



2019 Minerals Yearbook

MADAGASCAR [ADVANCE RELEASE]

THE MINERAL INDUSTRY OF MADAGASCAR

By Thomas R. Yager

In 2019, Madagascar played a significant role in the world's production of cobalt, graphite, ilmenite, mica, nickel, rare earths, and zircon. The country's share of world production of graphite and ilmenite was 4% each; cobalt, rare earths, and zircon, 2% each; and nickel, 1%. Other domestically significant minerals produced included chromite, gemstones, and ornamental stones. Madagascar was not a globally significant consumer of minerals in 2019 (Banque Centrale de Madagascar, 2020, p. 116; Gambogi, 2021a, b; Jasinski, 2021; McRae, 2021; Olson, 2021; Sangine, 2021; Shedd, 2021).

Minerals in the National Economy

In 2019, the mining and quarrying sector accounted for an estimated 4.1% of the gross domestic product, and the manufacturing sector, 10.1%. The value of output in the mining and quarrying sector increased by 10.3% in 2019 after decreasing by 2% in 2018 (Economic Commission for Africa, 2020).

In 2019, Madagascar's total exports were valued at \$2.61 billion,¹ of which minerals accounted for at least 30%. Nickel accounted for 17.3% of the value of total exports in 2019; cobalt, 4%; ilmenite, 3.6%; gold, 3.3%; zircon, 0.9%; and chromite and graphite, a total of 1.2%. In 2019, total imports were valued at \$3.8 billion, of which mineral fuels accounted for 14.7% (Banque Centrale de Madagascar, 2020, p. 114–116).

The United States imported nickel from Madagascar valued at \$11.2 million in 2019 and \$24.1 million in 2018. Other mineral imports from Madagascar included nonferrous metals other than copper and gold, which were valued at \$57.5 million in 2019 and \$65.2 million in 2018. Imports of gemstones other than diamond increased in value to \$30.7 million in 2019 from \$17.8 million in 2018 (U.S. Census Bureau, 2021).

Formal employment was about 6,000 workers in large-scale mining operations and 4,000 workers as licensed gold panners in 2016 (the latest year for which data were available). Estimates of informal employment in artisanal and small-scale mining were between 500,000 and more than 1 million workers. Informal gold mining was estimated to employ about 450,000 workers; sapphire mining, more than 65,000 workers; and mica mining, more than 22,000 workers (van der Waal, 2019, p. 15, 23, 46).

Madagascar's mining and quarrying sector is governed by the Mining Code and its implementing decree (law No. 99–022 of August 19, 1999, as amended by law No. 2005–021 of October 17, 2005, and Decree No. 2006–910 of December 19, 2006). Exploration and production of petroleum are governed by the Petroleum Code and its implementing decree (law No. 96–018 of September 4, 1996, and Decree No. 97–740 of June 23, 1997).

¹Where necessary, values have been converted from Malagasy ariary (MGA) to U.S. dollars (US\$) at the annual average exchange rate of MGA4,998.9=US\$1.00 for 2019.

In December 2019, the Government was considering the adoption of a new mining law. The draft of the new mining code had provisions to increase royalty rates and to mandate a Government interest of at least 20% in mining projects. Royalty rates for cut gemstones, cobalt, nickel, and precious metals would increase to 4% from 2%. Royalty rates for rough gemstones would increase to 8% from 2%; the rates for rough industrial stones and cut industrial stones would be set at 6% and 3%, respectively (Rabary, 2019).

Production

In 2019, crude petroleum production increased by an estimated 350%; rare earths, by an estimated 100%; granite, by 49%; amethyst, by an estimated 29%; zircon, by 25%; ilmenite and rutile, by 21% each; quartz, by 12%; and graphite, by 11%. Between 2015 and 2019, the output of graphite increased by 567%; rutile, by an estimated 179%; ilmenite, by 178%; clay (other than kaolin) and zircon, by 140% each; granite, by 135%; and mica, by 101%.

The production of mica decreased by 31% in 2019; chromite and gold, by 30% each; and amazonite, by an estimated 10%. Between 2015 and 2019, quartz production decreased by 95%; garnet, by an estimated 91%; tourmaline, by an estimated 80%; ruby, by an estimated 59%; and chromite, by 49%.

In 2019, increased production of ilmenite and rutile may have been attributable to higher prices on world markets. Amethyst production increased as operations were restored after civil unrest in 2018. Data on mineral production are in table 1.

