to 701,000 t in 2016 from 695,000 t in 2015 (South32 Ltd., 2016, 2017).

Antimony.—The Cons Murch Mine was South Africa's only producer of antimony. In 2014, production declined sharply because of aging equipment and undercapitalization of the operations. The mine was in provisional liquidation in early 2015; Stibium Mining (Pty) Ltd. of Australia and its joint-venture partners purchased the mine and restarted production in September 2015. Production increased to an estimated 1,200 t in 2016 from 400 t in 2015 (Ramane, 2016).

Chromium.—Most of South African chromite production was mined in the Bushveld Complex. In 2016, chromite production was 14.71 million metric tons (Mt) compared with 15.66 Mt in 2015 and 7.13 Mt in 2006. Increased production since 2006 was partially attributable to PGM mining companies producing chromite as a coproduct. From 2006 to 2016, employment in chromite mining increased to 15,459 workers from 7,899 (table 1; Chamber of Mines of South Africa, 2015, p. 14, 17; 2017, p. 17; Precious Satsha, Administrative Officer, Department of Minerals and Energy of the Republic of South Africa, written commun., April 19, 2017).

Glencore plc of Switzerland (formerly Glencore Xstrata plc) and its joint-venture partner Merafe Resources Ltd. operated the Boshoek, the Helena, the Kroondal, the Magareng, the Thorncliffe, and the Waterval Mines. Glencore and Merafe produced about 4 Mt of chromite in 2016 compared with nearly 3.7 Mt in 2015; increased output was attributable to fewer safety stoppages and power supply interruptions and higher volumes of ferrochromium produced (Merafe Resources Ltd., 2017, p. 17–18).

Glencore and Merafe operated the Boshoek, the Lion, the Lydenburg, the Rustenburg, and the Wonderkop ferrochromium

plants, which had a total capacity of 2.34 million metric tons per year (Mt/yr). The companies produced 1.92 Mt of ferrochromium in 2016 compared with 1.84 Mt in 2015; the increase was attributable to the Lion plant and the reopening of a furnace at the Rustenburg plant (Merafe Resources Ltd., 2017, 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 (Golder Associates Inc., 2016, p. 11; Khaile, 2016).

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 2016, the company was producing at the rate of more than 1.1 Mt/yr of ferrochromium, which was nearly unchanged from that of the first half of 2015 (Matlala and Bissessor, 2015, p. 27; Golder Associates Inc., 2016, p. 11).

In 2015, International Ferro Metals Ltd. of Australia (IFM) operated the Buffelsfontein ferrochromium plant with a capacity of 267,000 metric tons per year (t/yr) in North West Province (table 2). At yearend 2015, the company was in bankruptcy proceedings, which may be attributable to low ferrochromium prices on world markets and power supply interruptions. Samancor Chrome purchased the Buffelsfontein plant from IFM and restarted production in 2016 (Markram, 2016; Wilkinson, 2017).

Assmang (Pty) Ltd. [African Rainbow Minerals Ltd. (ARM), 50%, and Assore Ltd., 50%] operated the Dwarsrivier Mine in Mpumalanga. In the first half of 2016, Assmang produced at the rate of more than 1.3 Mt/yr. Production was 1.13 Mt in 2015. ARM sold its share in Dwarsrivier to Assore in July (African Rainbow Minerals Ltd., 2016a, p. 4, 101; 2016b, p. 9).

Assmang's ferrochromium production at the Machadodorp plant decreased to 15,000 t in 2016 from 21,000 t in 2015. The company converted its remaining ferrochromium furnaces at Machadodorp to ferromanganese in mid-2013. Ferrochromium continued to be produced from stockpiles of slag at Machadodorp's metal recovery plant (African Rainbow Minerals Ltd., 2016a, p. 4, 101; 2016b, p. 9; 2017, p. 8).

ARM and its joint-venture partner MMC Norilsk Nickel of Russia comprised the Nkomati Joint Venture, which operated the Nkomati chromite mine. Chromite sales from Nkomati decreased to 174,000 t in 2016 from 385,000 t in 2015. Chromite sales from the Two Rivers Mine increased to 285,706 t in 2016 from 270,177 t in 2015; ARM planned to increase total chromite sales at Nkomati Chrome and Two Rivers to more than 600,000 t/yr by 2017 (African Rainbow Minerals Ltd., 2016a, p. 83–84; 2016b, p. 16–17; 2017, p. 14, 16).

Hernic Ferrochrome (Pty) Ltd. (a subsidiary of Mitsubishi Corp. of Japan) operated the Bokone Mines, which had a capacity of 1.5 Mt/yr, and a ferrochromium plant with a capacity of 420,000 t/yr (table 2). In the first half of 2015, Hernic was producing ferrochromium at the rate of between 300,000 t/yr and 350,000 t/yr. In 2016, the company's ferrochromium production was limited by the high cost of its mining operations (Matlala and Bissessor, 2015, p. 27; Creamer, Martin, 2016d).

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 t/yr and 400,000 t/yr, respectively. In the first half of 2015, the company was producing ferrochromium at the rate of between 200,000 and 250,000 t/yr. In March 2016, ASA Metals was operating only one of its four furnaces when it entered bankruptcy proceedings. As of late September the company was not in production because of the high cost of its mining operation (Matlala and Bissessor, 2015, p. 27; Creamer, Martin, 2016c, d; Tex Report, The, 2016).

In its fiscal year 2016 (which ended on September 30, 2016), Tharisa Minerals (Pty) Ltd. of Cyprus produced about 1.24 Mt of chromite at the Tharisa Mine compared with 1.12 Mt in fiscal year 2015. The company planned to reach steady-state production of 1.3 Mt/yr in fiscal year 2017. The remaining life of the open pit was estimated to be 18 years, which was expected to be followed by an underground mine with a life of 40 years (Tharisa Minerals (Pty) Ltd., 2016, p. 3, 8).

Afarak Group Oyj of Finland operated the Mecklenburg, the Stellite, and the Vlakpoort Mines and the Mogale Alloys plant. In 2016, Afarak produced 201,741 t of chromite compared with 411,545 t in 2015; output was reduced by the closure of the Mecklenburg Mine. Total ferroalloy sales were 77,092 t in 2016 compared with 78,441 t in 2015; Afarak switched one of its furnaces from silicomanganese to ferrochromium in 2016 (Afarak Group Oyj, 2017, p. 12, 24).

Tata Steel (KZN) (Pty) Ltd. operated a ferrochromium plant with a capacity of 150,000 t/yr; the company was operating at between 80% and 90% of capacity in the first half of 2015. In July 2015, the company started bankruptcy proceedings. In 2016, Traxys Group purchased the plant (Matlala and Bissessor, 2015, p. 27; Markram, 2016; Wilkinson, 2017).

PGM producers and other companies also mined chromite as a coproduct of mining of Upper Group 2 (UG2) PGM 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. Technological advances have allowed ferrochromium producers to use UG2 ore, which has a grade of about 10% Cr_2O_3 that is much lower than the grades in LG6 ore (Ryan's Notes, 2012).

Lonmin plc of the United Kingdom's sales of chromite from UG2 ore were 1.51 Mt in 2016, which was unchanged from that of 2015. The company's bulk tailings treatment project would increase chromite production by treating 26 Mt of UG2 tailings during a 7-year period; full production was planned by the third quarter of 2018 (Lonmin plc, 2016, p. 191; 2017).

In 2016, Anglo American Platinum Ltd. (Amplats) produced 685,600 t of chromite from UG2 ore compared with 566,500 t in 2015. In August, 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; about 50% of the production was sold domestically and about 50% was exported to China in December. Sibanye Gold Ltd. purchased the Rustenburg PGM mine from Amplats in October 2016; the company planned to produce 400,000 t of chromite from Rustenburg in 2017 (Anglo American Platinum Ltd., 2017, p. 33; Sibanye Gold Ltd., 2017, p. 43; Slater, 2017).

In its fiscal year 2016 (which ended on June 30, 2016), Northam Platinum Ltd. produced 538,405 t of UG2 ore from its Booysendaal North and Zondereinde Mines compared with 371,051 t in fiscal year 2015 as its PGM mining operations shifted from the Merensky Reef to the UG2 Reef. Northam's output was expected to increase to 1 Mt/yr because of the expansion of its PGM operations (Creamer, Martin, 2016e).

Chromtech Holdings (Pty) Ltd. produced about 250,000 t/yr of chromite from its ChronMin and Waterval Chrome Services plants, which treated UG2 tailings. In 2016, Thakadu Battery Minerals (Pty) Ltd. purchased a 26% share in Chromtech (Creamer, Martin, 2016f).

Impala Platinum Holdings Ltd. (Implats) held a 65% share in Impala Chrome (Pty) Ltd., which produced about 200,000 t/yr of chromite. The company produced chrome by processing about 4 Mt/yr of tailings from Implats' PGM operations (Creamer, Martin, 2017c).

Siyanda Chrome Smelting Co. was considering the development of a new plant that would process UG2 ore to produce more than 150,000 t/yr of ferrochromium. Depending on the results of a feasibility study, production could start in 2019 (Davies, 2015; Creamer, Martin, 2016b).

Cobalt.—Refined cobalt production decreased to 1,101 t in 2016 from an estimated 1,300 t in 2015, most of which was attributable to South African PGM mining operations. ARM and Norilsk also produced 831 t of mined cobalt at the Nkomati Mine in 2016 compared with 1,112 t in 2015 (African Rainbow Minerals Ltd., 2016a, p. 84; 2016b, p. 17; 2017, p. 16; Tex Report, The, 2017a).

Gold.—The long-term decline in South Africa's mined gold output continued in 2016, with production decreasing to 142,077 kilograms (kg) from 144,504 kg in 2015 and about 275,100 kg in 2006. During the same period, the country's share of world gold production decreased to about 5% from 11%. Decreased output was primarily attributable to mines operating at depths of as great as 4 kilometers, which led to difficult geologic conditions, high ore haulage and refrigeration costs, and low labor productivity. From 2006 to 2016, employment in gold mining decreased to 115,822 workers from 159,782 (table 1; du Venage, 2013; Chamber of Mines of South Africa, 2015, p. 14, 28; 2017, p. 8; Precious Satsha, Administrative Officer, Department of Minerals and Energy of the Republic of South Africa, written commun., April 19, 2017).

Sibanye mined gold at the Beatrix, the Driefontein, and the Kloof Mines, which were underground mines. Production at Driefontein decreased to 16,130 kg in 2016 from 17,350 kg in 2015, and at Beatrix, to 10,041 kg from 10,105 kg. The Cooke Operations, which were a combination of underground mines and tailings retreatment, produced 5,653 kg in 2016 compared with 6,252 kg in 2015. Production at the Kloof Mine increased to 15,210 kg in 2016 from 14,068 kg in 2015. Sibanye planned to produce a total of between 47,000 and 48,000 kg of gold in 2017 (Sibanye Gold Ltd., 2017, p. 40, 42–43).

In 2016, Sibanye was engaged in the reopening of the Burnstone Mine. The company planned to restart mining at Burnstone in 2018 and to produce at the full capacity of 3,700 kilograms per year (kg/yr) of gold between 2021 and 2029. The estimated life of the mine was 26 years. The company also started development on 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 2,900 kg/yr between mid-2020 and 2042, and from Kloof, an average of 1,200 kg/yr between mid-2020 and 2034 (Sibanye Gold Ltd., 2017, p. 44–46).

Sibanye completed a feasibility study on the development of the West Rand Tailings Retreatment Project (WRTRP) in the fourth quarter of 2016. Planned steady-state production in the study was 3,100 kg/yr in the first phase of the project; total planned production in the first 40 years was 84,000 kg. Development of the WRTRP depended on the results of operations at a pilot plant expected to start in the second quarter of 2017 (Sibanye Gold Ltd., 2017, p. 46–47).

Sibanye completed a prefeasibility study on the Beisa project, which had resources of 22,000 kg of contained gold and 7,300 t of contained uranium; development depended on increased uranium prices. The company 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 (Sibanye Gold Ltd., 2017, p. 47).

Harmony Gold Mining Company Ltd. produced a total of 30,410 kg of gold from its South African operations in 2016. The Tshepong Mine produced 4,313 kg in 2016; the Joel Mine, 3,804 kg; the Phakisa Mine, 3,535 kg; the Bambanani Mine, 3,442 kg; the Kusasalethu Mine, 3,398 kg; the surface mining operations, 3,022 kg; the Target 1 Mine, 2,450 kg; the Doornkop Mine, 2,416 kg; the Masimong Mine, 2,317 kg; and the Unisel Mine, 1,713 kg (Harmony Gold Mining Company Ltd., 2016b, 2017).

