



2012 Minerals Yearbook

MADAGASCAR

THE MINERAL INDUSTRY OF MADAGASCAR

By Thomas R. Yager

In 2012, Madagascar played a significant role in the world's production of ilmenite, rutile, and zirconium. The country's share of world mine production of ilmenite amounted to about 8%; rutile, about 2%; and zirconium, about 1% (Bedinger, 2013; Loferski, 2013). Other domestically significant minerals produced included chromite, gemstones, and ornamental stones. Madagascar was not a globally significant consumer of minerals in 2011.

Minerals in the National Economy

Based on provisional data for 2011 (the latest year for which data were available), the manufacturing sector accounted for 11% of the gross domestic product, and the mining and construction materials sectors combined, 1.6%. Employment in artisanal mining was estimated to be about 500,000 workers in 2012; artisanal miners accounted for most of the employment in the domestic mining industry (Ministry of the Economy, Commerce, and Industry, 2011, p. xiv, xvi; World Bank Group, undated, p. 17).

Production

In 2012, the production of gold increased by an estimated 900%; ruby, by an estimated 344%; mined cobalt, by an estimated 44%; ilmenite and mined nickel, by an estimated 40% each; rutile, by an estimated 38%; beryl, by an estimated 33%; zircon, by an estimated 30%; and graphite, by an estimated 15%. Refined cobalt and nickel production started in 2012. 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 miners produced gemstones and gold. State-owned Kraomita Malagasy S.A. (KRAOMA) was the country's only chromite producer. Cobalt, ilmenite, nickel, rutile, and zircon were also mined by a single producer at the end of 2012. The Ambatovy project produced refined cobalt and nickel and the Mandena Mine engaged in downstream processing of zircon. Table 2 lists major mineral industry facilities in Madagascar.

Commodity Review

Metals

Bauxite and Alumina.—In late October 2012, Aziana Ltd. of Australia estimated that bauxite resources at the Manantenina project in southeastern Madagascar were 10.1 million metric tons (Mt) at a grade of 34.1% aluminum oxide (Al_2O_3). Aziana hoped to increase resources at

Manantenina to between 100 and 140 Mt at a grade of between 33% and 38% (Aziana Ltd., 2013, p. 7–8).

Cobalt and Nickel.—In July 2010, a joint venture of Sherritt International Corp. of Canada (40%), Sumitomo Corp. of Japan (27.5%), Korea Resources Corp. of the Republic of Korea (27.5%), and SNC-Lavalin Inc. of Canada (5%) started mining nickel-cobalt laterite deposits at Ambatovy. In the second quarter of 2012, the processing of lateritic slurry from the Ambatovy ore-processing plant into mixed cobalt and nickel sulfides started 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 starting in the third quarter of 2012 (Sherritt International Corp., 2013, p. 7, 34).

The opening of the refinery resulted in substantially increased mined cobalt and nickel production. In 2012, production of nickel and cobalt in mixed sulfides amounted to nearly 9,000 metric tons (t) compared with an estimated 6,400 t of mined cobalt and nickel in 2011. Refined nickel output was 5,695 t in 2012, and refined cobalt, 493 t. Sherritt and its joint-venture partners planned to produce 35,000 t of refined nickel and 3,000 t of refined cobalt in 2013. In 2011, reserves at Ambatovy were estimated to be about 170 Mt at grades of 0.94% nickel and 0.082% cobalt. The life of the mine was estimated to be 29 years (Mining Journal, 2011; Sherritt International Corp., 2013, p. 34–35).

Gold.—Artisanal miners produced gold at Betsiaka and other locations. In 2012, artisanal gold mining increased to an estimated 400 kilograms (kg) from 40 kg in 2011 (table 1). The increase may have been attributable to higher gold prices.

Torian Resources NL of Australia planned to complete its drilling program at the Vatovorona project by March 2012 and subsequently to start trial mining. Depending on the results of the trial mining, Torian could start large-scale production at Vatovorona in 2013 and produce about 600 kilograms per year of gold. By the end of the third quarter of 2012, Torian put Vatovorona on care-and-maintenance status. Aziana explored for gold at Alakamisy, Anosivola, Antakasina, Antandrokazo, Grigri, Marovato, and Sakaleona (Andrews, 2012; Torian Resources NL, 2012; Aziana Ltd., 2013, p. 12–19).

