



2016 Minerals Yearbook

MADAGASCAR [ADVANCE RELEASE]

THE MINERAL INDUSTRY OF MADAGASCAR

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In 2016, Madagascar played a significant role in the world's production of cobalt, ilmenite, mica, and nickel. The country's share of world production of mica amounted to about 6%; mined and refined cobalt; 3% each; and ilmenite and mined nickel, 2% each. Other domestically significant minerals produced included chromite, gemstones, and ornamental stones. Madagascar was not a globally significant consumer of minerals in 2016 (Cobalt Development Institute, 2017; Bedinger, 2018; Jasinski, 2018; McRae, 2018; Shedd, 2018).

Minerals in the National Economy

In 2016, the mining sector accounted for a projected 3% of the gross domestic product (GDP); the metal manufacturing sector, 1%; and the construction materials sector, 0.5%. The mining sector's share of the GDP was 0.7% in 2012; the increase was primarily attributable to increased production at the Ambatovy nickel-cobalt project. The manufacturing sector other than metal manufacturing accounted for a projected 10.5% of the GDP in 2016 (Ministry of Economy and Planning, 2016, p. xxiv).

In 2015 (the latest year for which data were available), total exports were valued at \$1.77 billion, of which nickel accounted for 26.5%; cobalt, 4.5%; and chromite, 1.5%. Madagascar also exported gemstones, graphite, ilmenite, mica, ornamental stones, rutile, and zircon. In 2007, total exports were valued at \$1.3 billion, of which minerals accounted for 2.9%. Increased mineral exports were attributable to the rampup of ilmenite, rutile, and zircon production starting in 2009, and cobalt and nickel production starting in 2012 (World Trade Organization, 2015, p. 17; Ministry of Economy and Planning, 2016, p. 22).

In 2015, Madagascar's imports were valued at \$2.78 billion, of which mineral fuels accounted for about 17%. The United States imported nickel from Madagascar valued at \$29.6 million in 2016 and \$91.5 million in 2015. Other mineral imports from Madagascar included nonferrous metals other than copper and gold, which were valued at \$27.7 million in 2016 and \$24.3 million in 2015. Imports of gemstones other than diamond increased to \$18.7 million in 2016 from \$15 million in 2015 (Ministry of Economy and Planning, 2016, p. 24; U.S. Census Bureau, 2017).

In 2014, formal employment in the mining and quarrying sector was reported to be 5,583 workers compared with 4,600 workers in 2013. More than 500,000 additional workers were estimated to be employed in artisanal mining (PricewaterhouseCoopers Madagascar, 2016, p. 25, 89; Extractive Industries Transparency Initiative, undated).

Madagascar's mining and quarrying sector was 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 was 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).

In late 2016, the Government was considering the adoption of new mining and petroleum codes. The draft of the new mining code had provisions to increase royalty rates and to give the Government a 10% free-carried interest in all new mining projects. As of yearend, the new legislation had not been adopted (Australia's Paydirt, 2016; Stoddard, 2017).

Production

In 2016, ruby production increased by an estimated 50%; mica, by 34%; sapphire, by an estimated 30%; ilmenite, by 25%; and graphite, by 15%. Ruby and sapphire production increased because of the opening of new mines; ilmenite production increased because of higher prices on world markets. Between 2012 and 2016, the output of beryl increased by an estimated 775%; ammonium sulfate, by 752%; ruby, by an estimated 650%; refined nickel, by 639%; refined cobalt, by 564%; mined nickel, by an estimated 410%; mined cobalt, by an estimated 375%; graphite, by 225%; sapphire, by an estimated 149%; mica, by 78%; and dolomite, by an estimated 65%.

The production of industrial quartz decreased by 83% in 2016 compared with that of 2015; chromite, by 60%; and mined and refined nickel, by 11% each. Between 2012 and 2016, ilmenite production decreased by 64%; rutile, by an estimated 62%; zircon, by 61%; and quartz, by 51%. 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 sand, nickel, and salt mines and the cement plants. Artisanal miners produced gemstones, gold, mica, and salt. State-owned Kraomita Malagasy SA (KRAOMA) was the country's only chromite producer. Table 2 is a list of major mineral industry facilities.