For fiscal year 2017 (which ended on June 30, 2017), Harmony's planned production at Tshepong was about 4,800 kg; Kusasalethu; about 4,400 kg; Phakisa, about 4,200 kg; Target 1, about 3,400 kg; Bambanani and the surface mining operations, about 2,800 kg each; Doornkop, about 2,600 kg; Masimong and Joel, about 2,100 kg each; and Unisel, 1,700 kg. The remaining life of the Bambanani and the Kusasalethu Mines was 5 years, and that of the Masimong Mine, 2 years (Harmony Gold Mining Company Ltd., 2016a, p. 79).

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 30,000 kg in 2016 from 31,200 kg in 2015. Production at the Moab Khotsong Mine was 8,700 kg in 2016; the Mponeng Mine, 7,900 kg; the surface mining operations in the Vaal River and West Wits areas and Mine Waste Solutions, 5,800 kg; the TauTona Mine, 4,500 kg; and the Great Noligwa and Kopanang Mines, a total of 2,800 kg. Production decreased at TauTona by 30% in 2016; at Kopanang, by 22%; and at the surface mining operations, by 4%.

In 2016, ore grades decreased at every operation except for Moab Khotsong (AngloGold Ashanti Ltd., 2017a, p. 101).

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 planned to produce about 9,800 kg in 2017. Gold Fields previously had planned to increase output at South Deep to between 20,200 and 21,700 kg/yr by the end of 2017. The estimated remaining life of the mine was 77 years (Projects in Progress, 2014a; Kotze, 2017b).

In its fiscal year 2016 (which ended on June 30, 2016), Pan African Resources plc produced 6,374 kg of gold compared with 5,470 kg in fiscal year 2015. Production at the Barberton Mine was 2,634 kg in fiscal year 2016; the Evander Mine, 2,286 kg; the Barberton Tailings Retreatment Project (BTRP), 889 kg; and the Evander Tailings Retreatment Project (ETRP), 565 kg. The Barberton and Evander Mines had capacities of nearly 3,000 kg/yr each; the BTRP, 930 kg/yr; and the ETRP, 620 kg/yr. The estimated remaining life of the Barberton Mine was 22 years; the Evander Mine and the ETRP, 16 years each, and the BTRP, 14 years (Pan African Resources plc, 2016, p. 10–11, 56–57).

In December 2016, Pan African completed its feasibility study on the Elikhulu Tailings project with favorable results. The project was expected to be commenced in January 2017, with gold production starting in the fourth quarter of 2018. Pan African planned to produce more than 1,700 kg/yr by processing tailings from the Evander Mine in the first 8 years of the project and 1,400 kg/yr in the remaining 5 years (Modern Mining, 2017b).

In its fiscal year 2016 (which ended on June 30, 2016), DRDGold Ltd. 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 planned to produce between 4,500 and 4,700 kg in fiscal year 2017 at Ergo, which is located near Johannesburg (Creamer, Martin, 2016f).

In 2015, Gold One International Ltd. mined nearly 4,000 kg of gold at the Modder East Mine, which was a record level of production for the company. Production at Modder East was expected to be 4,000 kg/yr through 2020 and then gradually to decrease until the closure of the mine in 2026. Gold One planned to start mining at the Holfontein project north and northeast of Modder East in 2021 and to reach the full capacity of 1,100 kg/yr in 2022 (Chen, 2016; Cornish, 2016b).

White Rivers Exploration (Pty) Ltd. and Harmony were considering the development of their joint-venture project, which was adjacent to Harmony's Target 1 Mine. In 2016, White Rivers completed a scoping study on a new mine. 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 (Andrews, 2017b; White Rivers Exploration (Pty) Ltd., 2017, p. 6, 9, 11–12).

Gold was also produced at PGM mining operations. Amplats produced about 2,400 kg of gold from its South African PGM mining operations in 2016 compared with 2,600 kg in 2015 (Anglo American Platinum Ltd., 2017, p. 33, 36–46).

Rand Refinery (Pty) 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 (Seccombe, 2017).

Iron Ore and Iron and Steel.—In 2016, iron ore production was about 66.5 Mt compared with 72.8 Mt in 2015 and 41.3 Mt in 2006. 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. From 2006 to 2016, employment in iron ore mining increased to 17,081 workers from 8,859 (Chamber of Mines of South Africa, 2015, p. 14, 18; 2017, p. 17; Precious Satsha, Administrative Officer, Department of Minerals and Energy of the Republic of South Africa, written commun., April 19, 2017).

Kumba Iron Ore Ltd.'s iron ore production decreased to 41.5 Mt in 2016 from 44.9 Mt in 2015. In 2016, production at the Sishen Mine decreased to 28.4 Mt from 31.4 Mt in 2015. At the Kolomela Mine, output increased to 12.7 Mt from 12.1 Mt. The Thabazimbi Mine, which produced 1.4 Mt in 2015, closed in mid-2016 (Kumba Iron Ore Ltd., 2017, p. 5, 14).

Kumba planned to maintain production at Sishen of between 27 and 28 Mt/yr. The company planned to produce between 13 and 14 Mt/yr at Kolomela between 2017 and 2020. Kolomela had an estimated remaining life of 18 years, and Sishen, 17 years (Kumba Iron Ore Ltd., 2017, p. 5, 65–66).

Assmang produced iron ore at the Beeshoek and the Khumani Mines. In 2016, total production at Beeshoek and Khumani remained nearly unchanged at 16.7 Mt. The company planned to maintain production at Beeshoek at 3 Mt/yr. Assmang increased Khumani's production to 13.6 Mt/yr in 2016; the company planned a further increase to at least 14.5 Mt/yr by mid-2017 (African Rainbow Minerals Ltd., 2016a, p. 88–89, 99; 2016b, p. 9; 2017, p. 8).

Palabora Mining Mining Ltd. produced magnetite at Palabora. In 2015, Palabora Mining completed a new magnetite plant. The company planned to increase its production to 10 Mt/yr eventually. At the end of 2016, it was unclear when the rampup to 10 Mt/yr would be completed (O'Hanlon, 2015).

Foskor (Pty) Ltd. sold magnetite, which was a byproduct of its past phosphate rock mining. The company was not producing magnetite as of mid-2016. In its 2016 fiscal year (which ended in March 2016), Foskor sold 5.2 Mt of magnetite compared to its sales target of 6.6 Mt. The company's plans to beneficiate magnetite were on hold because of decreased magnetite prices on world markets (Foskor (Pty) Ltd., 2016, p. 4, 38).

Evraz Highveld Steel and Vanadium Corp. Ltd. (Evraz plc of the United Kingdom, 85.11%) produced magnetite at the Mapochs Mine. Lumpy iron ore from Mapochs was consumed in Highveld's steel mill at Witbank. Highveld shut its mine and steel plant down in 2015; operations remained closed at the end of 2016 (Wilkinson, 2017).

In early 2015, Ferrum Crescent Ltd. of Australia was considering the development of a new mine at its Moonlight magnetite deposit. The company planned to raise between $10 million and $12 million to complete its feasibility study. Depending on the results of the study, production at Moonlight

was expected to be 6 Mt/yr of iron ore pellets. Mining could start in 2019. Ferrum Crescent had an offtake agreement with Duferco Group of Luxembourg for 4.5 Mt/yr of Moonlight's production. As of the end of 2016, the feasibility study had not been completed (Andrews, 2015a).

In September 2014, Government-owned Industrial Development Corp. (IDC) signed an agreement with Hebei Iron & Steel Group of China for the development of a new steel mill in Limpopo Province. Depending on the results of a feasibility study, the companies planned to produce 3 Mt/yr of steel in the first phase of the project and 5 Mt/yr in the second phase. In 2016, Hebei and IDC canceled plans to build the plant (Barradas, 2014; Alix, 2016).

Lead and Zinc.—The Black Mountain Mine, which was operated by Vedanta Resources plc of the United Kingdom, produced copper, lead, silver, and zinc. Lead mine production increased to 39,344 t in 2016 from 34,573 t in 2015, and zinc mine production decreased to 26,695 t from 29,040 t (Precious Satsha, Administrative Officer, Department of Minerals and Energy of the Republic of South Africa, written commun., April 19, 2017).

In 2016, 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. Vedanta planned to export about 150,000 t/yr of zinc in concentrate to its refinery in Namibia and about 100,000 t/yr to international customers. 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 2016, manganese ore production was 13.74 Mt compared with 15.95 Mt in 2015 and 5.21 Mt in 2006. 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. From 2006 to 2016, employment in manganese mining increased to 7,200 workers from 3,332 (Chamber of Mines of South Africa, 2015, p. 14, 19; 2017, p. 17; Precious Satsha, Administrative Officer, Department of Minerals and Energy of the Republic of South Africa, written commun., April 19, 2017).

Samancor Manganese (Pty) Ltd. (South32 Ltd., 60%) operated the Mamatwan open pit mine and the Wessels underground mine near Hotazel in Northern Cape Province. In 2016, Samancor Manganese's production of manganese ore increased to 3.15 Mt from 3 Mt in 2015. The company started a temporary shutdown of its mining operations in November 2015; production was restarted in February 2016. Production was expected to be maintained at about 2.9 Mt/yr (South32 Ltd., 2016, 2017).

In 2016, Samancor Manganese produced 137,000 t of manganese alloys at its Meyerton plant compared with 253,000 t in 2015. Decreased output was attributable to the shutdown of three of the plant's furnaces in May 2015 because of low manganese prices on world markets (South32 Ltd., 2016, 2017).

Assmang produced manganese ore at the Gloria and the Nchwaning Mines. Output at Gloria and Nchwaning decreased to 2.71 Mt in 2016 from 3.13 Mt in 2015; 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., 2016a, p. 100, 2016b, p. 9; 2017, p. 8; Buchholz and Foya, 2017, p. 24, 26).

In 2016, Assmang decreased production to 198,000 t of ferromanganese at its Cato Ridge and Machadodorp plants from 259,000 t in 2015. Machadodorp was on care-and-maintenance status in 2016, and only three of the six furnaces at Cato Ridge were operating by the end of June. Assmang planned to maintain sales of ferromanganese at about 120,000 t/yr through mid-2019 (African Rainbow Minerals Ltd., 2016a, p. 94–95, 100; 2016b, p. 9; 2017, p. 8).

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, a 49.9% share. In the fiscal year ending in February 2015, Jupiter and Ntsimbitntle produced 1.83 Mt of manganese ore at a grade of 37% manganese from the Tshipi Borwa Mine, which was adjacent to the Mamatwan Mine. The mine had a capacity of 3.6 Mt/yr and an estimated remaining life of 56 years. The companies initially planned to produce more than 2 Mt in fiscal year 2016; actual production was 1.54 Mt (Kotze, 2015c; Buchholz and Foya, 2017, p. 25, 28).

In its fiscal year 2015, United Manganese of Kalahari (Pty) Ltd. (UMK) (Majestic Silver Trading 40 (Pty) Ltd., 51%, and Renova Group of Russia, 49%) produced 2.55 Mt of manganese ore at a grade of 37.5% manganese at the Kalahari Mine. UMK decreased its production to 1.35 Mt in fiscal year 2016. The estimated remaining life of the mine was at least 22 years (Buchholz and Foya, 2017, p. 25, 29).

Manganese 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 late May 2016, Renova and Majestic announced plans to shut down production in June because of world market conditions (Davies, 2016).

Asia Minerals Ltd. (AML) of Hong Kong operated the Kudumane Mine at Farm York; the mine was producing manganese ore at the rate of about 1 Mt/yr. The company planned to increase production to 1.5 Mt/yr by expanding mining operations at Farm Hotazel and subsequently to 2 Mt/yr by opening a new underground mine at Farm Telele. AML planned to start mining at Farm Telele by 2020 (Kudumane Manganese Resources Ltd., 2015a, b).

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 in recent years 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 IDC, 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% manganese; 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 (Green, 2014; Projects in Progress, 2014b; Zakhele Mashile, Business Development Manager, Kalagadi Manganese (Pty) Ltd., oral commun., February 8, 2017).

About 1.7 Mt/yr of Kalagadi's sintered output from its new mine was planned to be exported. Kalagadi also planned to build a new ferromanganese plant at Coega with a capacity of 320,000 t/yr; the plant was expected to consume about 700,000 t/yr of the mine's sintered output. As of yearend 2016, the development of the ferromanganese plant was on hold (Projects in Progress, 2014b; 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 on a new mine at the Avontuur project. Aquila planned to produce nearly 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 (Buchholz and Foya, 2017, p. 30–31; Creamer, Martin, 2017a).