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 the first 11 months of 2012, QMM exported nearly 584,000 t of ilmenite to Canada for smelting. The company's goal for the entire year was more than 660,000 t. By 2013, QMM planned to reach its full capacity of 750,000 t/yr of ilmenite and 60,000 t/yr of zirsill, which is composed of quartz, sillimanite, and zircon (Chamber of Commerce and Industry of Antananarivo, 2012; Eisner, 2013, p. 36, 120).

In August 2012, World Titanium Resources Ltd. (WTR) of Australia completed its feasibility study on the Ranobe Mine, which is part of the Toliara Sands project in southwestern Madagascar. WTR planned to produce 407,000 t/yr of ilmenite and 43,000 t/yr of rutile and zircon concentrate during the estimated 21-year life of the mine. Depending on Government approval in the first quarter of 2013, mining was likely to start in the fourth quarter of 2014. Resources were estimated to be 959 Mt at grades of 4.4% ilmenite, 0.34% zircon, and 0.14% rutile, of which the reserves were 161 Mt at grades of 5.9% ilmenite, 0.45% zircon, and 0.2% rutile (World Titanium Resources Ltd., 2012, p. 1–5, 14).

Vanadium.—In 2011, Energizer Resources Inc. of Canada was considering the development of a new mine at its Green Giant property in southwestern Madagascar. Resources at the Green Giant property were estimated to be 59.2 Mt at a grade of 0.682% vanadium pentoxide (V_2O_5). Vanadium mineralization was hosted in graphite-rich sediment. Depending on the results of feasibility studies, Energizer planned to start a new mine to produce battery-grade V_2O_5 in 2014. The company expected to produce between 13% and 14% of the world's vanadium supply. In 2012, Energizer put its plans to mine vanadium on hold because of the discovery of graphite deposits at Green Giant (Grace, 2011; Reed, 2013).

Industrial Minerals

Gemstones.—In recent years, Madagascar has produced a variety of gemstones that included aquamarine, emerald, and other types of beryl; demantoid, 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 discovered in southern Madagascar at Ilakaka and Sakaraha in 1998, and Madagascar became one of the world's leading sapphire producers. Alexandrite and other chrysoberyl, garnet, spinel, zircon, and other gemstones were also mined at Ilakaka and Sakaraha. In August 2012, between 10,000 and 20,000 miners were estimated to be involved in gemstone production near Ilakaka and Sakaraha, which included about 6,500 in the Taheza River Basin, about 2,500 in the Fiherenana River and Malio River Basins, between 500 and 1,000 in the Benahy River and Imaloto River Basins, and 300 in the Ilakaka River Basin. Most of the mining operations were artisanal in 2012; mechanized operations produced at Amabrazy, Ambinany, and Ankaboka in the Ilakaka River Basin. The mechanized operations in the Benahy River Basin ceased between 2010 and 2012 (Pardieu, 2013).

In March 2012, the discovery of ruby and sapphire at Didy in northeastern Madagascar led to the migration of many artisanal miners from Ilakaka and Sakaraha from April to July. In July, the Government shut down mining at Didy for environmental reasons, and production at Ilakaka and Sakaraha had returned to previous levels by August. National ruby production increased to an estimated 400 kg in 2012 from 90 kg in 2011 because of mining at Didy (Pardieu, 2013).

In December 2011, small amounts of spessartine garnet were mined near Ambatofotsikely in central Madagascar. From January to April 2012, miners produced several hundred kilograms of transparent to translucent beryl at the deposit; aquamarine and pale orange beryl were also produced. The output of industrial-grade beryl was estimated to be several tons (Danet and others, 2012).

EUROMAD S.A. of Italy, Marbres et Granits de Madagascar SARL (MAGRAMA) of Italy, and SQNY International of India had royalty agreements with Malagasy Minerals Ltd. (MML) of Australia to mine labradorite from the anorthosite intrusives at Ianapera and Maniry. Norcross Madagascar Group of the United States opened a new labradorite quarry near Maniry in August 2011; the company was producing at the rate of about 3,600 t/yr in March 2012 (Norcross Madagascar Group, undated).

Graphite.—Madagascar had four graphite mining companies that produced more than 16,000 t/yr in the late 1990s. National production declined to an average of about 4,000 t/yr between 2008 and 2012 because of competition from Chinese producers, world market conditions, and the increasing cost of petroleum products used for drying graphite. Processing costs also increased because of declining grades at local deposits as higher grade materials were depleted. Etablissements Gallois S.A. was the only remaining producer that regularly mined and exported graphite; the company planned to increase its exports to 4,100 t in 2012 from 3,853 t in 2011 (National Institute of Statistics, 2000, p. 12; Feytis, 2010; Syrett, 2012).

