

THE MINERAL INDUSTRY OF MADAGASCAR

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The Republic of Madagascar, which is the world's fourth largest island, is located about 420 kilometers (km) east of Mozambique in the Indian Ocean. Madagascar has an area of 587,040 square kilometers (km²) and had a population of more than 16 million in 2003. Its mining industry has been chiefly noted for the production and export of chemical- and metallurgical-grade chromite ore, high-quality crystalline flake graphite, and mica. In addition to these minerals, small quantities of beryllium, gold, rare-earth minerals, and such industrial mineral commodities as cement, feldspar, ornamental stones, precious and semiprecious gemstones, quartz, and salt have been produced. Madagascar is also known to have resources of bauxite, coal, cobalt, copper, lead, manganese, nickel, platinum, tin, titanium, zinc, and zirconium.

In 2003, Madagascar's gross domestic product (GDP) based on purchasing power parity amounted to about \$13.1 billion. It rose by 9.8% in 2003 after falling by 12.7% in 2002. The energy, manufacturing, and mining sectors accounted for 11% of the GDP in 2002, and the construction sector, 2% (International Monetary Fund, 2003, p. A.III.5; 2004, p. 206; 2004^{§1}).

Government Policies and Programs

In May 2003, the World Bank approved \$32 million in funding for the Mineral Resources Governance Project, which would assist Madagascar in increasing production and tax revenues from its mining sector. The Government of Madagascar would provide an additional \$5 million; the Government of South Africa, \$1 million; and the Government of the United States, \$500,000. The Mineral Resources Governance Project would decentralize tax collection procedures to increase revenues from royalties; finance geochemical and geologic mapping and airborne geophysics; improve environmental conditions at small-scale mines; promote private investment in the mining sector; and encourage small-scale gemstone and gold miners to declare their production. In the gemstone sector, the project would also establish a certification program for gemstones, create a gemstone exchange, train miners in gem-processing techniques, and increase domestic gemstone cutting and polishing (Mining Journal, 2004; World Bank Group, 2003, p. 28-31, 37).

In 2003, the Government issued 36 mining licenses compared with 26 in 2001. The number of exploration licenses fell to 146 in 2003 from 158 in 2001; the number of small-scale mining licenses rose to 640 in 2003 from 429 in 2001. Mining licenses were renewable and had a duration of 40 years. Exploration licenses had a duration of 10 years and were renewable for a single 5-year period (Mining Journal, 2004; Ministry of Energy and Mines, 2004a).

¹A reference that includes a section mark (§) is found in the Internet Reference Cited section.

Commodity Review

Metals

Chromium.—The Government-owned company Kraomita Malagasy (KRAOMA) produced chromite concentrates and lumpy ore from its mine at Ankazotaolana. In recent years, chromite production has fallen because of competition from producers in South Africa. At the end of 2002, reserves at the Ankazotaolana Mine were estimated to be 480,000 metric tons (t) at a grade of 29% to 33% Cr₂O₃; production was expected to continue until 2006. KRAOMA planned to restart production at the Bemanevika Mine before the closure of the Ankazotaolana Mine. Reserves at Bemanevika were estimated to be 2.5 million metric tons (Mt); KRAOMA was seeking a foreign partner to fund the removal of 6 Mt of overburden (Mining Journal, 2004; Banque Centrale du Madagascar, undated, p. 11-12).

Cobalt and Nickel.—Dynatec Corp. of Canada and Phelps Dodge Corp. of the United States were engaged in a joint venture to develop the Ambatovy nickel and cobalt deposit, which had resources of 210 Mt at grades of 1.1% nickel and 0.1% cobalt. The mine was expected to produce 50,000 metric tons per year (t/yr) of nickel and 4,000 t/yr of cobalt. The life of the mine was expected to be more than 40 years. Expenses were likely to be \$900 million, which included the development of infrastructure, a power supply, and a metallurgical plant near Toamasina. The companies planned to complete their feasibility study at Ambatovy in June 2004 (Mining Journal, 2004; Ministry of Energy and Mines, 2004b).

In November 2003, Diamond Fields International Ltd. (DFI) of Canada negotiated the exclusive right to purchase a 100% interest in the Valozoro nickel laterite deposit. Valozoro, which is located in south-central Madagascar, had resources of 3.7 Mt at a grade of 1.75% nickel. DFI planned to explore at Valozoro in March 2004 (Diamond Fields International Ltd., 2003b).

Gold.—Artisanal miners produced gold at numerous deposits in Madagascar, which included those at Ampanihy and Maevatanana in the east and Andavakoera in the northeast. In recent years, small mining companies and individual miners have produced from about 1,000 to 2,000 kilograms per year (kg/yr) of gold from small high-grade deposits. Officially reported gold output has been minimal in recent years. Resources of gold were estimated to be at least 33 t. In 2003, the Government issued exploration licenses to Madagascar Goldfields SARM, PAM Madagascar SARM, and Société Bijou Internationale (Mining Journal, 2004; Ministry of Energy and Mines, 2004c).