In mid-2012, Lehating Mining (Pty) Ltd. completed a feasibility study on its new Lehating Mine. Lehating Mining's environmental impact assessment was approved by the Government in December 2014, and its mining license was approved in October 2015. Mining could start in 2017 depending on the company successfully obtaining financing; output was planned to be 600,000 t/yr of ore at a grade of more than 44% manganese during the estimated 14-year life of the mine (Cornish, 2013; Lehating Mining (Pty) Ltd., undated).

Nickel.—The majority of South Africa's nickel mine production was a coproduct of PGM mining. Amplats produced 25,400 t of refined nickel in 2016, which was nearly unchanged from that of 2015. About 20,400 t of nickel was mined at the company's South African PGM mining operations in 2016 compared with 20,200 t in 2015. Implats produced 17,500 t of refined nickel in 2016, of which about 3,300 t was attributable to the company's South African PGM mining operations (Impala Platinum Holdings Ltd., 2016, p. 43, 57, 72; 2017; Anglo American Platinum Ltd., 2017, p. 33, 37–46).

ARM and Norilsk produced 16,665 t of nickel at the Nkomati Mine in 2016 compared with 22,265 t in 2015. The companies planned to produce at least 17,000 t/yr through mid-2021 (African Rainbow Minerals Ltd., 2016a, p. 79, 84; 2016b, p. 17; 2017, p. 16).

In November 2016, Lonmin and Thakadu Group formed a joint venture to build a new nickel sulfate plant at Lonmin's Base Metals Refinery with a capacity of 25,000 t/yr. The companies planned to complete a feasibility study on the plant by the second quarter of 2017. Depending on the results of the study, production could start by the first half of 2018 (Creamer, Martin, 2016e).

Platinum-Group Metals.—South's Africa's PGM mines were located in the Bushveld Complex. In 2016, PGM mine production was 263,653 kg compared with 275,515 kg in 2015 and about 309,300 kg in 2006. From 2006 to 2016, the share of platinum in PGM production by volume decreased to 51% from 55%. During the same period, employment in PGM mining increased to 172,369 workers from 168,530 (table 1; Chamber of Mines of South Africa, 2015, p. 14, 34; 2017, p. 11; Precious Satsha, Administrative Officer, Department of Minerals and Energy of the Republic of South Africa, written commun., April 19, 2017).

In 2016, Amplats produced about 142,200 kg of refined PGMs compared with 147,900 kg in 2015. The company's production of refined platinum was 72,617 kg in 2016; refined palladium, 45,542 kg; refined rhodium, 9,872 kg; and other PGMs, about 14,200 kg. About 101,200 kg was attributable to the South African mining operations of Amplats and its joint-venture partners in 2016 (not including the Bafokeng-Rasimone Platinum, the Bokoni, and the Styldrift Mines), of which platinum accounted for 50,285 kg; palladium, 32,164 kg; rhodium, 6,855 kg; and other PGMs, about 11,900 kg (Anglo American Platinum Ltd., 2017, p. 33, 37–46).

In 2016, PGM production at Amplats' Mogalakwena Mine amounted to 26,593 kg; the Amandelbult Mine, 26,503 kg; the Rustenburg Mine 20,961 kg; the Kroondal Platinum Mine, 17,007 kg; the Union Mine, 8,799 kg; the Modikwa Platinum Mine, 8,675 kg; the Mototolo Platinum Mine, 7,527 kg; and the Twickenham Mine, 479 kg. Production increased at Amandelbult and Modikwa by 4% each in 2016. Production decreased at Mototolo by 4%, and at Kroondal, by 1% (Anglo American Platinum Ltd., 2017, p. 33, 37–46).

In 2016, Sibanye purchased the Rustenburg Mine from Amplats and a 50% share in the Kroondal Platinum Mine from Aquarius Platinum Ltd. Sibanye sold 4,286 kg of PGMs (not including iridium or ruthenium) from Rustenburg in the last 2 months of 2016 (Sibanye Gold Ltd., 2017, p. 4, 41).

In 2016, Atlatsa Resources Corp. and joint-venture partner Amplats produced 4,953 kg of PGMs (not including iridium or ruthenium) at the Bokoni Mine compared with 5,933 kg in 2015. The Klipfontein Merensky opencast operations and the vertical and UM2 shafts were placed on care-and-maintenance status in 2016 (Atlatsa Resources Corp., 2017, p. 10).

Royal Bafokeng Platinum Ltd. (RBPlat) operated the Bafokeng-Rasimone Platinum Mine. Production of PGM (not including iridium or ruthenium) at the mine was nearly 8,600 kg in 2016 compared with nearly 8,500 kg in 2015. Platinum production remained nearly unchanged at 5,500 kg in 2016. Output of PGMs (not including iridium or ruthenium) was likely to decrease to 5,000 kg/yr by 2020 (Royal Bafokeng Platinum Ltd., 2016, p. 23–24; 2017, p. 103).

RBPlat produced 900 kg of PGMs at the Styldrift Mine (not including iridium or ruthenium) in 2016 compared with 190 kg in 2015. Platinum production increased to 590 kg in 2016 from 120 kg in 2015. The company could ramp up production at Styldrift to its full capacity of about 10,000 kg/yr of PGM by 2020, depending on market conditions. Platinum would account for 69% of production, and palladium, rhodium, and gold, a total of 31%. The remaining life of RBPlat's operations was estimated

to be about 60 years (Projects in Progress, 2012; Royal Bafokeng Platinum Ltd., 2016, p. 23–24; 2017, p. 6, 26, 103).

In 2016, Implats produced 95,877 kg of refined PGMs compared with 83,342 kg in 2015. About 43,600 kg was attributable to Implats' South African mining operations, of which platinum accounted for about 21,700 kg; palladium, 11,600 kg; rhodium, 3,000 kg; and other PGMs, about 7,300 kg. The remainder was attributable to the Two Rivers joint venture with ARM, company operations in Zimbabwe, recycling, and toll refining (Impala Platinum Holdings Ltd., 2016, p. 43, 57, 71–72; 2017).

The Impala Mines near Rustenburg in North West Province produced about 37,200 kg of PGMs in 2015, of which about 19,300 kg was platinum, 9,100 kg was palladium, and 2,500 kg was rhodium. In 2016, palladium and platinum output at Marula were about 2,500 kg each, and rhodium, about 510 kg. Implats planned to increase platinum production at the Impala Mines to nearly 26,000 kg/yr by 2020. The company also planned to increase platinum production at Marula to 2,800 kg/yr (Impala Platinum Holdings Ltd., 2016, p. 39, 43, 55, 57; 2017).

ARM and Implats operated the Two Rivers Mine; output increased to 12,933 kg of PGMs in 2016 from 11,924 kg in 2015. Platinum accounted for about 46% of Two Rivers' PGM output; palladium, 28%; ruthenium, 14%; rhodium 8%; iridium, 3%; and gold, 1%. Production was expected to be nearly 12,500 kg of PGMs in 2017 (African Rainbow Minerals Ltd., 2016a, p. 76, 83; 2016b, p. 16; 2017, p. 14).

In 2016, Lonmin produced 42,138 kg of refined PGMs compared with 46,548 kg in 2015. Lonmin's mining operations produced 38,209 kg of PGMs in 2016, of which platinum accounted for 20,220 kg; palladium, 9,329 kg; ruthenium, 4,787 kg; rhodium, 2,890 kg; and iridium, 982 kg. Most of the mine production was attributable to the Marikana Mine. Lonmin planned to produce nearly 21,000 kg of platinum in 2017 (Lonmin plc, 2016, p. 2, 190–191; 2017).

Northam Platinum Ltd. operated the Booysendal North (formerly the Booysendal) and the Zondereinde Mines. In 2016, Booysendal North and Zondereinde produced a total of about 8,400 kg of platinum, 4,400 kg of palladium, and 1,400 kg of rhodium compared with about 7,500 kg of platinum, 3,800 kg of palladium, and 1,200 kg of rhodium in 2015 because of the rampup of Booysendal North towards full capacity (CPM Group, 2017, p. 13, 116, 186).

Northam planned to increase production at Booysendal North to more than 5,400 kg of PGMs (not including iridium or ruthenium) in 2017 by mining ore from the Merensky Reef. The company also planned a deepening of its UG2 operations that would increase production at Booysendal North to nearly 6,700 kg/yr starting in 2018 (Cornish, 2017).

Northam also planned to produce nearly 6,700 kg/yr of PGMs (not including iridium or ruthenium) at its new Booysendal 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 Booysendal South Mine. Production at full capacity at Booysendal South was expected by 2021 (Cornish, 2017).

ARM and Norilsk produced PGMs at the Nkomati nickel mine; output decreased to 3,637 kg of PGM in 2016 from 5,074 kg in 2015. Production was expected to remain nearly unchanged until at least mid-2019 (African Rainbow Minerals Ltd., 2016a, p. 79, 84; 2016b, p. 17; 2017, p. 16).

Sedibelo Platinum Mines Ltd. produced about 3,100 kg of platinum, 1,550 kg of palladium, and 310 kg of rhodium at the Pilanesberg Mine in 2016 compared with about 3,300 kg of platinum, 1,650 kg of palladium, and 330 kg of rhodium in 2015. The company's production in 2017 was expected to be 3,000 kg of platinum, 1,500 kg of palladium, and 300 kg of rhodium (CPM Group, 2017, p. 13, 116, 186).

In its fiscal year 2016 (which ended on September 30, 2016), Tharisa produced more than 4,100 kg of PGMs compared with about 3,700 kg in fiscal year 2015. Platinum accounted for 55.9% of production by volume in fiscal year 2016; palladium, 16.1%; ruthenium, 13.9%; rhodium, 9.4%; and iridium, 4.5%. The company planned to produce 5,400 kg of PGMs in fiscal year 2017. Sylvania Platinum Ltd. produced about 1,200 kg of platinum, 560 kg of palladium, and 310 kg of rhodium from its chromite tailings retreatment plants in 2016 compared with 1,000 kg of platinum, 470 kg of palladium, and 260 kg of rhodium in 2015 (Tharisa Minerals (Pty) Ltd., 2016, p. 3, 7, 13; CPM Group, 2017, p. 13, 116, 186).

Platinum Group Metals Ltd. of Canada was engaged in the development of the Maseve Mine [formerly the Western Bushveld Joint Venture (WBJV) project]; the company had planned to start mining by the fourth quarter of 2015. By the fourth quarter of 2017, production was expected to reach the full capacity of nearly 8,600 kg/yr of PGMs and gold (not including iridium or ruthenium), 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. The mine was opened in late 2016 (Platinum Group Metals Ltd., 2015, p. 13–14; van Wyngaardt, 2016).

In late 2016, Platinum Group Metals completed a prefeasibility study on a new mine at the Waterberg project. The company planned to complete a feasibility study on Waterberg, 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 and gold (not including iridium or ruthenium), of which palladium would account for 63%; platinum, 30%; gold, 6%; and rhodium, 1%. The estimated life of the mine was 18 years (Breytenbach, 2016; Engineering & Mining Journal, 2016).

In 2016, Wesizwe Platinum Ltd. was engaged in the development of the Bakubung Mine. Wesizwe planned to start mining in 2017 and to reach the full capacity of 13,000 kg/yr of PGMs and gold (not including iridium or ruthenium) in 2021. Platinum was expected to account for 62.4% of Bakubung's production; palladium, 28%; rhodium, 7.4%; and gold, 2.2%. The estimated life of the mine was 30 years (Engineering & Mining Journal, 2015b; Naidoo, 2017).

In January 2015, Ivanhoe Mines Ltd. of Canada completed a prefeasibility study of a new mine at its Platreef project, located in the Northern Limb of the Bushveld Complex. In the first phase of mining, Ivanhoe would mine about 4 Mt/yr of ore. Production was likely to be 8,600 t/yr of nickel, 5,400 t/yr of copper, and 13,500 kg/yr of PGMs and gold (not including

iridium or ruthenium). In the second phase, ore production would increase to 8 Mt/yr, and in the third phase, to 12 Mt/yr. Depending on the results of a feasibility study, mining could start at Platreef in 2019. Ivanhoe planned to complete the feasibility study of the first phase of mining in the first half of 2017 (Engineering & Mining Journal, 2015a; Kilian, 2016b).