Commodity Review

Metals

Chromium.—KRAOMA produced high-grade chromite from the Bemanevika Mine in Betsiboka Region. In 2016, the company exported 79,345 metric tons (t) compared with 197,750 t in 2015 and 97,250 t in 2014 (table 1; Ministry of Economy and Planning, 2016, p. 67).

Cobalt and Nickel.—Sherritt International Corp. of Canada and its joint-venture partners Sumitomo Corp. of Japan and Korea Resources Corp. 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 Toamasina. The sulfide product was processed at a refinery with a capacity of 60,000 metric tons per year (t/yr) of refined nickel and 5,600 t/yr of cobalt (Sherritt International Corp., 2017, p. 2).

In 2016, production of nickel and cobalt in mixed sulfides amounted to 45,678 t compared with 48,995 t in 2015. Refined nickel production decreased to 42,105 t in 2016 from 47,271 t in 2015 and refined cobalt, to 3,273 t from 3,464 t. The recovery rate for nickel was nearly 86% in 2016. Sherritt and its joint-venture partners planned to produce between 48,000 and 52,000 t of refined nickel in 2017; refined cobalt output was likely to be between 3,800 and 4,100 t. The remaining life of the mine at Ambatovy was estimated to be 27 years (Sherritt International Corp., 2017, p. 2, 16, 21).

Titanium and Zirconium.—QIT Madagascar Minerals SA (QMM) (Rio Tinto plc, 80%, and the Government, 20%) mined ilmenite, rutile, and zircon at Mandena in southeastern Madagascar. In 2015, QMM produced 177,176 t of ilmenite and 12,550 t of zircon compared with 333,736 t of ilmenite and 27,275 t of zircon in 2014. Production decreased because of weak demand in world markets. In 2016, ilmenite production increased to 222,227 t; zircon production decreased to 12,250 t (table 1; Jorgic and Rabary, 2015; Ministry of Economy and Planning, 2016, p. 67).

World Titanium Resources Ltd. (WTR) of Australia was considering the development of the Ranobe Mine, which was part of the Toliara Sands project in southwestern Madagascar. The company had planned to produce 407,000 t/yr of ilmenite and 44,000 t/yr of rutile and zircon at Ranobe during an estimated 21-year mine life. In January 2016, WTR completed a scoping study on a revised mining plan. Planned production in the study was 670,000 t/yr of ilmenite and 66,000 t/yr of rutile and zircon during an estimated 17-year mine life. WTR planned to stockpile the ilmenite because of unfavorable world market prices. The new mining plan had a reduced estimated capital cost (Cann, 2014; World Titanium Resources Ltd., 2016).

Industrial Minerals

Gemstones.—In recent years, Madagascar has produced a variety of gemstones that included aquamarine, emerald, and other types of beryl; tsavorite and other types of garnet; amethyst, citrine, and other types of quartz; and agate, amazonite, cordierite, jasper, labradorite; ruby, sapphire, and tourmaline. Most gemstones were exported prior to cutting and polishing.

Sapphire was mined at locations that included Ilakaka, Manombe, Marosely, and Sakara. Production increased to an estimated 5,000 kilograms (kg) in 2015 from 4,534 kg in 2014 because of the discovery of new deposits at Andrebabe. In 2016, production increased to an estimated 6,500 kg because of the discovery of new deposits of blue sapphire near Andranondambo in January and near Ambatondrazaka in October. About 45,000 artisanal miners were estimated to be working at the new mines near Ambatondrazaka (Pardieu and others, 2016; Perkins and Pardieu, 2016; PricewaterhouseCoopers Madagascar, 2016, p. 66).

Ruby was mined at Andilamena; output increased to an estimated 180 kg in 2016 and 120 kg in 2015 from 73 kg in 2014. Increased production was attributable to the discovery of new deposits near Ambodivoangy in July 2015. The Government shut down the mines, which were located in

Zahamena National Park, because of environmental concerns in August 2015. The closure was difficult to enforce because of the remoteness of the mines and was only temporarily successful (Pardieu and others, 2015; PricewaterhouseCoopers Madagascar, 2016, p. 66).