Structure of the Mineral Industry

Most of Madagascar's mining and mineral-processing operations were privately owned, including the gemstone, graphite, mineral sands, nickel, and salt mines and the cement plants. Artisanal and small-scale miners produced most of Madagascar's gemstones, gold, and mica; salt also was produced by artisanal miners. State-owned Kraomita Malagasy SA (KRAOMA) held a 20% share in the country's only chromite-mining operation. The Government also held a 20% share in the country's only mineral-sands mine. Ammonium sulfate fertilizer, cobalt, crude petroleum, and nickel also were produced by one company each. Table 2 lists major mineral industry facilities in Madagascar.

Commodity Review

Metals

Chromite.—KRAOMA Mining S.A. produced high-grade chromite from the Bemanevika Mine in the Betsiboka Region. The company's production decreased to about 76,100 metric tons (t) in 2019 from 109,200 t in 2018 and 208,100 t in 2017. Decreased output was attributable to aging equipment

and a labor dispute that shut down mining operations in late November 2018. After restarting in early 2019, mining operations were shut down again in July because of the collapse of an embankment. Production had not resumed at yearend (table 1; Rakotobe and Raymond, 2018; Banque Centrale de Madagascar, 2020, p. 116; Ihariliva, 2020).

Cobalt and Nickel.—Sumitomo Corp. of Japan and its joint-venture partners Korea Resources Corp. of the Republic of Korea and Sherritt International Corp. of Canada mined nickel-cobalt laterite deposits at Ambatovy. Lateritic slurry from the Ambatovy ore-processing plant was processed into mixed cobalt and nickel sulfides at a pressure-acid-leaching plant at Tamatave. The sulfide product was processed at a refinery at Tamatave with a capacity of 60,000 metric tons per year (t/yr) of refined nickel and 5,600 t/yr of cobalt (table 2).

Refined nickel production at Ambatovy increased to 33,733 t in 2019 from 33,183 t in 2018, and refined cobalt, to 2,900 t from 2,852 t. In 2019, production was limited by problems with the acid, hydrogen, lime, and limestone plants. Planned production for 2019 was between 34,000 and 36,000 t of refined nickel and between 2,800 and 3,000 t of refined cobalt. The estimated remaining life of the mine was at least 24 years (Sherritt International Corp., 2020, p. 6, 19, 31).

In 2018 (the latest year for which data were available), Japan accounted for about 51% of Madagascar's nickel exports of 32,862 t, and the Republic of Korea, 49%. The United Kingdom accounted for 40% of Madagascar's cobalt exports of 2,701 t in 2018; the United States, 33%; China, 16%; and Japan, 9% (Ernst & Young Global Ltd., 2019b, p. 33).

Gold.—Artisanal and small-scale miners produced gold at various locations, including at Isaka River. In 2019, gold production decreased to 2,100 kilograms (kg) from 3,000 kg in 2018. In August, the Government reportedly shut down two dredging operations that produced gold because of mercury pollution; the operations were located in northern Madagascar. The United Arab Emirates accounted for 97% of Madagascar's gold exports, by volume, in 2018 (Ernst & Young Global Ltd., 2019b, p. 38; Banque Centrale de Madagascar, 2020, p. 116; Carver, 2020).

Rare Earths, Titanium, and Zirconium.—QIT Madagascar Minerals SA (QMM) [QIT Fer et Titane of Canada (a subsidiary of Rio Tinto plc), 80%, and the Government of Madagascar, 20%] mined ilmenite, rutile, and zircon at Mandena in southeastern Madagascar. In 2019, QMM produced 461,800 t of ilmenite and 28,500 t of zircon compared with a revised 381,924 t of ilmenite and 22,757 t in 2018 (Ernst & Young Global Ltd., 2019b, p. 30; Banque Centrale de Madagascar, 2020, p. 116).

The United States accounted for 50% of Madagascar's ilmenite exports of 413,412 t in 2018; Canada, 42%; and Australia, 8%. China accounted for 74% of Madagascar's zircon exports of 22,350 t in 2018; Italy, 17%; and Brazil, 9% (Ernst & Young Global Ltd., 2019b, p. 33).

QMM started the recovery of monazite from tailings at Mandena in 2018. In 2019, the company produced an estimated 4,000 t of rare-earth oxides in monazite compared with 2,000 t in 2018 (table 1; Ernst & Young Global Ltd., 2019a, p. 23).