Silicon.—In 2015, South Africa accounted for more than 1% of the world's total production of ferrosilicon and silicon metal. 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 production at eMalahleni and Polokwane because of high power costs and reduced demand in world markets (Njobeni, 2017; Schnebele, 2018; Martin Kohler, Deputy Director of Statistics, Department of Minerals and Energy of the Republic of South Africa, written commun., November 4, 2016).

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, 2016, p. 8).

RBM mined nearly 1.8 Mt of ilmenite from the Zulti North deposit in 2013. By 2015, production was estimated to have decreased by more than 25% from that of 2013 because of reduced global demand. Based on estimates of zircon production levels, ilmenite production was estimated to have decreased by 10% between 2015 and 2016 (Rio Tinto plc, 2014, p. 28; 2016, p. 9; Baker, 2018, p. 6).

Production at Zulti North was expected to decrease after 2015; RBM was engaged in a feasibility study on the development of the Zulti South deposit in 2016. Depending on the result of the study, the company could start mining at Zulti South in 2019. 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 2036 and 2041, respectively (Rio Tinto plc, 2014, p. 28; 2016, p. 6, 10; Munyu, 2016).

Titanium slag production by RBM was about 880,000 t in 2012. In 2014, production was at more than 90% of 2012 levels. In 2015, output was estimated to have decreased by more than 25% from that of 2014 because of reduced global demand. Based on estimates of zircon production levels, titanium slag production was estimated to have decreased by 10% between 2015 and 2016 (Rio Tinto plc, 2013, p. 10; 2015, p. 10; 2016, p. 9; Baker, 2018, p. 6).

Zircon production by RBM was about 264,000 t in 2012, and rutile production, about 97,000 t. In 2014, rutile and zircon production were at about the same levels as in 2012. In 2015, rutile and zircon production were estimated to have decreased by more than 25% each from that of 2014 because of reduced global demand. Rutile and zircon production were estimated to have decreased by 10% between 2015 and 2016; zircon production was about 160,000 t in 2016. RBM's zircon output could increase by 90,000 t/yr after the opening of Zulti South in 2019 (Rio Tinto plc, 2013, p. 10; 2015, p. 10; 2016, p. 9; Munyu, 2016; Baker, 2018, p. 6).

Tronox Ltd. of the United States' (Exxaro Resources Ltd., 44.65%) produced 133,000 t of zircon at the Namakwa Sands project in 2016 compared with 115,000 t in 2015; rutile production decreased to 26,000 t in 2016 from 28,000 t in 2015. Titanium slag production decreased to 113,000 t in 2016 from 155,000 t in 2015. The company's ilmenite production was estimated to be about 490,000 t in 2016 compared with 470,000 t in 2015. Production was limited by power supply interruptions in the third quarter of 2016 (Munyu, 2016; Tronox Ltd., 2016, p. 32; 2017, p. 36).

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. 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, 41).

Mineral Commodities Ltd. (MCL) of Australia operated the Tormin Mine in Western Cape Province. In 2016, production was 211,704 t of ilmenite and 35,813 t of rutile and zircon (most of which was zircon) from 587,515 t of heavy-mineral concentrate. In 2015, production was 109,959 t of ilmenite and 44,489 t of rutile and zircon. MCL planned to produce 200,000 t of ilmenite and 25,000 t of rutile and zircon in 2017. The company planned to upgrade its concentrator and increase heavy-mineral concentrate production to 900,000 t/yr. MCL also planned to invest in a new mineral separation plant with a capacity of 200,000 t/yr of finished ilmenite and 70,000 t/yr of finished rutile and zircon in 2017 and 2018 (Mineral Commodities Ltd., 2017, p. 12, 15–16, 20).

Most of the titanium slag produced in South Africa was exported before additional processing. Huntsman International LLC of the United States operated a titanium dioxide (TiO_2) pigment plant at Umbogintwini with a capacity of 25,000 t/yr; the company shut its plant down in 2016. Nyanza Light Metals Ltd. (Arkein Group of Companies, 80%, and Highveld, 20%) was considering the development of a new TiO_2 pigment plant in the Richards Bay Industrial Development Zone. The company could produce 50,000 t/yr of TiO_2 pigment starting in 2020. Pigment would be produced using titanium-rich tailings from Highveld's iron ore and vanadium mining operations, which had stockpiles of 45 Mt that were sufficient to supply the plant for about 200 years (Hughes and Ollett, 2013; Cassidy, 2017).

In 2013, the Council for Scientific and Industrial Research (CSIR) started a pilot plant to produce titanium metal powder using an experimental production process. Depending on the results of the process, a new plant with a capacity of 500 t/yr of titanium metal powder could be opened by 2019. Depending on the success of the new plant, a large-scale plant with a capacity of 20,000 t/yr could be opened by 2023 (Campbell, 2013; Mjwara, 2016).

Vanadium.—Until 2015, Evraz produced vanadium from titaniferous magnetite at the Mapochs Mine, which was operated by Highveld. The company produced vanadium slag from the lumpy iron ore at Mapochs; the slag was exported to Germany for processing into ferrovanadium. Fine ore was sold domestically to Vanchem Vanadium Products Ltd. for processing.

Highveld shut down its vanadium plant in 2015; the company's operations remained closed at the end of 2016 (Wilkinson, 2017).

Glencore produced vanadium pentoxide (V_2O_5) and ferrovanadium at the Rhovan Mine and smelter in Brits. In 2016, the production of V_2O_5 at Rhovan was nearly 9,600 t compared with 9,500 t in 2015. Production of ferrovanadium was 6,600 t with a vanadium content of 80% in 2015. The estimated remaining life of the Rhovan Mine was 30 years (Glencore plc, 2017a, p. 211; Buchholz and Foya, 2017, p. 49–50).

Vametco Minerals Corp. operated the Vametco Mine and Brits plant. The company produced ferrovanadium, nitride vanadium, and V_2O_5 at Brits. In 2016, Vametco produced at its full capacity of 2,850 t/yr of contained vanadium (Buchholz and Foya, 2017, p. 52).

In 2014, Ironveld plc of the United Kingdom completed a feasibility study with favorable results on its Ironveld pig iron project, which is located on the Northern Limb of the Bushveld Complex. Ironveld planned to mine magnetite, which would be processed at the company's new smelters, into 46,000 t/yr of pig iron, nearly 8,300 t/yr of titanium in slag, and 381 t/yr of vanadium in slag. Production could start in 2018 (Ironveld plc, 2016, p. 2, 12).

In January 2016, Bushveld Minerals Ltd. of the United Kingdom 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. Bushveld received the environmental permits for Mokopane in September. Construction could start in 2017, and mining, in 2019. The estimated life of the mine was at least 30 years (Bushveld Minerals Ltd., 2016; Buchholz and Foya, 2017, p. 52–54).

Industrial Minerals

Cement.—At the end of 2016, South Africa had six cement producers with a total capacity of 21.2 Mt/yr of cement and 12.5 Mt/yr of clinker. Pretoria Portland Cement Co. (Pty) Ltd.'s plants had a combined cement capacity of 7 Mt/yr; AfriSam Consortium (Pty) Ltd., 4.6 Mt/yr; Lafarge South Africa Ltd., 3.5 Mt/yr; Dangote Cement South Africa (Pty) Ltd., 2.7 Mt/yr; Natal Portland Cement Co. (Pty) Ltd., 2.4 Mt/yr; and Mamba Cement Company (Pty) Ltd., 1 Mt/yr. Dangote's and Mamba's plants were completed in 2014 and 2015, respectively. Some producers were unable to operate at full capacity because of aging kilns (International Cement Review, 2017).

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; Osho Ventures Ltd., undated).

Diamond.—In 2016, diamond production was 8.45 million carats compared with 8.23 million carats in 2015 and 15.15 million carats in 2006 because of decreased production at the Cullinan, the Finsch, and the Venetia Mines. From 2006 to 2016, employment in diamond mining decreased to 17,885 workers from 19,686 (table 1; Chamber of Mines of South Africa, 2015, p. 14, 26; 2017, p. 13; Precious Satsha, Administrative Officer, Department of Minerals and Energy of the Republic of South Africa, written commun., April 19, 2017).

De Beers Consolidated Mines Ltd. accounted for the majority of South Africa's rough diamond production. In 2016, the company's total output decreased to 4.23 million carats from 4.67 million carats in 2015 because of the sale of the Kimberley Surface Mining Operations in January to Petra Diamonds Ltd. The Venetia Mine's production increased to 3.52 million carats from 3.13 million carats and the Voorspoed Mine's production decreased to 649,000 carats from 704,000 carats. Reserves near the surface at Venetia were likely to be depleted by 2021; De Beers planned to build an underground mine at Venetia that would extend the life of the project until 2043. Planned production from the underground mine was 4.4 million carats per year (Cornish, 2016a; Anglo American plc, 2017, p. 8).

In 2016, diamond production at the Finsch Mine by Petra amounted to 2.15 million carats; the Kimberley Surface Mining Operations and Kimberley Underground Mine, a total of 943,000 carats; the Cullinan Mine, about 778,000 carats; and the Koffiefontein Mine, about 55,000 carats. Petra planned to ramp up production at the Cullinan and 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., 2017a, p. 11–16; 2017b).

DiamondCorp plc of the United Kingdom recovered small amounts of diamond at the Lace Mine in 2015; production was planned to reach commercial levels in the first half of 2016. The company's planned peak output was 500,000 carats per year, which could be increased to more than 700,000 carats per year with the installation of a high-volume waste sorter. The estimated life of the Lace Mine was 25 years. Production was halted by heavy rains that flooded the mine in November 2016; restarting mining operations was likely to require 3 months of repairs (Kotze, 2015a; Kilian, 2016a).

Fluorspar.—In 2016, South Africa's production of fluorspar was 177,000 t compared with an estimated 120,000 t in 2015. Between October 2014 and March 2015, sales of fluorspar were at the rate of 162,000 t/yr. More than 90% of sales were exports and nearly 10% was consumed domestically by Pelchem SOC (a subsidiary of South African Nuclear Energy Corp.). A majority of Pelchem's consumption was attributable to hydrofluoric acid production (Modiselle, 2015b; Motsie, 2015).

Minerales y Productos Derivados S.A. of Spain held an 85% share in the Vergenoeg Mine, which was South Africa's only active fluorspar mine at the end of 2016. Vergenoeg's capacity of acid-grade fluorspar was 250,000 t/yr, and its capacity of metal-grade fluorspar powder and briquette, 30,000 t/yr. Production was limited in 2015 by reduced global demand for fluorspar (Modiselle, 2015a, b).

Sephaku Fluoride Ltd. (SepFluor) planned to start production at the Nokeng fluorspar project by 2017. In the first 9 years of the project, SepFluor planned to produce 185,000 t/yr of acid-grade fluorspar from the Plattekop deposit. Production was expected to decrease subsequently to 130,000 t/yr as mining

shifted to the Outwash Fan deposit. SepFluor also planned to build a new processing plant that would consume 130,000 t/yr of fluorspar and 156,000 t/yr of sulfuric acid in the production of 60,000 t/yr of hydrogen fluoride (HF). About 42,600 t/yr of HF was expected to be consumed in the production of 60,000 t/yr of aluminum fluoride (AlF_3). In 2016, SepFluor temporarily suspended plans for downstream processing because of low world market prices for fluorspar. As of yearend, construction of the mine had not started (Sephaku Fluoride Ltd., 2013, p. 4, 18, 21; Lismore-Scott, 2017).

Garnet, Industrial.—In 2016, MCL produced 270,802 t of industrial garnet at the Tormin Mine compared with 284,990 t in 2015 and 254,816 t in 2014. The company expected production to increase to 300,000 t in 2017. MCL also planned to invest in a new mineral separation plant with a capacity of 75,000 t/yr of finished garnet in 2017 and 2018 (Mineral Commodities Ltd., 2017, p. 14, 20).

Kyanite and Related Minerals (Andalusite).—South Africa was the world's leading producer of andalusite. In 2016, national production decreased to an estimated 180,000 t from 190,000 t in 2015. Production was shut down in December 2016 by flooding and heavy rains. Between October 2014 and March 2015, export sales of andalusite were at the rate of 114,000 t/yr, and domestic sales, 86,000 t/yr. Andalusite was consumed by the domestic steel industry for use in refractories (Motsie, 2015; Singo, 2015; Ghilotti, 2017).

Imerys South Africa (Pty) Ltd. (a subsidiary of Imerys Group of France) operated the Annesley, the Segorong, and the Thabazimbi (Rhino) Mines, which accounted for about 61% of South Africa's andalusite production in 2015. Andalusite Resources (Pty) Ltd. operated the Maroeloesfontein Mine, which accounted for about 39% of production in 2015. Exports to Japan accounted for between 35% and 45% of the company's production; exports to European countries, between 30% and 40%; and domestic sales, about 25%. In April 2015, the Government's Competition Committee blocked a proposed merger between Imerys and Andalusite Resources. The companies planned to appeal the decision; the dispute was unresolved at the end of 2016 (Lismore-Scott, 2015; Patel, 2015; Singo, 2015).