At the end of September 2012, Graphmada Equity Pte Ltd. completed its graphite processing plant at Loharano with a capacity of 12,000 t/yr and started pilot production. Graphmada held mining permits for the Antsirabe and the Loharano deposits; the company planned to produce at the Loharano plant for 20 years (Stratmin Global Resources plc, 2013).

Societe Malagache du Graphite planned to restart production from the Ambatomitamba Mine. The company planned to produce 1,500 t/yr of graphite initially before ramping up production to 2,500 t/yr in the second phase and to the mine's full capacity of 4,000 t/yr in the third phase (Syrett, 2012).

In December 2012, Energizer estimated that resources at its Molo graphite deposit, which is part of the Green Giant vanadium project, were 124 Mt at a grade of 6.34% graphite. Energizer planned to complete a preliminary economic assessment on a new mine at Molo in the first quarter of 2013. The company was considering the development of three processing modules at Molo with a capacity of 50,000 t/yr each. Depending on the results of the assessment and further studies, Energizer and joint-venture partner MML could start initial production at 50,000 t/yr and ramp up to 150,000 t/yr if worldwide demand were sufficient (Lanham, 2012; Malagasy Minerals Ltd., 2013).

MML also engaged in rock-chip sampling at the Magrama Camp and the Maniry prospects in 2012. Depending on the results of further rock-chip sampling in the first quarter of 2013, MML could start drilling and trenching at the Magrama Camp. The company hoped to identify a resource of more than 5 Mt at a grade of at least 15% graphite (Malagasy Minerals Ltd., 2013).

Rare Earths.—In December 2011, Tantalus Rare Earths AG of Germany estimated that resources at its TRE project on the Ampasindava Peninsula in northwestern Madagascar

were 130 Mt at a grade of 0.08% rare-earth elements. About 20% of the rare earths were estimated to be heavy rare earths. Tantalus was considering plans for expanding its exploration activities in late 2012; the company hoped to increase resources (Tantalus Rare Earths AG, 2011, 2012).

Mineral Fuels

Coal.—Asia Thai Mining Co. Ltd. of Thailand and Red Island Minerals Ltd. of Australia held deposits in the Greater Sakoa basin with resources of 750 Mt and 180 Mt, respectively. The companies were considering the development of coal mines with an initial capacity of 5 million metric tons per year (Mt/yr) each (O’Neil, 2012).

Lemur Resources Ltd. of Australia held the Ianapera, the Imaloto, and the Sakaraha projects in the northern part of the Greater Sakoa basin. The company planned to produce 1 Mt/yr of coal initially at Imaloto; production could be expanded to between 3 and 3.5 Mt/yr depending on the development of a new railway and port. In 2011, Lemur signed an agreement with the Government-owned power company Jirama to build a new coal-fired power station with a capacity of 45 megawatts adjacent to Imaloto. Other possible consumers of Lemur’s coal included the new power station at the Ambatovy Mine, which could use about 400,000 t/yr of coal. Resources at Imaloto were estimated to be 176 Mt; Lemur hoped to discover 500 Mt at Ianapera and Sakaraha from exploration starting in the second half of 2012 (O’Neil, 2012).

Petroleum.—At the onshore Tsimiroro project (located in Block 3104), Madagascar Oil Ltd. of Bermuda planned to engage in pilot production at Tsimiroro from the end of 2012 through 2014. Output was likely to reach 1,000 barrels per day (bbl/d) by late 2013. The company subsequently delayed the start of pilot production until the second quarter of 2013 because of the extended rainy season and operational problems resulting from the remoteness of Tsimiroro. Madagascar Oil could start large-scale production for export as early as mid-2017 depending on the results of the pilot production; output was expected to reach the peak of 150,000 bbl/d by 2029. The life of the project was estimated to be about 50 years (Oil & Gas Journal, 2012; Madagascar Oil Ltd., 2013, p. 2, 4).