Companies such as Norcross Madagascar Group (NMG) of the United States produced labradorite. In December 2016, Sun Minerals Madagascar SARL [a joint venture of NMG and SRE (India)] opened a new labradorite quarry near NMG's quarries at Maniry (Norcross Madagascar Group, undated).

NMG produced amazonite from its mine in the Amboasitra Region. In December 2016, the company completed a new road to the mine that would allow mining to take place for the entire year and to transport equipment that would increase productivity. Mining previously was limited to 8 months of the year because of the rainy season (Norcross Madagascar Group, undated).

Graphite.—Madagascar's graphite production increased to 9,224 t in 2016 from a revised 8,006 t in 2015 and a revised 5,316 t in 2014. Etablissements Gallois S.A. mined the majority of domestic graphite production at the Ambalafotaka, the Antsirakambo, and the Marovintsy Mines (table 1; Ministry of Economy and Planning, 2016, p. 67).

In 2016, Bass Metals Ltd. of Australia purchased the Graphmada Large Flake Graphite Mine from StratMin Global Resources plc of the United Kingdom. Sales from the mine were about 1,500 t of concentrate with a content of 94% graphite in 2015, of which 63% was jumbo flake or large flake and 37% was medium flake, small flake, or fine flake. Bass Metals planned to increase production to the mine's capacity of 6,000 t/yr in 2017 and to build a new processing plant with a capacity of between 12,000 and 20,000 t/yr. The company also planned to complete a new resource estimate in the second quarter of 2017 (Andrews, 2016; Louw, 2016).

StratMin and its joint-venture partner Tirupati Carbon & Chemicals Pvt. Ltd. of India planned to build a new graphite mine and processing plant at the Vatomaina project. The companies expected to commission the plant by October 2017; planned production was 12,000 t/yr. Resources at the Vatomaina deposit were about 35% large-flake graphite and 30% jumbo-flake graphite (StratMin Global Resources plc, 2016).

In 2015, Energizer Resources Inc. of Canada completed a feasibility study on a new mine at its Molo project. Planned production in the study was about 50,000 t/yr of graphite. At the end of 2016, Energizer was considering initial production of 15,000 t/yr of concentrate at a grade of 98% graphite because a smaller mine would have much lower capital costs. Resources at Molo were estimated to be 141 million metric tons (Mt) at a grade of 6.13% graphite and reserves were estimated to be 22.4 Mt at a grade of 7.02% graphite (Hamer, 2017; Northern Miner, 2017).

Mica.—Groupe AKESON Mineragrex S.A. produced mica from its five mines in southeastern Madagascar. Artisanal miners also produced mica near Analamaria in the Anosy Region in recent years. National mica output increased to 22,311 t in 2016 from a revised 16,664 t in 2015 and a revised 12,234 t in 2014 (table 1; Ministry of Economy and Planning, 2016, p. 67).

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 134,770 t in 2016 from 137,325 t in 2015. The ammonium sulfate production capacity at Ambatovy was 210,000 t/yr (table 2; Sherritt International Corp., 2017, p. 21).

Mineral Fuels

Petroleum.—Madagascar Oil Ltd. of Bermuda produced crude petroleum at its pilot plant at the onshore Tsimiroro heavy oil project (located in Block 3104). As of 2015, depending on the company obtaining financing, finding a joint-venture partner, and converting resources to reserves, large-scale production could start in 2018. Madagascar Oil could increase petroleum production to about 20,000 barrels per day (bbl/d) by 2019, and 80,000 bbl/d by 2022, and to the planned peak of 160,000 bbl/d by 2025. As of the end of 2016, it was unclear when large-scale production would start (Madagascar Oil Ltd., 2015, p. 7, 9–11, 17).