Phosphate Rock.—Foskor was South Africa's leading producer of phosphate rock. In 2016, phosphate rock production decreased to about 1.7 Mt from 1.85 Mt in 2015. Between October 2015 and March 2016, domestic sales of phosphate rock were at the rate of 1.43 Mt/yr, and export sales, about 760,000 t/yr (Singo, 2016).

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 2016 fiscal year (which ended on March 31, 2016), the company produced 307,000 t of phosphoric acid compared with 393,000 t in fiscal year 2015. Fertilizer production decreased to 198,000 t from 297,000 t. Decreased production was attributable to problems that included local unrest and power shortages. By fiscal year 2018, Foskor planned to increase phosphate rock output to 2.3 Mt/yr; phosphoric acid, to 700,000 t/yr; and fertilizers, to 450,000 t/yr (Foskor (Pty) Ltd., 2016, p. 3, 27, 40).

Kropz SA (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 (Mining Mirror, 2017c).

In 2012, Montero Mining & Exploration Ltd. of Canada completed a preliminary economic assessment on a new mine at its Duyker Eiland project, which was located near Saldanha Bay. Depending on the results of prefeasibility and feasibility studies, Montero could produce 490,000 t/yr of phosphate rock at Duyker Eiland, which would be processed to fertilizer at a nearby processing plant. The company hoped to identify resources sufficient for a mine life of 50 years. As of the end of 2016, the feasibility study on Duyker Eiland had not been completed (Montero Mining & Exploration Ltd., 2015).

Sand and Gravel, Industrial.—In early 2016, silica sand was produced at 23 quarries in South Africa. Domestic sales of silica sand were about 1.9 Mt in 2016. Silica sand was consumed by glass producers, including Consol Glass (Pty) Ltd., PG Group, and Nampak Glass (Pty) Ltd. (Lourens and De Water, 2016, p. 83–85; Precious Satsha, Administrative Officer, Department of Minerals and Energy of the Republic of South Africa, written commun., April 19, 2017).

Vermiculite.—Palabora Mining was the world's leading producer of vermiculite. The company 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 2016, production at the Palabora Mine increased to 166,483 t from 138,290 t in 2015. Palabora Mining had difficulty supplying coarse-grade vermiculite because of decreased recovery rates. In the first half of 2016, export sales of vermiculite were at the rate of 69,000 t/yr, and domestic sales, 12,000 t/yr (Muravha, 2015, 2016; Precious Satsha, Administrative Officer, Department of Minerals and Energy of the Republic of South Africa, written commun., April 19, 2017).

Mineral Fuels and Related Materials

Coal.—In 2016, coal production was about 251 Mt compared with 252.2 Mt in 2015 and 244.8 Mt in 2006. From 2006 to 2016, employment in coal mining increased to 77,226 workers from 57,778. 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. More than 70 Mt/yr was exported (table 1; Chamber of Mines of South Africa, 2015, p. 14, 20; 2017, p. 15; Prevost, 2017; Precious Satsha, Administrative Officer, Department of Minerals and Energy of the Republic of South Africa, written commun., April 19, 2017).

Anglo American's coal production was 53.8 Mt in 2016 compared with 50.3 Mt in 2015. The New Vaal Mine produced 15.9 Mt in 2016; the Kriel Mine, 6.34 Mt; the Zibulo Mine, 6.01 Mt; the Goedehoop Mine, 4.69 Mt; the Isibonelo Mine, 4.4 Mt; the Landau Mine, 4.32 Mt; the Greenside Mine, 3.95 Mt; the Kleinkopje Mine, 3.87 Mt; the New Denmark Mine, 2.55 Mt; and the Mafube Mine, 1.76 Mt. Output increased at Kleinkopje by 23%; at Mafube, by 22%; at New Vaal, by 12%; at Goedehoop, by 9%; and at Zibulo, by 8% (Anglo American plc, 2017, p. 14).

In 2016, Exxaro's coal production was 42.8 Mt, which was nearly unchanged from that of 2015. Output at the Grootegeluk Mine was 22.6 Mt in 2016; the Matla Mine, 7.9 Mt; Exxaro Coal Central (formerly the the Dorstfontein and the Forzando Mines), 3.9 Mt; the Leeuwpan Mine, 3.78 Mt; the North Block Complex, 2.86 Mt; and the Mafube Mine, 1.76 Mt. The Arnot and the Inyanda Mines were shut down in 2015, and the North Block Complex was scheduled to be shut down in 2017 (Exxaro Resources Ltd., 2017, p. 9; Tex Report, The, 2017b).

In 2016, Exxaro and joint-venture partner Anglo American were engaged in the construction of the Mafube Nooitgedacht project. Mining was expected to start in 2018; planned production was 3.1 Mt/yr of thermal coal. Exxaro planned to start construction on the new Belfast and Thabametsi Mines and the Leeuwpan extension project in 2017. The Thabametsi Mine was expected to be completed in 2020 and to produce 3.9 Mt/yr of thermal coal. The Belfast Mine and the Leeuwpan extension project were expected to produce 2.7 Mt/yr each of thermal coal, and to start production in the second quarter of 2018 and the fourth quarter of 2019, respectively (Exxaro Resources Ltd., 2017, p. 68).

Exxaro also planned to make an investment decision on an expansion of the Grootegeluk Mine by 2.7 Mt/yr by the first quarter of 2017. Depending on its decision, the expansion could be completed by the fourth quarter of 2020 (Exxaro Resources Ltd., 2017, p. 68).

In fiscal year 2016 (which ended on June 30, 2016), Sasol Ltd.'s coal production increased to 42.3 Mt from 41.2 Mt in fiscal year 2015. The Syferfontein Mine accounted for 11.1 Mt; the Twistdraai Mine, 8.2 Mt; Middelbult Mine, 7.6 Mt; the Bosjesspruit Mine, 6.6 Mt; the Brandspruit Mine, 5.3 Mt; and the Sigma Mine, 1.8 Mt. Sasol opened the new Impumelelo Mine to replace the Brandspruit Mine; production was 1.7 Mt in fiscal year 2016. Most of Sasol's coal production was consumed in the company's synthetic fuel operations (Sasol Ltd., 2016, p. 34).

South32 produced coal at the Khutala, the Klipspruit, the Middelburg, and the Wolverkrans Mines in Mpumalanga Province. In 2016, the company's output decreased to 30.1 Mt from 34.1 Mt in 2015 (South32 Ltd., 2016, 2017).

Glencore and ARM operated the Goedgevonden Complex, the Impunzi Complex, and the Tweefontein Complex. Output at Goedgevonden decreased to 6.81 Mt in 2016 from 7.27 Mt in 2015 and increased to a total of 15.8 Mt from 14 Mt at Impunzi and Tweefontein. Glencore and ARM planned to increase production at Goedgevonden to about 9 Mt/yr by mid-2018; output at Impunzi and Tweefontein was expected to decrease to a total of about 10 Mt/yr by mid-2018 (African Rainbow Minerals Ltd., 2016a, p. 106; 2016b, p. 20–21; 2017, p. 19–20).

As of the end of 2016, Glencore had received the necessary mining licenses and environmental permits to start a new coal mine at Zonnebloem, which was part of the Impunzi complex. Mining could start at Zonnebloem in 2017; production at full capacity was expected to be 10 Mt/yr of run-of-mine coal. The mine had an estimated life of 24 years. The company also was considering the development of the Paardekop project, which could produce 8 Mt/yr starting in 2021. At yearend, Paardekop was awaiting mining rights and environmental permits (Inside Mining, 2014; Glencore plc, 2017b, p. 57–58; Sewala, 2017, p. 22).

Optimum Coal Holdings (Pty) Ltd. [Tegeta Exploration & Resources (Pty) Ltd., 67.6%] operated the Koornfontein Complex and the Optimum Complex. Production at Optimum increased to 10.3 Mt/yr in July 2016 from 6.6 Mt/yr in December 2015. At Koornfontein, output increased to 3 Mt/yr in July from 2 Mt/yr in April. The company was considering a new open pit mine at Koornfontein. Glencore sold its share in Optimum Coal Holdings to Tegeta in April (Oakbay Investments (Pty) Ltd., 2016).

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

Izimbiwa Coal (Pty) Ltd. [Shanduka Resources (Pty) Ltd., 50.01%, and Glencore, 49.99%] operated the Corobrik, the Graspan, and the Springlake Mines; the company was formerly known as Shanduka Coal (Pty) Ltd. In 2016, salable coal production at Corobrik, Graspan, and Springlake was about 4 Mt. Izimbiwa Coal planned to develop the Argent and the Springboklaagte projects, which could produce 2.4 Mt/yr of run-of-mine coal each. The company received mining licenses for Argent and Springboklaagte in May 2016. At yearend, the projects were awaiting environmental permits (Inside Mining, 2014; Glencore plc, 2017b, p. 58).

Mbuyelo Coal (Pty) Ltd. (Mbuyelo Group, 49%, and IchorCoal N.V. of the Netherlands, 45%) started production at the Manungu and the Welgemeend Mines in 2015. In October 2016, production at Welgemeend and Manungu was 1.7 Mt/yr and 1.6 Mt/yr, respectively. Mbuyelo Group also operated the Rirhandzu and the Vlakvarkfontein Mines, which produced 1.2 Mt/yr of coal each for sale to Eskom. 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, 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).

Wescoal Holdings Ltd. operated the Elandspruit, the Intibane, and the Khanyisa Mines. Total sales from the mines were at the rate of 2.6 Mt/yr between April and September 2016. Run-of-mine production was at the rate of 3 Mt/yr, most of which was attributable to the Elandspruit Mine. The Khanyisa Mine was on care-and-maintenance status as of November. Wescoal planned to increase run-of-mine production to 8 Mt/yr, which would require the company to purchase additional deposits. Elandspruit's remaining life was 15 years and that of Intibane and Khanyisa was between 4 and 5 years each (Creamer, Martin, 2016a).

In the second half of 2016, Universal Coal plc of the United Kingdom's sales from the Kangala Mine and the New Clydesdale Colliery (NCC) in Mpumalanga Province were 2.5 Mt/yr compared with nearly 2 Mt/yr in the second half of 2015. Most of Universal's production was attributable to the Kangala Mine. In early September, Universal restarted mining at the NCC, which had been on care-and-maintenance status. The company signed agreements to supply the NCC's production to

Eskom and to export markets. Universal would supply 1.2 Mt/yr of thermal coal to Eskom for 7 years and 650,000 t/yr of thermal coal to export markets for 5 years (Tex Report, The, 2017c, d).

HCI Coal (Pty) Ltd. operated the Mbali and the Palesa Mines. In HCI's fiscal year 2016 (which ended on March 31, 2016), sales from Palesa decreased to 1.89 Mt from 2.09 Mt in fiscal year 2015 and sales from Mbali increased to nearly 608,000 t from 547,000 t in 2015. Coal from Palesa was sold to Eskom (Hosken Consolidated Investments Ltd., 2016, p. 24).

Keaton Energy Holdings Ltd. produced about 2 Mt/yr of salable thermal coal at its Vanggatfontein Mine in Mpumalanga Province. The company was seeking financing for its Moabsvelden project, which could produce between 1.5 Mt/yr and 1.6 Mt/yr of salable thermal coal. Keaton planned to produce a total of 4 Mt/yr from Moabsvelden and Vanggatfontein (Mining Mirror, 2017b).

The Penumbra Mine, which was operated by Continental Coal Ltd., was placed on care-and-maintenance status in February 2015. IchorCoal purchased Penumbra in December 2015 and restarted mining in November 2016; planned production was 500,000 t/yr. 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).

Resource Generation Ltd. (Resgen) of Australia had planned to start production at its new Boikarabelo Mine in the first half of 2016. In the first stage of the project, production was likely to be 6 Mt/yr of thermal coal, of which about 3 Mt/yr would be consumed domestically and 3 Mt/yr would be exported. Resgen planned to start the second phase of the project by 2020; production was expected to increase to 20 Mt/yr of thermal coal. The startup of the mine was delayed until the first quarter of 2019 (Projects in Progress, 2014c; Mining Mirror, 2017a).