In March 2019, Base Resources Ltd. of Australia completed a prefeasibility study on the development of the Ranobe Mine, which is part of the Toliara Sands project in southwestern Madagascar. The company completed a feasibility study in December. Planned production according to the study was 780,000 t/yr of ilmenite, 53,000 t/yr of zircon, and 7,000 t/yr of rutile during an estimated 33-year mine life. Base Resources planned to make its final investment decision on the mine in September 2020; mining could start by November 2022, depending on the results. Estimated capital costs of the mine were more than \$440 million (Base Resources Ltd., 2019, p. 3, 5, 49).

Industrial Minerals

Cement.—In 2019, LaFargeHolcim (Madagascar) S.A. produced an estimated 230,000 t of cement compared with 210,000 t in 2018. In late December, China Building Material Product announced plans to reopen its plant at Ambohimambola, which had been closed for several years (table 1; Edmond, 2019).

Clay and Shale, Pumice and Pumicite, and Stone, Crushed.—LaFargeHolcim (Madagascar) produced clay, pozzolanic materials, and limestone for use in its cement plant. The company's production of limestone increased to a revised 190,455 t in 2018 from a revised 166,002 t in 2017 and 164,178 t in 2013. The output of pozzolanic materials was 35,129 t in 2018 compared with 25,070 t in 2017 and 65,000 t in 2013. The increase in the ratio of limestone production to pozzolanic material production could be attributable to the company decreasing its production of pozzolanic cement. The production of clay other than kaolin had decreased to 60,140 t in 2018 from 63,410 t in 2017 (Ernst & Young Global Ltd., 2015, p. 7; 2019a, p. 27; 2019b, p. 30).

Gemstones.—In recent years, Madagascar produced a variety of gemstones that included agate, amazonite, amethyst, calcite, cordierite, emerald, garnet, labradorite, ruby, sapphire, and tourmaline. Gemstones were exported to countries that included India, Indonesia, Italy, and the United States (Ernst & Young Global Ltd., 2019b, p. 34).

Emerald was produced at Mananjary in the Vatovavy Fitovinany Region at the rate of 35 kilograms per year (kg/yr) in 2018 and 2019. Most of the mining was during the dry season between May and December. Production decreased to 36 kg in 2017 from 140 kg in 2012 (table 1; Ministry of Economy and Planning, 2013, p. 55; Onjaniaina, 2018, p. 59).

Madagascar produced garnet, including almandine, grossular, and pyrope garnet. Tsavorite, which is a green grossular garnet that obtains its color from trace amounts of chromium and vanadium, was mined at Behara. In 2018 and 2019, national garnet production was estimated to be 210 kg/yr. Production increased to a revised 2,663 kg in 2014 from 1,531 kg in 2013 before decreasing to 214 kg in 2017 (table 1; Onjaniaina, 2018, p. 63).

In 2018 and 2019, ruby production was estimated to be about 70 kg/yr. Production increased to 171 kg in 2015 from 24 kg in 2012 before decreasing to 72 kg in 2017; decreased output after 2015 could be attributable to the depletion of deposits at Ambodivoangy (table 1; Ministry of Economy and Planning, 2013, p. 55; Pardieu, 2017; Onjaniaina, 2018, p. 60).

In 2018 and 2019, sapphire production was estimated to be 2,100 kg/yr. Production increased to a revised 4,298 kg in 2014 from 2,606 kg in 2012 before decreasing to 2,130 kg in 2017. Decreased output from Ilakaka and other locations was only partially offset by the discovery of new deposits at Bemainty in 2016 (table 1; Ministry of Economy and Planning, 2013, p. 55; Pardieu, 2017; Onjaniana, 2018, p. 61).

Tourmaline was mined at various locations, including Alatsaininuy Ibity. In 2018 and 2019, national tourmaline production was estimated to be 120 kg/yr. Tourmaline production increased to 3,087 kg in 2016 from 594 kg in 2013 before decreasing to 124 kg in 2017 (table 1; Onjaniana, 2018, p. 62).

Norcross Madagascar Group (NMG) of the United States produced about 180 t/yr of amethyst at Ambatondrazaka between 2015 and 2017. The company's mining was disrupted by local unrest in 2018; production was estimated to have increased to previous levels in 2019. NMG's amazonite mine in the Amboasitra Region also was shut down in 2018 by local unrest (Norcross Madagascar Group, undated; Robert Grant, President, Norcross Madagascar Group, written commun., June 10, 2019).