Outlook

Ammonium sulfate, cobalt, and nickel production is likely to increase in 2017 after decreasing in 2016. Amazonite, labradorite, and sapphire production is also expected to increase in 2017 because of increased capacity or recent mine openings. Madagascar could become a globally significant graphite producer with the expansion of the Loharano Mine and the development of the Molo and Vatomaina projects. Ilmenite, rutile, and zircon production output could increase in the future with the development of the Ranobe Mine. The development of the mineral industry in Madagascar in the next few years 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	2012	2013	2014	2015	2016
METALS					
Beryllium, primary, beryl in quartz concentrates ^c	16	85	135	140	140
Chromium, mine, chromite	111,500 ³	88,000 ³	97,250 ³	197,750 ^{r,3}	79,345 ⁴
Cobalt:					
Mine, Co content, recoverable ^c	800 ^r	2,400 ^r	3,400	4,000	3,800
Refinery, metal	493	2,083	2,915	3,464	3,273
Gold, mine, Au content ⁵ kilograms	157	--	--	--	587 ³
Nickel:					
Mine, Ni content ^c	9,600	31,000	43,000	55,000	49,000
Refinery, metal, electrolytic	5,695	25,148	37,053	47,271	42,105
Titanium mineral concentrates:					
Ilmenite	620,700	530,421	333,736	177,176 ^r	222,227 ⁴
Rutile ^c	12,000	11,000	6,900	3,700 ^r	4,600
Zirconium mineral concentrates, zircon	31,242	31,345	27,275	12,550 ^r	12,250 ⁴
INDUSTRIAL MINERALS					
Cement, hydraulic ^c	230,000	230,000	240,000	240,000	240,000
Clay and shale:					
Kaolin	230	200	221	220 ^c	220 ^c
Other	24,085	29,751	26,797	27,000 ^c	27,000 ^c
Fertilizers, ammonium sulfate	15,823	65,410	97,780	137,325	134,770
Gemstones: ⁶					
Agate, ornamental ^c	1,000	1,000	800	670	670
Amazonite, ornamental ^c	240	280	420	350	350
Amethyst ^{c,7} kilograms	90,000	90,000	90,000	76,000	75,000
Calcite, ornamental	175	200	150	130 ^c	130 ^c
Cordierite ^c kilograms	730	880	1,100	900	900
Emerald do.	140	80 ^c	15	15 ^c	15 ^c
Garnet ^c do.	1,100	1,300	1,600	1,300	1,300
Labradorite, ornamental ^c	8,500	11,000	13,000	11,000	12,000
Ruby kilograms	24	50 ^c	73	120 ^c	180 ^c
Sapphire do.	2,606	3,500 ^c	4,534	5,000 ^c	6,500 ^c
Tourmaline ^{c,7} do.	290,000	360,000	430,000	350,000	350,000
Graphite, all grades	2,842 ³	4,297 ³	5,316 ³	8,006 ^{r,3}	9,224 ⁴
Gypsum ^c	130	130	130	130	130
Mica, phlogopite	12,556 ³	9,782 ³	12,234 ^{r,3}	16,664 ^{r,3}	22,311 ⁴
Quartz, industrial	221 ³	347 ³	243 ³	631 ^{r,3}	108
Pumice and pumicite, pozzolan	54,979	65,000	42,129	43,000 ^c	43,000 ^c
Salt, sea ^c	110,000	110,000	120,000	120,000	130,000
Stone:					
Stone, crushed, limestone ⁸	164,183	164,718	164,218	170,000 ^c	170,000 ^c
Stone, dimension:					
Dolomite	2,540	3,730	4,153	4,200 ^c	4,200 ^c
Granite	2,519	3,078	3,100 ^c	3,100 ^c	3,100 ^c
MINERAL FUELS AND RELATED MATERIALS					
Petroleum, crude thousand 42-gallon barrels	--	40	116	95	100 ^c

^cEstimated. ^rRevised. do. Ditto. -- Zero.

¹Table includes data available through February 5, 2018. 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 (apatite and rhodonite), industrial abrasives, and calcite may have been produced in Madagascar, but available information was inadequate to make reliable estimates of output.

³Reported exports.

⁴Reported exports from DESA/UNSD, United Nations Comtrade database.

⁵Does not include smuggled artisanal production, which is estimated to be between 1,000 to 2,000 kilograms per year.

⁶Does not include smuggled artisanal production.

⁷Includes both gem and ornamental quality.

⁸Cement producers only.