Coal of Africa Ltd. planned to start construction of the Makhado project at the Southpansberg coalfield in Limpopo Province in 2016; production was expected to start in 2019. The company planned to produce 3.2 Mt/yr of thermal coal and 2.3 Mt/yr of coking coal during the estimated 16-year life of the mine. Coal of Africa received an Integrated Water Use License from the Government in 2016; the license subsequently was suspended after an appeal based on environmental concerns. At yearend, the license remained suspended and construction had not started (Australia's Paydirt, 2016; Modern Mining, 2017a).

Uranium.—AngloGold Ashanti mined uranium as a coproduct of gold. The company's production of uranium from its Kopanang and Moab Khotsong Mines was about 310 t in 2016 compared with 350 t in 2015 (AngloGold Ashanti Ltd., 2017b).

In 2016, Sibanye produced 47 t of uranium from the Cooke Operations as a coproduct of gold. The company completed a feasibility study on the development of the WRTRP in the fourth quarter of 2016. Planned steady-state production in the study was about 410 t/yr of U_3O_8 in the first phase of the project; total planned production in the first 40 years was more than 14,000 t. Development of the WRTRP depended on the results of operations at a pilot plant expected to start in the second quarter of 2017 (Sibanye Gold Ltd., 2017, p. 46–47).

Shiva Uranium Ltd. (a subsidiary of Oakbay Resources & Energy) produced between 420 and 480 kg/yr of gold and small amounts of uranium at its mine in North West Province in 2015. Uranium operations were on care-and-maintenance status in late 2016. The company had planned to complete a feasibility study on restarting large-scale underground mining by early 2016. Depending on the results of the study, Shiva could produce between 1,100 and 1,300 t/yr of U_3O_8 starting in May 2017. As of late 2016, the feasibility study had not yet started (Kotze, 2015b; Oakbay Investments (Pty) Ltd., 2016).

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. Depending on the results of the prefeasibility and feasibility studies, Peninsula could start mining at Karoo in 2019. Contained resources at Karoo were estimated to be 25,800 t of U_3O_8, and Peninsula hoped to increase the resources to between 110,000 and 160,000 t of U_3O_8 (Andrews, 2015b, 2016).

Reserves and Resources

South Africa's estimated share of world reserves of PGMs amounted to 94%; chromite, 40%; manganese, 29%; zirconium, 19%; vanadium, 18%; fluorspar, 16%; rutile, 14%; gold, 11%; ilmenite, 8%; and nickel, 5%. The country also had substantial reserves of andalusite, antimony, coal, copper, iron ore, lead, phosphate rock, uranium, vermiculite, and zinc (table 3; Bedinger, 2017a, b; Corathers, 2017; George, 2017; Loferski, 2017; McRae, 2017; Papp, 2017; Polyak, 2017; Schnebele, 2017).

Outlook

Numerous producers are planning new mines and plants and capacity expansions of existing operations for cement, chromite, coal, copper, diamond, ferrochromium, fluorspar, gold, ilmenite, iron ore, manganese ore, nickel, pig iron, PGMs, phosphate fertilizers, phosphate rock, rutile, titanium metal, 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 will depend upon increased rail network capacity. In 2016, Government-owned Transnet deferred plans to spend nearly $800 million on increasing its railway capacity dedicated to iron ore exports. Transnet planned to spend $1 billion on maintaining the capacity of the iron ore railways at 60 Mt/yr. Plans to open a new railway to the Waterberg coal field were delayed until 2021 or 2022; projected spending on coal railways was nearly $1.5 billion. Transnet also planned to spend about $1.2 billion on increasing the capacity of the manganese railways to 16 Mt/yr from 5.5 Mt/yr (Creamer, Terrence, 2016).

Increased coal production will also depend 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 PGMs subsectors will depend upon the adoption of mechanized mining methods. Increased mechanization could lead to an additional 600,000 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, 2017, p. 34).

In the PGMs 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 PGMs other than platinum. 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 COMMODITIES[1]

(Metric tons, gross weight, unless otherwise specified)

Commodity		2012	2013	2014	2015	2016
METALS						
Aluminum metal, primary		665,000	822,000	745,000	695,000	701,000
Antimony, mine, Sb content		3,066	2,405	815	400 e	1,200 e
Chromium, mine, chromite:						
44% to 48% Cr_2O_3	thousand metric tons	1,073	1,608	2,043	2,128	1,935
Less than 44% Cr_2O_3	do.	10,244	12,082	11,995	13,528	12,770
Total	do.	11,300 r	13,700 r	14,000 r	15,700 r	14,700
Cobalt:						
Mine, Co content[e]		2,500	3,000 r	3,000 r	2,900	2,500
Refinery, metal		1,102	1,294	1,332	1,300 e	1,101
Copper:						
Mine, Cu content		81,000	76,500	87,600	77,400	62,000
Smelter, primary		62,300	69,700	71,800 r	71,800	70,300
Refinery, primary		66,416	80,821	78,697	77,360	66,257
Ferroalloys:						
Ferrochromium	thousand metric tons	3,063	3,219	3,719	3,685	3,596
Ferromanganese	do.	706	702	772	512 r	335
Ferronickel, high nickel		800 r, e	1,040 e	--	--	-- e
Ferrosilicon	thousand metric tons	83	78	88 r	91 e	45 e
Ferrovanadium	do.	18 e	18 e	19 e	15 e	7
Silicomanganese[2]	do.	149	134	228	210	144
Gold:						
Mine, Au content	kilograms	155,286	160,016	151,622	144,504	142,077
Refinery[e, 3, 4]	do.	440,000	400,000	370,000 r	340,000 r	300,000
Iron ore, mine:						
Gross weight	thousand metric tons	67,100	71,645	80,759	72,806	66,456
Fe content[e]	do.	43,000 r	46,000 r	51,500 r	46,000 r	42,000
Iron and steel:						
Direct-reduced iron	do.	1,493	1,295	1,612 r	1,125 r	702
Pig iron	do.	4,599	4,928	4,402 r	4,464	4,311
Raw steel	do.	6,938	7,162	6,412 r	6,417 r	6,141
Products, stainless	do.	505	493	473	515	582
Lead:						
Mine, Pb content		52,489	41,848	29,348	34,573	39,344
Refinery, secondary		54,000	52,000	52,000	52,000	54,000
Manganese:						
Mine production:						
Metallurgical, gross weight:						
30% to 40% Mn	thousand metric tons	4,833	6,581	9,776	12,259	11,220
40% to 45% Mn	do.	1,187	1,319	1,703	2,499	1,082
45% to 48% Mn	do.	2,711	3,057	2,572	1,194	1,434
More than 48% Mn	do.	200	--	--	--	--
Total	do.	8,930 r	11,000 r	14,100 r	16,000 r	13,700
Chemical, 35% to 65% MnO_2	do.	12	1	--	--	--
Grand total	do.	8,950 r	11,000 r	14,100 r	16,000 r	13,700
Mn content[e]	do.	3,600	4,300	5,300	5,900	5,200
Electrolytic, metal	do.	30	30 e	30 e	30 e	30 e
Nickel:						
Mine, Ni content		45,945	51,208	54,956	56,689	48,994
Smelter, matte		26,000	31,000	36,000	35,000	35,000
Chemicals		5,093	5,000 r, e	3,500 r, e	5,300 r, e	4,700 e
Refinery, metal, electrolytic		32,900	33,200	34,100	42,000	42,900

See footnotes at end of table.

TABLE 1—Continued
SOUTH AFRICA: PRODUCTION OF MINERAL COMMODITIES[1]

(Metric tons, gross weight, unless otherwise specified)

Commodity		2012	2013	2014	2015	2016
METALS—Continued						
Platinum-group metals:						
Mine, elemental content:						
Iridium	kilograms	5,665	5,680	4,231	6,230	6,624
Palladium	do.	74,738	76,008	58,410	82,691	76,273
Platinum	do.	128,590	137,024	93,991	139,125	133,241
Rhodium	do.	17,810	18,129	12,916	18,722	19,237
Ruthenium	do.	27,535	27,347	18,896	28,747	28,278
Total	do.	254,000	264,000	188,000	276,000	264,000
Refinery:						
Palladium	do.	84,800	82,300	64,100	85,600 r	84,700
Platinum	do.	141,700	144,700	102,400	142,700	142,100
Rhodium	do.	19,300	18,600	13,900	18,200	19,700
Other	do.	32,400	32,100	22,700 r	31,300 r	33,800
Total	do.	278,000 r	278,000 r	203,000 r	278,000 r	280,000
Selenium, anode slimes, Se content[e]	do.	14,000	15,000	12,000 r	13,000 r	15,000
Silicon, metal	thousand metric tons	53	34	47 r	47 r, e	23 e
Silver, mine, Ag content	kilograms	67,304	68,777	49,220	51,861	52,127
Tellurium, anode slimes, Te content[e]	do.	6,400	7,100 r	5,600 r	6,300 r	6,800
Titanium:						
Mineral concentrates:						
Ilmenite[e]	thousand metric tons	2,650	2,530	2,390 r	1,900 r	2,200
Rutile[e]	do.	150	70	120 r	100 r	100
Total	do.	2,800 r	2,600 r	2,510 r	2,000 r	2,300
Titaniferous slag[e]	do.	1,300	1,170	1,090	950	770
Vanadium, mine, V content		19,957	21,397	21,582	17,788	10,000 e
Zinc, mine, Zn content		37,034	30,145	26,141	29,040	26,695
Zirconium mineral concentrates, baddeleyite and zircon		367,190	224,446	398,101 r	330,000 e	350,000 e
INDUSTRIAL MINERALS						
Cement and clinker:						
Cement, hydraulic, sales	thousand metric tons	11,560	12,168	12,068	12,992 r	13,000 e
Granulated slag, fly ash, and others[e]	do.	1,200	1,300	1,300	1,400 r	1,400
Clay and shale:						
Bentonite		120,592	177,187	171,119	165,535	148,742
Brick clay, local sales	thousand metric tons	7,227	6,897	6,687	7,056	6,861
Fire clay		643,285	506,019	239,906	751,711	985,333
Flint clay, raw and calcined		21,065	22,984	26,891	19,785	10,203
Fuller's earth, attapulgite		15,019	21,233	17,668	17,627	16,374
Kaolin		20,791	22,295	27,258	20,150	21,141
Plastic clay		NA	1,328	268	4,554	--
Shale:						
For cement	thousand metric tons	423	464	404	354	391
For brickmaking	do.	547	830	785	872	1,538
Diamond, gem and industrial	thousand carats	7,250	8,129	8,059	8,233	8,451
Diatomite		282	144	--	-- e	-- e
Feldspar, mine		94,458	191,443	102,541	130,184	131,023
Fluorspar, mine:						
Acid grade[e]		160,000	150,000	150,000	110,000	160,000
Metallurgical grade[e]		10,000	8,000	14,000	10,000	17,000
Total		170,000 r	158,000 r	164,000 r	120,000 e	177,000
Garnet, industrial		--	--	254,816	284,990	270,802
Gypsum, crude		558,242	559,443	376,223	231,688	266,811
Kyanite and related minerals, andalusite		163,801	175,328	172,657	190,000 e	180,000 e
Lime	thousand metric tons	1,209	1,187	1,255	1,115	1,117
Magnesite, crude		12,878	8,219	12,335	12,000 e	12,000 e

See footnotes at end of table.