Red Graniti Madagascar SARL and Societe Labrador Madagascar SARL produced labradorite in the Atsimo-Andrefana Region. Societe Labrador's production increased to 3,080 t in 2018 from 2,440 t in 2017, and Red Graniti's production decreased to 1,748 t from 2,885 t (Ernst & Young Global Ltd., 2019a, p. 27; 2019b, p. 31).

Graphite.—In 2019, graphite production increased to 53,400 t from 47,900 t in 2018 and 13,300 t in 2017. Madagascar produced graphite at the rate of 65,000 t/yr in the first half of 2019 before output decreased in the second half. In 2018, China accounted for 99% of Madagascar's exports of graphite, by volume (Chen, 2019; Ernst & Young Global Ltd., 2019b, p. 34; Banque Centrale de Madagascar, 2020, p. 116).

Etablissements Gallois S.A accounted for most domestic graphite production; the company's exports increased to 46,723 t in 2018 from 10,702 t in 2017. Increased production in 2018 was attributable to recent increases in capacity to 150,000 t/yr (table 2; Ernst & Young Global Ltd., 2019a, p. 30; 2019b, p. 34).

Bass Metals Ltd. of Australia restarted mining at its Graphmada project near Mahatsara in 2018. The company planned to produce 6,000 t/yr of graphite in the first phase of the project and to increase production to 20,000 t/yr starting in 2020. In its fiscal year 2019 (which started on July 1, 2018, and ended on June 30, 2019), Bass Metals produced 4,031 t of graphite. In July and August, large-flake graphite accounted for 61% of production compared with 42% between April and June (Andrews, 2018; Argus Media, 2019).

In March 2019, Tirupati Graphite PLC of the United Kingdom opened a new processing plant with a capacity of 3,000 t/yr at its Sahamamy project; the company was producing at full capacity in December. Production at Sahamamy was 50% jumbo-flake graphite (flakes larger than 300 microns) and 35% large-flake (flakes between 180 and 300 microns). Tirupati planned to increase its capacity at Sahamamy to 21,000 t/yr by the third quarter of 2020. The new module at the plant could produce concentrate with grades of as much as 96% graphite (Kotze, 2019).

Tirupati planned to develop a new mine and four processing plants at the Vatomina project. The company planned to complete the construction of a processing plant with a capacity of 6,000 t/yr in the third quarter of 2019 and three additional plants with capacities of 18,000 t/yr each by 2021. The plants at Vatomina could produce concentrate with grades of as much as 96% graphite. As of yearend, construction of the first plant had not been completed. Tirupati planned to use 25% of its production from Sahamamy and Vatomina in new downstream processing plants in India and to export 75% to other countries (Kotze, 2019; Shaw, 2020).

Global Li-Ion Graphite Corp. of Canada planned to reopen mines near Andasibe in 2020. The mines shut down in 2008 because of the retirement of a previous owner. The company planned to exceed the historical production of a total of 3,100 t/yr of concentrate at a grade of 95% graphite (Global Li-Ion Graphite Corp., undated).

NextSource Materials Inc. of Canada completed a revised feasibility study on its Molo project in the Tular Region in September 2019. Planned production in the first phase of mining was 17,000 t/yr of concentrate at a grade of 97% graphite and 45,000 t/yr in the second phase. Depending on obtaining financing, NextSource planned to start the first phase of mining by the second quarter of 2021 and the second phase in early 2023. The estimated life of the mine was 30 years. Resources were estimated to be 141 million metric tons (Mt) at a grade of 6.1% graphite, and reserves, 22.4 Mt at a grade of 7.02% graphite. Jumbo-flake graphite was expected to account for nearly 24% of Molo's output, and large-flake graphite, nearly 23% (NextSource Materials Inc., 2019; Caesars Report, 2020).

In 2019, BlackEarth Minerals NL completed a scoping study on its Maniry project in the Atsimo-Andrefana Region. Planned production in the study was 30,000 t/yr of concentrate at a grade of between 95% and 96% graphite for the first 3 years of production and 60,000 t/yr subsequently. The estimated life of the mine was 10 years. The estimated capital costs of the first phase of mining were \$41 million, and of the second phase, an additional \$29 million. BlackEarth planned to complete a feasibility study on Maniry in 2020. Depending on the results of the study, the mine could be commenced in the fourth quarter of 2021 (Cornish, 2019; Washbourne, 2019).