TABLE 2
MADAGASCAR: STRUCTURE OF THE MINERAL INDUSTRY IN 2016

(Metric tons unless otherwise specified)

Commodity		Major operating companies	Location of main facilities	Annual capacity
Cement		Madagascar Long Cimenterie (Maloci)	Plant at Ambohimambola	360,000.
Do.		LaFargeHolcim (Madagascar) S.A. (LaFargeHolcim Ltd., 90%)	Plant at Ibity	200,000.
Chromium		Kraomita Malagasy S.A. (KRAOMA) (Government, 100%)	Mine at Bemanevika and three other mines	300,000. ^c
Clay		LaFargeHolcim (Madagascar) S.A.	Mine in Manjakandriana Region	30,000. ^c
Cobalt:				
Mined		Ambatovy Minerals S.A. (Sherritt International Corp., 40%; Sumitomo Corp., 32.5%; Korea Resources Corp., 27.5%)	Mine at Ambatovy	6,500. ^c
Refined		do.	Refinery near Toamasina	5,600.
Gemstones:				
Amazonite		Norcross Madagascar Group (NMG)	Mine in Amboasitra region	420. ^c
Amethyst		do.	Mines at Ambatondrazaka	90. ^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		Norcross Madagascar Group (NMG)	Quarries at Maniry	3,600. ^c
Do.		Red Graniti Madagascar SARL	Quarry in Atsimo-Andrefana Region	3,600. ^c
Do.		Marbres et Granits de Madagascar SARL (MAGRAMA) and EUROMAD S.A.	Quarries at Ianapera and Maniry	3,000. ^c
Do.		SQNY International	do.	2,000. ^c
Do.		Societe Labrador Madagascar	Quarry in Atsimo-Andrefana Region	600. ^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 Ambodivoangy and Andilamena	200. ^c
Sapphire	do.	do.	Mines at Ambatondrazaka, Andranondambo, Andrebabe, Ilakaka, Manombe, Marosely, and Sakara	9,000. ^c
Tourmaline	do.	do.	Mines at Alatsinainy Ibity	NA.
Graphite		Etablissements Gallois S.A.	Antsirakambo Mine near Brickaville	4,800.
Do.		do.	Marovintsy Mine near Vatondromy	3,600.
Do.		do.	Ambalafotaka Mine	NA.
Do.		Graphmada Equity Pte Ltd.	Mine at Loharano	6,000.
Do.		do.	Plant at Loharano	6,000.
Gypsum		Compagnie Salinière de Madagascar	Antsahampano	500.
Mica		Groupe AKESSON Mineragrex S.A.	5 mines in southeastern Madagascar	1,500. ^c
Do.		Artisanal and small-scale miners	Mines near Analamaria in Anosy Region	22,000. ^c
Nickel:				
Mined		Ambatovy Minerals S.A.	Mine at Ambatovy	70,000. ^c
Refined		do.	Refinery near Toamasina	60,000.
Nitrogen fertilizers		do.	do.	210,000 ammonium sulfate
Petroleum, crude	thousand 42-gallon barrels	Madagascar Oil Ltd.	Tsimiroro	180.
Pumice and pumicite, pozzolan		LaFargeHolcim (Madagascar) S.A.	Quarry in Vakinankaratra Region	65,000. ^c
Salt		Compagnie Salinière de Madagascar	Mine near Antsiranana	80,000.
Do.		Grand Salines du Menabe and other companies	Menabe Region	23,000. ^c
Do.		Artisanal miners	Tulear Province	13,000. ^c
Stone:				
Dolomite		PROCHIMAD	Quarry in Amoron'i Mania Region	4,200. ^c
Granite		Granitex SARL	Quarry in Manjakandriana Region	3,300. ^c
Limestone		LaFargeHolcim (Madagascar) S.A.	Quarry in Vakinankaratra Region	170,000. ^c
Titanium minerals		QIT Madagascar Minerals S.A. (Rio Tinto plc, 80%, and Government, 20%)	Mine at Mandena	750,000 ilmenite; 15,000 rutile.
Zirconium minerals		do.	do.	40,000 zircon.

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