TABLE 1—Continued
SOUTH AFRICA: PRODUCTION OF MINERAL COMMODITIES[1]

(Metric tons, gross weight, unless otherwise specified)

Commodity		2012	2013	2014	2015	2016
INDUSTRIAL MINERALS—Continued						
Mica, ground and scrap		400	309	83	29	8
Nitrogen, ammonia, N content[e]		620,000	620,000	620,000	620,000	620,000
Perlite		NA	1,078	1,100	1,000 [e]	1,000 [e]
Phosphate rock:						
Gross weight	thousand metric tons	2,242	2,132	2,011	1,852	1,697
P_2O_5 content	do.	829	788	743	685	630 [e]
Salt		399,135	479,024	493,798	517,159	488,984
Sand and gravel, industrial, silica	thousand metric tons	2,155	2,296	2,605	2,271	1,879
Sodium sulfate, natural		36,435	41,428	51,751	38,374	26,248
Stone, sand, and gravel, construction:						
Aggregates, unspecified	thousand metric tons	41,305	46,553	47,972	49,058	51,054
Sand, construction	do.	13,344	14,861	14,220	14,743	14,746
Stone, crushed, limestone and dolomite	do.	17,269	21,966	21,776	22,905	23,537
Stone, dimension:						
Granite, including norite		187,475	236,231	233,420 [r]	270,427 [r]	266,958
Slate		23,938	19,266	19,051	885 [r, 5]	2,189 [5]
Sulfur, byproduct, S content:						
Metallurgy		103,114 [r]	110,903 [r]	102,438 [r]	105,000 [r, e]	103,000 [e]
Petroleum		153,905 [r]	159,270 [r]	174,580 [r]	179,000 [r, e]	177,000 [e]
Total		257,000 [r]	270,000 [r]	277,000 [r]	284,000 [r]	281,000
Talc and related materials:						
Pyrophyllite, wonderstone		18,734	17,336	22,500	16,801	19,114
Talc		4,765	4,924	4,827	4,497	4,462
Vermiculite		132,886	127,658	143,007	138,290	166,483
Wollastonite[e]		4,500 [r]	6,700 [r]	9,000 [r]	9,000 [r]	9,000
MINERAL FUELS AND RELATED MATERIALS						
Coal, marketable:						
Anthracite	thousand metric tons	3,005	3,621	3,517	3,395	2,612
Bituminous[e]	do.	252,000 [r]	249,000 [r]	255,000 [r]	245,000 [r]	245,000
Metallurgical[e]	do.	4,000	3,900	3,400	3,800	3,400
Coke, metallurgical, marketable	do.	2,070	2,218	2,111	2,100 [e]	2,100 [e]
Natural gas	million cubic meters	1,313	927	1,194	1,476	908
Natural gas liquids	thousand 42-gallon barrels	928 [r]	636 [r]	924 [r]	738 [r]	405
Petroleum:	do.					
Crude	do.	343	139	--	--	--
Refinery production:						
Distillate fuel oil	do.	57,494	58,442	52,220	41,800 [r]	42,000
Gasoline	do.	53,295	58,976	49,227	47,800 [r]	48,000
Jet fuel	do.	9,445	13,077	12,434	14,600 [r]	15,000
Kerosene	do.	2,729	3,278	3,448	3,550 [r]	3,500
Liquefied petroleum gas	do.	3,422	3,387	2,494	3,690 [r]	3,700
Residual fuel oil	do.	19,021	22,344	20,806	25,200 [r]	25,000
Other, inlcuding lubricants and greases[e]	do.	17,000	19,000	17,000	16,000 [r]	16,000
Total[e]	do.	163,000	179,000 [r]	158,000 [r]	153,000 [r]	153,000
Uranium, mine production, U content		467 [r]	531 [r]	566 [r]	448 [r]	382

[e]Estimated. [r]Revised. do. Ditto. NA Not available. -- Zero.

[1]Table includes data available through March 15, 2018. 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.

[2]Reported by the International Manganese Institute.

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

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

[5]May include other types of dimension stone.

TABLE 2
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 2016

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
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, near Thabazimbi, Northern Province	70.
Antimony, mine	Stibium Mining (Pty) Ltd.	Cons Murch Mine near Gravelotte	7.
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 South Africa Ltd. (LafargeHolcim Ltd.)	Lichtenburg plant in North West Province	3,500.
Do.	Dangote Cement South Africa (Pty) Ltd. (Dangote Industries Ltd., 64%)	Plants near Delmas in Mpumalanga Province and at Lichtenburg	2,700.
Do.	Natal Portland Cement Co. (Pty) Ltd. (Cimentos de Portugal SGPS, S.A., 98%)	Simuma plant in KwaZulu-Natal Province	2,400.
Do.	Mamba Cement Company (Pty) Ltd	Plant near Northam	1,000.
Chromite	Glencore plc, 79.5%, and Merafe Resources Ltd., 20.5%	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.	do.	Magareng Mine in Mpumalanga Province	1,200.
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 Mines	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.	Anglo American Platinum Ltd. (Amplats) (Anglo American plc, 78%)	Plant at Amandelbult Mine	700.
Do.	Anglo American Platinum Ltd. (Amplats) and Siyanda Resources	Masa plant at Union Mine	330.
Do.	Nkomati Joint Venture (African Rainbow Minerals Ltd., 50%, and MMC Norilsk Nickel, 50%)	Nkomati Chrome Mine in Mpumalanga Province	1,000.
Do.	ASA Metals (Pty) Ltd. (Sinosteel Corp., 60%, and Limpopo Economic Development Enterprise, 40%)	Dilokong Mine, near Burgersfort in Mpumalanga Province[1]	800.
Do.	Northam Platinum Ltd.	Booysendal North and Zondereinde Mines	590.[e]
Do.	Afarak Group Oyj	Mecklenburg, Stellite, and Vlakpoort Mines	500.[e]
Do.	Bayer (Pty) Ltd.	Rustenburg Chrome Mine	450.
Do.	Sibanye Gold Ltd.	Waterval plant near Rustenburg Mine	400.[e]
Do.	Chromtech Holdings (Pty) Ltd.	ChronMin and Waterval Chrome Services plants	280.[e]
Do.	Impala Platinum Holdings Ltd. (Implats)	Impala Mines near Rustenburg	220.[e]
Coal	Anglo Coal Ltd. (Anglo American plc, 100%)	New Vaal Mine near Vanderbijlpark	18,000.
Do.	Anglo Coal Ltd., 73% (Anglo American plc, 100%)	Kriel Mine in Mpumalanga Province	10,000.
Do.	do.	Zibulo Mine in Mpumalanga Province	8,000.
Do.	Anglo Coal Ltd. (Anglo American plc, 100%)	Goedehoop Mine in Mpumalanga Province	7,500.
Do.	do.	Isibonelo Mine in Mpumalanga Province	5,000.
Do.	do.	New Denmark Mine in Mpumalanga Province	5,000.
Do.	do.	Kleinkopje Mine near Witbank	4,500.

See footnotes at end of table.

TABLE 2—Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 2016

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Coal—Continued	Anglo Coal Ltd. (Anglo American plc, 100%)	Landau Mine near Witbank	4,200.
Do.	do.	Greenside Mine near Witbank	3,100.
Do.	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.[e]
Do.	do.	Leeuwpan Mine in Mpumalanga Province	4,200.[e]
Do.	do.	North Block Complex in Mpumalanga Province	3,300.
Do.	Exxaro Resources Ltd., 50%, and Anglo American plc, 50%	Mafube Mine	4,200.
Do.	Sasol Ltd.	Syferfontein Mine	9,500.
Do.	do.	Bosjesspruit Mine	7,900.
Do.	do.	Middelbult Mine	7,400.
Do.	do.	Brandspruit Mine[1]	6,900.
Do.	do.	Twistdraai Mine	6,900.
Do.	do.	Impumelelo Mine	2,100.
Do.	do.	Sigma Mine	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.	Glencore plc, 74%	Goedgevonden Complex at Witbank	7,700.
Do.	Glencore plc, 79.8%	Tweefontein Complex at Witbank	7,200.
Do.	do.	Impunzi Complex at Witbank	6,700.
Do.	Umcebo Mining Ltd. (Glencore plc, 48.7%)	Wonderfontein Mine	3,500.[e]
Do.	do.	Wildfontein Mine[1]	2,000.[e]
Do.	Izimbiwa Coal (Pty) Ltd. (Shanduka Resources (Pty) Ltd., 50.01%, and Glencore plc, 49.99%)	Corobrik, Graspan, and Springlake Mines	4,500.[e]
Do.	Optimum Coal Holdings (Pty) Ltd. [Tegeta Exploration & Resources (Pty) Ltd., 67.6%]	Optimum Complex	11,000.
Do.	do.	Koornfontein Complex	3,000.[e]
Do.	Mbuyelo Coal (Pty) Ltd. (Mbuyelo Group, 49%, and IchorCoal N.V., 45%)	Welgemeend Mine	1,700.[e]
Do.	do.	Manungu Mine	1,600.[e]
Do.	do.	Rirhandzu Mine	1,200.[e]
Do.	do.	Vlakvarkfontein Mine	1,200.[e]
Do.	Burgh Group Holdings	Leeeuwpoort, Mooifontein, and other mines	5,000.[e]
Do.	Wescoal Holdings Ltd.	Elandspruit Mine	2,000.
Do.	do.	Khanyisa Mine[1]	1,000.
Do.	do.	Intibane Mine	1,000.
Do.	Universal Coal plc	Kangala Mine in Mpumalanga Province	2,100.[e]
Do.	do.	New Clydesdale Mine in Mpumalanga Province[1]	1,400.
Do.	Kangra Group Pty. Ltd. (Shanduka Resources (Pty) Ltd., 30%)	Savmore Mine	3,000.
Do.	Imbawula Group	Mpumalanga Division (Spitzkop and Tselentis Mines) at Breyten and Ermelo	2,800.
Do.	Keaton Energy Holdings Ltd.	Vanggatfontein Mine in Mpumalanga Province	2,640.
Do.	Kuyasa Mining (Pty) Ltd.	Delmas Mine	2,000
Cobalt:			
Mine	Nkomati Joint Venture	Nkomati Mine in Mpumalanga Province	1,200.[e]
Do.	Anglo American Platinum Ltd. (Amplats) (Anglo American plc, 78%)	Amandelbult, Mogalakwena, Union, and other mines	500.[e]
Refinery	Anglo American Platinum Ltd. (Amplats)	Rustenburg Base Metal Refiners	700.[e]

See footnotes at end of table.

TABLE 2—Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 2016

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Copper:				
Mine		Palabora Mining Co. Ltd.	Palabora Mine at Phalaborwa	65.[2]
Do.		Anglo American Platinum Ltd. (Amplats)	Amandelbult, Mogalakwena, Union, and other mines	13.[2]
Do.		Nkomati Joint Venture	Nkomati Mine in Mpumalanga Province	10.
Do.		Impala Platinum Holdings Ltd. (Implats)	Impala Mines	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 Holdings Ltd. (Implats)	Smelter near Phokeng	7.[2]
Refinery		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 Ltd. (Implats)	Base Metals Refinery	7.[2]
Diamond	thousand carats	De Beers Consolidated Mines Ltd. (Anglo American plc, 85%)	Venetia Mine in Northern Province	7,500.
Do.	do.	do.	Voorspoed Mine	800.
Do.	do.	Petra Diamonds Ltd.	Finsch Mine, 100 kilometers west of Kimberley	2,000.
Do.	do.	do.	Kimberley surface and underground mines	1,670.
Do.	do.	do.	Cullinan Mine	950.[e]
Do.	do.	do.	Koffiefontein Mine in Free State Province	60.[e]
Do.	do.	DiamondCorp plc	Lace Mine[1]	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 S.A., 85%)	Vergenoeg Mine at Rust de Winter	250.
Garnet, industrial		Mineral Commodities Ltd. (MCL)	Tormin Mine in Western Cape Province	300.
Gold:				
Mine	kilograms	Sibanye Gold Ltd.	Driefontein Mine	18,000.[e]
Do.	do.	do.	Kloof Mine	17,000.[e]
Do.	do.	do.	Beatrix Mine	10,000.[e]
Do.	do.	do.	Cooke Operations	7,500.[e]
Do.	do.	do.	Burnstone Mine[1]	3,100.
Do.	do.	AngloGold Ashanti Ltd. (Anglo American plc, 41.8%)	Moab Khotsong Mine	13,000.
Do.	do.	do.	Mponeng Mine	10,000.
Do.	do.	do.	Great Noligwa and Kopanang Mines	9,000.
Do.	do.	do.	Tau Tona Mine	8,100.
Do.	do.	do.	Surface mining operations	6,500.[e]
Do.	do.	Harmony Gold Mining Co. Ltd.	Kusasalethu Mine	8,900.
Do.	do.	do.	Doornkop Mine	6,100.
Do.	do.	do.	Target 1 and Target 3[1] Mines	5,800.[e]
Do.	do.	do.	Tshepong Mine	4,500.
Do.	do.	do.	Joel Mine	4,200.[e]
Do.	do.	do.	Masimong Mine	3,900.
Do.	do.	do.	Phakisa Mine	3,900.[e]
Do.	do.	do.	Bambanani Mine	3,800.[e]
Do.	do.	do.	Surface operations	3,000.
Do.	do.	do.	Unisel Mine	1,900.
Do.	do.	Gold Fields Ltd.	South Deep Mine	9,200.

See footnotes at end of table.