Outlook

The mineral industry of Madagascar is likely to have substantial growth in the near future. Growth is expected to be broadly based, with increased production of ilmenite, rutile, and zircon planned for 2013 through 2017; cobalt and nickel, in 2013 and 2014; and graphite, starting in 2013. Madagascar’s graphite production could increase to 14% of the world’s 2012 output; most of the increase would be attributable to output from the new Molo Mine. The majority of the increase in ilmenite, rutile, and zircon production is expected to be attributable to output from the new Ranobe Mine. Cobalt and nickel production is expected to increase as the Amabatovy project reaches full production. Further growth in the mineral industry could result from the development of petroleum and coal projects. The development of the mineral industry will depend on world market conditions and domestic political stability (Olson, 2013).

References Cited

- Andrews, Mark, 2012, Size doesn’t matter for Torian: Australia’s Paydirt, v. 1, no. 190, December–January, p. 92.
- Aziana Ltd., 2013, 2012 annual report: Perth, Western Australia, Australia, Aziana Ltd., 95 p.
- Bedinger, G.M., 2013, Titanium mineral concentrates: U.S. Geological Survey Mineral Commodity Summaries 2013, p. 174–175.
- Chamber of Commerce and Industry of Antananarivo, 2012, Nubes—QMM près de sa capacité maximale: Chamber of Commerce and Industry of Antananarivo, December 17. (Accessed August 20, 2014, at http://www.cci.mg/index.php?p=journaux&id=9&id_det=6170#.)
- Danet, Fabrice, Schoor, Marie, Boulliard, Jean-Claude, Neuville, D.R., Beyssac, Olivier, and Bourgoin, Vincent, 2012, Inclusions in aquamarine from Ambatofotsikely, Madagascar: *Gems & Gemology*, v. 48, no. 3, Fall, p. 205–208.
- Eisner, Harold, 2013, Zircon—Insufficient supply in the future?: Berlin, Germany, Deutsche Rohstoffagentur, 288 p.
- Feytis, Alexandra, 2010, The bright side of graphite: *Industrial Minerals*, no. 514, July, p. 31–39.
- Grace, K.M., 2011, Fuelling the future: Victoria, British Columbia, Canada, ResourceClips.com press release, January 31, 1 p.
- Lanham, Andrew, 2012, Madagascar’s graphite giant nears compliance: *Mining Review Africa*, no. 12, December, p. 12–14.
- Loferski, P.J., 2013, Zirconium and hafnium: U.S. Geological Survey Mineral Commodity Summaries 2013, p. 190–191.
- Madagascar Oil Ltd., 2013, 2012 annual report: Hamilton, Bermuda. Madagascar Oil Ltd. 22 p.
- Malagasy Minerals Ltd., 2013, Activities report for the December quarter 2012: West Perth, Western Australia, Australia, Malagasy Minerals Ltd. press release, January 31, 13 p.
- Mining Journal*, 2011, Sherritt updates Ambatovy: *Mining Journal*, October 21, p. 9.
- Ministry of the Economy, Commerce, and Industry, 2011, Rapport économique et financier 2010–2011: Antananarivo, Madagascar, Ministry of the Economy, Commerce, and Industry, 128 p.
- National Institute of Statistics, 2000, Journée Africaine de la Statistique 1999—Les points saillants: Antananarivo, Madagascar, National Institute of Statistics, 42 p. (Accessed July 8, 2013, at <http://www.instat.mg/pdf/jas1999.pdf>.)
- Norcross Madagascar Group, [undated], Press releases: Norcross Madagascar Group. (Accessed August 2, 2012, at http://www.madagascarminerals.com/press_releases.cfm.)
- Oil & Gas Journal, 2012, Madagascar’s oil fortunes evolving slowly: *Oil & Gas Journal*, v. 110, no. 2, February 6, p. 56.
- Olson, D.W., 2013, Graphite (natural): U.S. Geological Survey Mineral Commodity Summaries 2013, p. 68–69.
- O’Neil, John, 2012, Global scene...: *Inside Coal*, no. 519, April 12, p. 1–3.
- Pardieu, Vincent, 2013, Update on sapphire mining in Ilakaka-Sakaraha, Madagascar: *Gems & Gemology*, v. 49, no. 1, Spring, p. 56–58.
- Reed, Camila, 2013, Turning a corner: *Mining Journal*, March 22, p. 12, 14.
- Sherritt International Corp., 2013, 2012 annual report: Toronto, Ontario, Canada, Sherritt International Corp., 146 p.
- Stratmin Global Resources plc, 2013, Operations update—March 2013: London, United Kingdom, Stratmin Global Resources plc, 6 p. (Accessed July 9, 2013, at http://www.stratminglobal.com/index.php/shareholder-information.html?file=uploads/documents/Stratmin_Operations_Report_March2013.pdf.)
- Syrett, Laura, 2012, Elsewhere in the world: *Industrial Minerals*, no. 543, December, p. 61–63.
- Tantalus Rare Earths AG, 2011, Maiden JORC resource of 130 million tonnes for TRE project: Düsseldorf, Germany, Tantalus Rare Earths AG press release, December 20, 2 p.
- Tantalus Rare Earths AG, 2012, Tantalus Rare Earths AG appointment of directors and operational update: Düsseldorf, Germany, Tantalus Rare Earths AG press release, October 22, 3 p.
- Torian Resources NL, 2012, Quarterly report for the period ending 30 September 2012: Sydney, New South Wales, Australia, Torian Resources NL, 1 p.
- World Bank Group, [undated], Artisanal mining in critical ecosystems—A look at Gabon, Liberia, and Madagascar: Washington DC, The World Bank, 23 p. (Accessed July 8, 2013, at <http://www.profor.info/sites/profor.info/files/docs/ASM-brochure.pdf>.)
- World Titanium Resources Ltd., 2012, Results of completed definitive engineering study for the Ranobe Mine: Mount Claremont, Western Australia, Australia, World Titanium Resources Ltd. press release, August 28, 15 p.