Mica.—Artisanal miners accounted for most of Madagascar's mica production. In 2019, national mica production decreased to 33,585 t from 48,763 t in 2018. Most of the mica mined in Madagascar was phlogopite. Mica was mined mostly in the dry season between April and September when pits and tunnels were more accessible (table 1; van der Waal, 2019, p. 20, 34).

Mica was produced from at least 73 mines by more than 20,000 miners. At least 23,500 t was produced in the Anosy Region in 2017, of which mines at Ranopiso accounted for 10,000 t; mines at Ambatoabo, 8,000 t; and those at Tranomaro, 4,000 t. Mica was purchased from the miners by about 400 traders and transported by truck to sorting centers; poor road conditions increased transportation costs (van der Waal, 2019, p. 23–25).

At least five mica exporting companies operated sorting facilities in various locations, including Amboasary, Tolagnaro, and Tranomaro; most exporters likely had sorting facilities.

About 2,000 sorters were estimated to be employed during the dry season. About 30 companies exported mica after sorting from Tamatave, Tolagnaro, and Toliara (van der Waal, 2019, p. 24–25).

Nitrogen.—Sherritt and its joint-venture partners consumed ammonia in the production of cobalt and nickel at Ambatovy. Ammonium sulfate fertilizer was produced as a byproduct; output decreased to about 91,892 t in 2019 from 94,342 t in 2018. The ammonium sulfate capacity at Ambatovy was 210,000 t/yr (table 2; Sherritt International Corp., 2020, p. 31).

Mineral Fuels and Related Materials

Coal.—Lemur Holdings (a subsidiary of Bushveld Minerals Ltd. of the United Kingdom) was considering the development of a coal-fired power station and mine at the Imaloto power project in the Atsimo-Andrefana Region. The power station had an initial planned capacity of 60 megawatts. Lemur planned to start a revised feasibility study on the mine in the third quarter of 2019. As of yearend, the feasibility study had not yet been started (Bushveld Minerals Ltd., 2019, 2020, undated).

Outlook

Graphite production is expected to increase substantially between 2020 and 2024 with the expansion of the Gallois, the Graphmada, and the Sahamamy Mines and the development of the Maniry, the Molo and the Vatomina projects. Ilmenite, rutile, and zircon production output could increase between 2022 and 2025 with the development of the Ranobe Mine. Coal mining could start in the near future because of the startup of Lemur's power station. The development of the mineral industry will depend on world market conditions and domestic political stability.

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TABLE 1
MADAGASCAR: PRODUCTION OF MINERAL COMMODITIES¹

(Metric tons, gross weight, unless otherwise specified)

Commodity ²	2015	2016	2017	2018	2019
METALS					
Chromium, mine, chromite	148,198	107,735	208,100 ³	109,200 ³	76,126 ³
Cobalt:					
Mine, Co content ^c	4,000	3,800	3,600	3,300	3,400
Refinery, metal powder	3,464	3,273	3,053	2,852	2,900
Gold, mine, Au content kilograms	--	586	2,833	3,000 ³	2,100 ³
Nickel:					
Mine, nickel cobalt sulfide, Ni content ^c	55,000	49,000	42,000	39,000	39,000
Refinery, metal, electrolytic	47,271	42,105	35,474	33,183	33,733
Rare earths:					
Monazite concentrate	--	--	--	16,000	21,000 ^e
Mineral concentrate, rare-earth oxide equivalent ^c	--	--	--	2,000	4,000
Titanium, mineral concentrates:					
Ilmenite	166,290	267,962	469,326 ^r	381,924 ^r	461,800 ³
Rutile ^c	3,300	5,400	8,100	7,600	9,200
Zirconium, mineral concentrates, zircon	11,879	15,582	26,040 ^r	22,757 ^r	28,500 ³
INDUSTRIAL MINERALS					
Beryl, beryl in quartz concentrates ^{e,4}	16	16	16	16	16
Cement, hydraulic	150,000	150,000	200,000 ^r	210,000 ^e	230,000 ^e
Clay:					
Kaolin ^{e,4}	220	220	220	220	220
Unspecified	25,000 ^e	23,996	63,410 ^r	60,140 ^r	60,000 ^e
Fertilizers, ammonium sulfate	137,325	134,770	110,000 ^e	94,342	91,892
Gemstones: ⁵					
Amazonite, ornamental ^c	350	350	520	390	350
Amethyst ^{e,6} kilograms	180,000	180,000	180,000	140,000 ^r	180,000
Calcite, ornamental ^c	130	130	130	130	130
Emerald kilograms	24 ^{r,3}	36 ^{r,3}	36 ^{r,3}	35 ^{r,e}	35 ^e
Garnet ⁷ do.	2,336 ^{r,3}	1,536 ^{r,3}	214 ^{r,3}	210 ^{r,e}	210 ^e
Labradorite, ornamental	6,832	11,059	5,325 ^r	4,828 ^r	4,800 ^e
Ruby kilograms	171 ^{r,3}	140 ^{r,3}	72 ^{r,3}	70 ^{r,e}	70 ^e
Sapphire do.	3,212 ^{r,3}	1,547 ^{r,3}	2,130 ^{r,3}	2,100 ^{r,e}	2,100 ^e
Tourmaline ⁶ do.	607 ^{r,3}	3,087 ^{r,3}	124 ^{r,3}	120 ^{r,e}	120 ^e
Graphite, crystalline flake, all grades ³	8,006	9,200	13,300	47,900	53,400
Gypsum ^e	130	--	--	--	--
Mica, phlogopite ³	16,710	22,311 ⁸	34,817 ⁸	48,763 ⁸	33,585 ⁸