TABLE 2—Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 2016

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Gold:				
Mine—Continued	kilograms	Pan African Resources plc	Barberton Mine	3,000.
Do.	do.	do.	Evander Mine	3,000.
Do.	do.	do.	Barberton Tailings Retreatment Project	930.
Do.	do.	do.	Evander Tailings Retreatment Project	620.
Do.	do.	Gold One International Ltd.	Modder East Mine	4,700.
Do.	do.	DRDGold Ltd.	Ergo operations near Johannesburg	4,500.[e]
Do.	do.	Village Main Reef Ltd.	Tau Lekoa Mine	3,200.[e]
Do.	do.	Anglo American Platinum Ltd. (Amplats)	Amandelbult, Mogalakwena, Union, and other mines	3,000.[e]
Refinery	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.	Kolomela Mine in Northern Cape Province	13,000.
Do.		do.	Thabazimbi Mine at Thabazimbi[1]	2,700.
Do.		Assmang (Pty) Ltd.	Khumani Mine in Northern Cape Province	16,000.
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 plc, 85.11%)	Mapochs Mine at Roossenekal[1]	2,700.
Do.		Vametco Minerals Corp. (Ervaz plc, 81%)	Vametco Mine near Brits	1,100.
Do.		Glencore plc	Rhovan Mine at Brits	400.
Ferroalloys		Glencore plc, 79.5%, and Merafe Resources Ltd., 20.5%	Lion plant at Steelpoort	720 ferrochromium.
Do.		do.	Wonderkop plant at Marikana	553 ferrochromium.
Do.		do.	Rustenburg plant at Rustenburg	430 ferrochromium.
Do.		Glencore plc, 69.6%, and Merafe Resources Ltd., 30.4%	Lydenburg plant at Lydenburg	396 ferrochromium.
Do.		Glencore plc, 79.5%, and Merafe Resources Ltd., 20.5%	Boshoek plant at Boshoek	240 ferrochromium.
Do.		Samancor Chrome (Pty) Ltd.	Plants at Middelburg, Steelpoort, and Witbank	1,200 ferrochromium.
Do.		do.	Buffelsfontein plant in North West Province	267 ferrochromium.
Do.		Hernic Ferrochrome (Pty) Ltd.	Plant at Brits	420 ferrochromium.
Do.		ASA Metals (Pty) Ltd.	Plant near Pietersburg, Northern Province[1]	400 ferrochromium.
Do.		International Ferro Metals Ltd.	Buffelsfontein plant in North West Province[1]	267 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%, and Anglo American plc, 40%)	Plant at Meyerton	500 ferromanganese.
Do.		Transalloys (Pty) Ltd. (Renova Group)	Plant at Witbank[1]	50 ferromanganese; 170 silicomanganese.
Do.		Ferroglobe plc	New Castle plant at Ballengeich[1]	45 ferrosilicon.
Do.		do.	eMalahleni plant[1]	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.	do.	Vametco Minerals Corp.	Plant near Brits	4,800 ferrovanadium.
Do.		Afarak Group Oyj	Mogale plant	110 ferroalloys.
Steel		ArcelorMittal South Africa Ltd.	Vanderbijlpark plant	4,500 crude steel.
Do.		do.	Newcastle and Vereeniging plants	2,300 crude steel.
Do.		do.	Saldanha plant	1,200 crude steel.

See footnotes at end of table.

TABLE 2—Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 2016

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Iron and steel:—Continued			
Steel—Continued	Evraz Highveld Steel and Vanadium Ltd.	Plant at Witbank[1]	815 crude steel.
Do.	Columbus Stainless (Pty) Ltd. (Acerinox SA, 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. (Cisco)	Kuilsrivier plant, Cape Town	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.
Manganese	Hotazel Manganese Mines (Pty) Ltd. (South32 Ltd., 44.4%, and Anglo American plc, 29.6%)	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%)	Kalahari Mine	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	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.
Nickel	Anglo American Platinum Ltd. (Amplats)	Amandelbult, Mogalakwena, Union, and other mines	33 mine.[e]
Do.	do.	Rustenburg Base Metal Refiners	33 refined.
Do.	Nkomati Joint Venture	Nkomati Mine in Mpumalanga Province	21 mine.
Do.	Impala Platinum Holdings Ltd.	Impala Mines	6 mine.[e]
Do.	do.	Base Metals Refinery	16 refined.[e]
Do.	Lonmin plc	Marikana and Pandora Mines	4 mine.[e]
Do.	do.	Base Metals Refinery	5 sulfate.[e]
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	Farmers World Limpopo (Pty) Ltd.	Plant at Phalaborwa	325.

See footnotes at end of table.

TABLE 2—Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 2016

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Platinum-group metals	kilograms	Sibanye Gold Ltd.	Rustenburg Mine	24,000 platinum; 11,900 palladium; 3,100 rhodium; 5,500 iridium and ruthenium.
Do.	do.	Anglo American Platinum Ltd. (Amplats)	Amandelbult Mine	16,000 platinum; 7,300 palladium; 2,400 rhodium; 4,200 iridium and ruthenium.
Do.	do.	Anglo American Platinum Ltd. (Amplats), 85%	Union Mine at Swartklip	10,700 platinum; 4,600 palladium; 1,800 rhodium; 3,100 iridium and ruthenium.
Do.	do.	Royal Bafokeng Platinum Ltd. (RBPlat) [Royal Bafokeng Nation, 67%, and Anglo American Platinum Ltd. (Amplats), 33%]	Bafokeng Rasimone Platinum Mine at Rasimone	5,900 platinum; 2,400 palladium; 790 ruthenium; 460 rhodium; 150 iridium.
Do.	do.	do.	Styldrift Mine	6,900 platinum; 3,100 palladium, rhodium, and gold.
Do.	do.	Kroondal Platinum Mines [Anglo American Platinum Ltd. (Amplats), 50%, and Sibanye Gold Ltd., 50%]	Kroondal Platinum Mine	7,800 platinum; 3,800 palladium; 2,300 ruthenium; 1,500 rhodium; 550 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.
Do.	do.	Anglo American Platinum Ltd. (Amplats)	Mogalakwena Mine at Ga-Masenya	13,000 platinum; 14,500 palladium; 880 rhodium; 870 iridium and ruthernium.
Do.	do.	Anglo American Platinum Ltd. (Amplats), 50%, and XK Platinum Partnership, 50%	Mototolo Mine at Steelpoort	4,100 platinum; 2,400 palladium; 630 rhodium; 1,300 iridium and ruthernium.
Do.	do.	Anglo American Platinum Ltd. (Amplats)	Polokwane smelter at Polokwane, Mortimer smelter at Swartklip, and Waterval smelter	85,000 platinum; 48,000 palladium; 12,000 rhodium.
Do.	do.	do.	Precious Metals Refinery	81,000 platinum; 45,700 palladium; 10,800 rhodium; 18,800 iridium and ruthernium.

See footnotes at end of table.

TABLE 2—Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 2016

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Platinum-group metals—Continued	kilograms	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.	do.	Smelter near Phokeng	81,000 platinum; 52,600 palladium; 11,600 rhodium; 17,000 gold, iridium, and ruthenium.
Do.	do.	do.	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	Marikana and Pandora Mines	24,900 platinum; 11,600 palladium; 5,300 ruthenium; 3,400 rhodium; 1,100 iridium.
Do.	do.	do.	Precious Metals Refinery at Western Platinum	31,000 platinum metal; 14,600 palladium metal; 7,000 ruthenium metal; 4,300 rhodium metal; 1,400 iridium metal.
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.	Booysendal North Mine	2,900 platinum; 1,600 palladium; 470 rhodium.
Do.	do.	Marikana Platinum Mine [Anglo American Platinum Ltd. (Amplats), 50%, and Aquarius Platinum Ltd., 50%]	Marikana Mine	2,700 platinum; 1,300 palladium; 760 ruthenium; 480 rhodium; 210 iridium.
Do.	do.	Sedibelo Platinum Mines Ltd.	Pilanesberg Mine	5,400 platinum; 1,700 palladium; 490 rhodium.
Do.	do.	Atlatsa Resource Corp., 51%, and Anglo American Platinum Ltd. (Amplats), 49%	Bokoni Mine at Sefateng	4,100 platinum; 2,700 palladium; 470 rhodium.
Do.	do.	Two Rivers Platinum Mine (Pty) Ltd. (African Rainbow Minerals Ltd., 55%, and Impala Platinum Holdings Ltd., 45%)	Two Rivers Platinum Mine near Steelpoort	5,100 platinum; 2,900 palladium; 1,500 ruthenium; 870 rhodium; 330 iridium.
Do.	do.	Platinum Group Metals Ltd.	Maseve Mine	5,500 platinum; 2,300 palladium; 430 rhodium.

See footnotes at end of table.

TABLE 2—Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 2016

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Platinum-group metals—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.	Platinum Australia Pty Ltd. (PLA)	Smokey Hills Mine[1]	3,000 platinum-group metals.
Do.	do.	Sylvania Platinum Ltd.	Sylvania Dump Operations	1,100[e] platinum; 520[e] palladium; 290[e] rhodium.
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.	Piet Retief Mine	NA.
Selenium	kilograms	Impala Platinum Holdings 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[1]	55 silicon metal.
Do.		do.	eMalahleni plant[1]	12 silicon metal.
Silver:				
Mine	metric tons	Vedanta Resources plc	Black Mountain Mine	50 mined silver.
Refinery	do.	Rand Refinery (Pty) Ltd. (AngloGold Ashanti Ltd., 53%, and Gold Fields Ltd., 33%)	Germiston, Gauteng Province	200 refined silver.
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 Holdings Ltd. (Implats)	Impala and Marula Mines	5,000.[e]
Do.	do.	Palabora Mining Co. Ltd.	Palabora Mine and plant at Phalaborwa	5,300.[e]
Titanium:				
Mineral concentrates		Richards Bay Minerals (RBM) (Rio Tinto plc, 74%, and Blue Horizon Investments, 24%)	Open cast operations, near Richards Bay	2,000 ilmenite;[e] 100 rutile.[e]
Do.		Tronox Ltd., 74% (Exxaro Resources Ltd., 44.65%)	Namakwa Mine 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	100 ilmenite; 5.5 rutile.
Slag		Richards Bay Minerals (RBM) (Rio Tinto plc, 74%, and Blue Horizon Investments, 24%)	Smelter at Richards Bay	1,050.
Do.		Tronox Ltd., 74% (Exxaro Resources Ltd., 44.65%)	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 project (MWS)	650.[e]
Do.	do.	Sibanye Gold Ltd.	Cooke Operations	120.[e]
Do.	do.	Shiva Uranium Ltd.	North West Province[1]	NA.

See footnotes at end of table.

TABLE 2—Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 2016

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Vanadium metric tons	Vanchem Vanadium Products (Pty) Ltd. (Duferco Group)	Plant at Witbank[1]	5,000.[e]
Do. do.	Vametco Minerals Corp.	Vametco Mine and Brits plant	2,850.
Vanadium pentoxide do.	Evraz Highveld Steel and Vanadium Ltd. (Ervaz plc, 85.11%)	Mapochs Mine near Lydenburg[1]	17,500.
Do. do.	do.	Plant at Witbank	10,800.
Do. do.	Glencore plc, 74%	Rhovan Mine at Brits	10,000.
Vermiculite	Palabora Mining Co. Ltd.	Palabora Mine and plant at Phalaborwa	200.
Wollastonite metric tons	Namaqua Wollastonite (Pty) Ltd.	Magata Mine	12,000.[e]
Zinc, mine	Black Mountain Mineral Development Co. (Pty) Ltd.	Black Mountain Mine near Aggeneys in Northern Cape Province	40.
Zircon	Richards Bay Minerals (RBM) (Rio Tinto plc, 74%, and Blue Horizon Investments, 24%)	Open cast mines near Richards Bay	300 zircon in concentrate.
Do.	Tronox Ltd., 74% (Exxaro Resources Ltd., 44.65%)	Namakwa Mine 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.

[e]Estimated. Do., do. Ditto. NA Not available.
[1]Not operating at the end of 2016.
[2]Data are from the International Copper Study Group.

TABLE 3
SOUTH AFRICA: RESERVES OF MAJOR MINERAL COMMODITIES IN 2016[1]

(Million metric tons unless otherwise specified)

Commodity		Reserves
Antimony	thousand metric tons	27
Coal, recoverable		66,700
Copper		11
Fluorspar		41
Gold	thousand metric tons	6
Iron ore		650
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
Zinc		15
Zirconium minerals		14

[1]Metallic minerals are contained metal or element in ore.

Sources:
Corathers, L.A., 2018, Manganese: U.S. Geological Survey Mineral Commodity Summaries 2018, p. 104–105.
Mwape, P., Mnguni, M., Malie, S., and Menoe, K., 2016, General review, *in* South Africa's Mineral Industry 2014/2015: Pretoria, South Africa, Department of Mineral Resources of the Republic of South Africa, p. 1–29.