TABLE 1
MADAGASCAR: PRODUCTION OF MINERAL COMMODITIES¹

(Metric tons unless otherwise specified)

Commodity ²	2008	2009	2010 ^c	2011 ^c	2012 ^c
METALS					
Beryllium, beryl in quartz concentrates ^e	12,000	12,000	12,000	12,000	16,000
Chromium, marketable output:	112,613 ³	133,000 ³	134,500 ³	66,700 ³	67,000
Cobalt, mine output, Co content					
Mine output, Co content	--	--	165	500	720
Refined	--	--	-- ⁴	-- ⁴	493 ⁴
Gold, mine output, Au content ^{e,5}	51 ^{r,3}	30 ^{r,3}	30 ^r	40 ^r	400
Nickel:					
Mine output, Ni content	--	--	2,000	5,900	8,250
Refined	--	--	-- ⁴	-- ⁴	5,695 ⁴
INDUSTRIAL MINERALS					
Cement, hydraulic ^e	460,000	370,000	410,000	410,000	410,000
Gemstones: ^{e,6}					
Amethyst ⁷	600	3,000 ^r	5,500 ^r	5,500 ^r	5,500
Cordierite	30	60	80	80	80
Emerald	34 ³	10 ³	2	2	2
Garnet	100	200	300	300	300
Ruby	1 ³	2 ³	90	90	400
Sapphire	660 ³	428 ³	2,300	2,300	2,300
Tourmaline ⁷	54,000	43,000	48,000	48,000	48,000
Graphite, all grades	4,922 ³	3,437 ³	3,783 ³	3,573 ³	4,100
Gypsum ^e	300	156 ⁴	127 ⁴	130	130
Kaolin	NA	90	259 ⁴	260	260
Mica, phlogopite	1,233 ³	358 ³	2,069 ³	3,411 ³	3,500
Ornamental stones: ^{e,6}					
Agate	13,000	1,500	6,000	6,000	6,000
Labradorite	4,200	4,700	6,200	7,000	7,000
Quartz	887 ³	104 ³	407 ³	214 ³	220
Salt, marine ^{e,8}	75,000	75,000	75,000	85,000	85,000
Stone:					
Granite	1,999 ³	1,239 ³	990	1,000	1,000
Limestone ^{e,9}	400,000	320,000	360,000	360,000	360,000
Marble	2 ³	3 ³	--	--	--
Other	2,401 ³	2,445 ³	670	670	670
Titanium:					
Ilmenite concentrate:					
Gross weight	--	160,000	287,000 ³	470,000	660,000
TiO ₂ content	--	96,000	172,000 ³	280,000	400,000
Rutile concentrate	--	3,200 ^e	5,700	9,400	13,000
Zirconium concentrate	--	4,755 ^r	7,490 ^{r,4}	13,075 ^{r,4}	17,000
MINERAL FUELS AND RELATED MATERIALS					
Petroleum, crude	2	2 ^e	--	--	--

^eEstimated; estimated data are rounded to no more than three significant digits; may not add to totals shown. ^rRevised. do. Ditto. NA Not available. -- Zero.