See footnotes at the end of table.

TABLE 1—Continued
MADAGASCAR: PRODUCTION OF MINERAL COMMODITIES¹

(Metric tons, gross weight, unless otherwise specified)

Commodity ²	2015	2016	2017	2018	2019
INDUSTRIAL MINERALS—Continued					
Quartz, crystal, industrial ³	631	108 ⁸	51 ⁸	26 ⁸	29 ⁸
Pozzolan, pozzolanic material	40,000 ⁶	36,846	25,070 ⁷	35,129 ⁷	35,000 ⁶
Salt, sea salt	120,000 ⁶	107,295	110,000 ⁶	110,000 ⁶	100,000 ⁶
Stone, sand, and gravel, construction:					
Stone:					
Crushed:					
Limestone ⁹	165,000 ⁶	166,001	166,002 ⁷	190,455 ⁷	190,000 ⁶
Dolomite ^{6,4}	4,200	4,200	4,200	4,200	4,200
Dimension, granite ^{3,8}	1,338	2,034	1,631	2,103	3,143
MINERAL FUELS AND RELATED MATERIALS					
Petroleum, crude	thousand 42-gallon barrels	95	70 ⁶	--	20 ⁶

⁶Estimated. ⁷Revised. do. Ditto. -- Zero.

¹Table includes data available through February 17, 2021. All data are reported unless otherwise noted. Estimated data are rounded to no more than three significant digits.

²In addition to the commodities listed, crude construction materials (other clays and sand and gravel), ornamental stones in addition to those listed (agate, apatite, cordierite, and rhodonite), industrial abrasives, and calcite may have been produced, but available information was inadequate to make reliable estimates of output.

³Reported exports.

⁴Estimated based on previous reported production.

⁵Does not include smuggled artisanal production.

⁶Includes both gem and ornamental quality.

⁷Includes almandine, grossular, and pyrope garnet.

⁸Department of Economic and Social Affairs, United Nations Statistics Division, United Nations Comtrade database.

⁹Cement producers only.