¹Table includes data available through February 10, 2014.

²In addition to the commodities listed, crude construction materials (other clays and sand and gravel), ornamental stones in addition to those listed (amazonite, apatite, and rhodonite), industrial abrasives, and calcite presumably are produced, but available information is inadequate to make reliable estimates of output.

³Reported exports.

⁴Reported production.

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

⁶Does not include smuggled artisanal production.

⁷Includes both gem and ornamental quality.

⁸Compagnie Salinere de Madagascar and Grand Salines de Menabe only. Other companies reportedly produced small amounts of salt.

⁹Cement producers only.

TABLE 2
MADAGASCAR: STRUCTURE OF THE MINERAL INDUSTRY IN 2012

(Metric tons unless otherwise specified)

Commodity		Major operating companies	Location of main facilities	Annual capacity
Cement		Holcim (Madagascar) S.A. (Holcim Group, 90%)	Plant at Ibity	160,000.
Do.		Madagascar Long Cimenterie (Maloci)	Plant at Ambohimambola	360,000.
Chromium		Kraomita Malagasy S.A. (KRAOMA) (Government, 100%)	Mine at Bemanevika	200,000. ^c
Cobalt:				
Mine		Ambatovy Minerals S.A. (Sherritt International Corp., 40%; Sumitomo Corp., 27.5%; Korea Resources Corp., 27.5%)	Mine at Ambatovy	5,600.
Refined		do.	Refinery near Toamasina	5,600.
Gemstones:				
Rough:				
Amethyst		Norcross Madagascar Group (NMG)	Mines at Ambatonrazaka	90. ^c
Aquamarine		Small-scale miners	Mine at Tsaramanga	NA.
Emerald	kilograms	Artisanal and small-scale miners	Mines at Mananjary	10. ^c
Garnet		do.	Mines at Antetazambato	NA.
Do.		do.	Mines at Behara	NA.
Labradorite		Marbres et Granits de Madagascar SARL	Mines at Ianapera and Maniry	3,000. ^c
Do.		(MAGRAMA) and EUROMAD SA	do.	
Do.		SQNY International	do.	2,000. ^c
Do.		Norcross Madagascar Group (NMG)	Mines at Maniry	3,600. ^c
Quartz		do.	Mines at Ramaratina	NA.
Do.		Small-scale miners	Mine at Tsaramanga	NA.
Ruby	kilograms	Artisanal and small-scale miners	Mines at Andilamena and Vatondry	100. ^c
Sapphire	do.	Various producers, including the following: Artisanal and small-scale miners World Sapphire Group Tany Hafa S.A. Canalta Gems Inc. Nantin Ltd. and artisanal miners	Locations: Mines at Ilakaka, Manombe, Marosely, and Sakara Mines at Ilakaka Mines at Sahambano Mines at Nose-Be and Andovokonko Mines at Ankazoabo	2,500. ^c
Tourmaline	do.	Artisanal and small-scale miners	Mines at Alatsinainy Ibity	NA.
Polished ¹	do.	Dream Stones Trading	Plant in Antananarivo	15.
Graphite		Etablissements Gallois S.A.	Artsirakambo Mine near Brickaville	4,800.
Do.		do.	Marovinsty Mine near Vatondry	3,600.
Do.		do.	Ambalafotaka Mine	NA.
Do.		Graphmada Equity Pte Ltd.	Mines at Antsirabe and Loharano	12,000. ^c
Do.		do.	Plant at Loharano	12,000.
Gypsum		Compagnie Salinere de Madagascar	Antsahampano	500.
Mica		Societe des Mines d'Ampandranhava	Tolagnaro	2,000 processed.
Nickel				
Mine		Ambatovy Minerals S.A.	Mine at Ambatovy	60,000.
Refined		do.	Refinery near Toamasina	60,000.
Petroleum, crude	thousand 42-gallon barrels	Madagascar Oil Ltd.	Tsimiroro ²	17. ^c
Salt				
Do.		Compagnie Salinere de Madagascar	Antsahampano	80,000.
Do.		Grand Salines du Menabe	Morondava	5,000. ^c
Titanium minerals		QIT Madagascar Minerals SA [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.

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

¹Includes amethyst, aquamarine, emerald, sapphire, tourmaline, and other gemstones.

²Not operating at the end of 2012.