TABLE 2
MADAGASCAR: STRUCTURE OF THE MINERAL INDUSTRY IN 2019

(Metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Cement		China Building Material Product	Plant at Ambohimambola ¹	360,000.
Do.		LaFargeHolcim (Madagascar) S.A. (LaFargeHolcim Ltd., 90%)	Plant at Ibity	230,000. ^c
Chromium		KRAOMA Mining S.A. [Ferrum Mining LLC, 80%, and Kraomita Malagasy S.A. (KRAOMA), 20%]	Mine at Bemanevika and three other mines ¹	300,000. ^c
Clay		LaFargeHolcim (Madagascar) S.A.	Mine in Manjakandriana Region	70,000. ^c
Cobalt:				
Mine		Ambatovy Minerals S.A. (Sumitomo Corp., 47.7%; Korea Resources Corp., 40.3%; Sherritt International Corp., 12%)	Mine at Ambatovy	6,600. ^c
Refined		do.	Refinery at Tamatave	5,600.
Gemstones:				
Amazonite		Norcross Madagascar Group (NMG)	Mine in Amboasitra region	580. ^c
Amethyst		do.	Mine at Ambatondrazaka	200. ^c
Aquamarine		Artisanal and small-scale miners	Mine at Tsaramanga	NA.
Emerald	kilograms	do.	Mines at Mananjary	150. ^c
Garnet		do.	Mines at Behara	NA.
Labradorite		Red Graniti Madagascar SARL	Quarry in Atsimo-Andrefana Region	3,900. ^c
Do.		Norcross Madagascar Group (NMG)	Quarries at Maniry	3,600. ^c
Do.		Societe Labrador Madagascar SARL	Quarry in Atsimo-Andrefana Region	3,400. ^c
Do.		SQNY International	Quarry in Atsimo-Andrefana Region ¹	2,000. ^c
Quartz		Norcross Madagascar Group (NMG)	Mines at Ramaratina	NA.
Do.		Artisanal and small-scale miners	Mine at Tsaramanga	NA.
Ruby	kilograms	do.	Mines at Andilamena	160. ^c
Sapphire	do.	do.	Mines at Ambatondrazaka, Andranondambo, Andrebabe, Ilakaka, Manombe, Marosely, and Sakara	9,000. ^c
Tourmaline		do.	Mines at Alatsinainuy Ibity	NA.
Gold	kilograms	Artisanal and small-scale miners	Various locations including Isaka River	3,000. ^c
Graphite		Etablissements Gallois S.A.	Gallois Mine near Tamatave	150,000.
Do.		Power Stand Development (H.K.) Ltd.	Mine in Atsinanana Region	10,000.
Do.		Bass Metals Ltd.	Graphmada Mine near Mahatsara	6,000.
Do.		Tirupati Graphite PLC	Sahamamy Mine in Atsinanana Region	3,000.
Gypsum		Compagnie Salinière de Madagascar	Mine at Antsahampano ¹	500.
Mica		Artisanal and small-scale miners	Mines at Ranopiso in Anosy Region	11,000. ^c
Do.		do.	Mines at Ambatoabo in Anosy Region	8,800. ^c
Do.		do.	Mines at Tranomaro in Anosy Region	4,400. ^c
Do.		do.	Other mines in Anosy Region	1,700. ^c
Do.		Groupe AKESSON Mineragrex S.A.	5 mines in southeastern Madagascar	2,200. ^c
Do.		Societe des Mines d'Ampandranhava	Mine at Tolagnaro ¹	2,200. ^c
Do.		Amboasary Mining Co.	Mine in Amboasary District	NA.
Nickel:				
Mine		Ambatovy Minerals S.A. (Sumitomo Corp., 47.7%; Korea Resources Corp., 40.3%; Sherritt International Corp., 12%)	Mine at Ambatovy	71,000. ^c
Refined		do.	Refinery at Tamatave	60,000.
Nitrogen		do.	do.	210,000 ammonium sulfate.
Petroleum, crude	thousand 42-gallon barrels	Madagascar Oil Ltd.	Tsimiroro	180.
Pozzolanic material		LaFargeHolcim (Madagascar) S.A.	Quarry in Vakinankaratra Region	65,000. ^c

See footnotes at end of table.

TABLE 2—Continued
MADAGASCAR: STRUCTURE OF THE MINERAL INDUSTRY IN 2019

(Metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Rare earths	QIT Madagascar Minerals S.A. (QMM) [QIT Fer et Titane (Rio Tinto plc), 80%, and Government, 20%]	Mine at Mandena	22,000 ^e monazite; 4,400 ^e rare-earth oxides.
Salt	Compagnie Salinière de Madagascar	Mine near Antsiranana	80,000.
Do.	Grand Salines du Menabe and other companies	Menabe Region	23,000. ^e
Do.	Artisanal miners	Tulear Province	13,000. ^e
Stone:			
Dolomite	PROCHIMAD	Quarry in Amoron'i Mania Region	4,200. ^e
Granite	Granitex SARL	Quarry in Manjakandriana Region	3,300. ^e
Limestone	LaFargeHolcim (Madagascar) S.A.	Quarry in Vakinankaratra Region	210,000. ^e
Titanium minerals	QIT Madagascar Minerals S.A. [QIT Fer et Titane of Canada (a subsidiary of Rio Tinto plc), 80%, and Government, 20%]	Mine at Mandena	750,000 ilmenite; 15,000 rutile.
Zirconium	do.	do.	40,000 zircon.

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

¹Not operating at the end of 2019.