Platinum-Group Metals.—Madagascar had primary occurrences of platinum-group metals (PGM) in the Andranomiely region, and secondary occurrences, in Antanambao, Antampombato, and Antara. In September 2003, Jubilee Platinum plc of the United Kingdom began exploration work for PGM in the Londokamanana area.

Titanium and Zirconium.—QIT Madagascar Minerals S.A. (QMM) [QIT Fer et Titane of Canada (a subsidiary of Rio Tinto plc), 80%, and the Government of Madagascar, 20%] planned to develop a mineral sands project at Tolagnaro in southeastern Madagascar. Production would be 700,000 t/yr of ilmenite and 33,000 t/yr of zircon at full capacity. Resources of ilmenite and zircon were estimated to be 67 Mt and 3 Mt, respectively. The cost of the project was estimated to be \$350 million, which included power, roads, and a new port near Tolagnaro. The investment decision was expected in 2005 (Mining Journal, 2004; Ministry of Energy and Mines, 2004b).

In 2003, Ticor Ltd. of Australia signed an agreement with Madagascar Resources NL of Mauritius to explore for titanium and zirconium in the Tulear region on the west coast. Madagascar Resources and Ticor planned to conduct a feasibility study on developing the Tulear deposit. Depending upon the results of the study, ilmenite from this project could be used to supply Ticor's smelter in South Africa (Africa Mining Intelligence, 2003).

Industrial Minerals

Cement.—Holcim (Madagascar) S.A. (formerly known as Société Malgache des Ciments) and SA Nouvelle Cimenterie Amboanio (66% owned by the Lafarge Group of France) operated cement plants with capacities of 150,000 t/yr and 40,000 t/yr, respectively (table 2). In 2003, Madagascar's imports of cement were 254,859 t, which was about twice the figure for 2002. Higher imports may have been attributable to the need to repair infrastructure damaged by civil unrest in 2002 (Institut National de la Statistique, 2004, p. 14).

Diamond.—In September 2003, DFI announced the discovery of diamond in Madagascar. DFI was awarded exploration licenses for areas that covered 45,000 km² at Midogne, which is located near the east coast, and Horombe, which is located in the central highlands (Diamond Fields International Ltd., 2003a).

Gemstones.—Madagascar produced an estimated 50% of the world's sapphire output; the country also produced emerald and ruby. Sapphire was mined at Ilakaka and Sakara; ruby, at Andilamena and Vatomaniry; and emerald, at Vananjary. In 2002, the value of precious stones produced in Madagascar was \$7.63 million compared with \$5.94 million in 2001 and \$2.61 million in 1998. From 1998 to 2002, exports of rough sapphire increased to 9,326 kilograms (kg) from 2,547 kg; ruby, to 889 kg from 30 kg; and emerald, to 31 kg from 1 kg (Mining Journal, 2004; Ministry of Energy and Mines, 2003, p. 38; 2004b).

In 2003, sapphire production at Ilakaka and Sakara was about 60% of the levels reached before 2002. Most of the buyers of rough sapphire at Ilakaka and Sakara were Sri Lankan. In February, a new deposit was discovered at Monombo Voavoava, which is located 38 km west of Ilakaka. Small amounts of sapphire were produced at Amboasary, Andrebabe, and Fenerive Est in north-central Madagascar and at an alluvial deposit in the Manantenina area near the southeastern coast (Laurs, 2003b).

Americana Gold and Diamond Holdings Inc. (AGDM) held the North Fork 14 sapphire concession at Ilakaka. In October 2003, the company announced plans to conduct trenching at North Fork 14 to determine the grades and qualities of its sapphire resources.

AGDM planned to begin full-scale production of sapphire and other gemstones in 2004. Depending upon the results of its exploration work, AGDM could produce nearly 3,000 kg/yr of sapphire and 1,400 kg/yr of semiprecious stones (Americana Gold and Diamond Holdings Inc., 2003a, b; Platinum Works Inc., 2001, p. 46).

In 2002, exports of cut sapphire amounted to 10 kg, and cut ruby, 4 kg. Magic Stone Madagascar cut domestically mined ruby and sapphire. The company recently expanded its operations and planned to produce about 5 kg/yr of gemstones with weights of more than 1 carat; these gemstones would be sold primarily in the United States. Gemstones that weighed less than 1 carat would be cut and sent to China for polishing. Magic Stone also planned to cut color-change garnet and tsavorite, which is a green grossular garnet that obtains its color from chromium and vanadium (Laurs, 2003a; Ministry of Energy and Mines, 2003).

Many types of semiprecious stones, which included amethyst, beryl, citrine, garnet, topaz, and tourmaline, were produced in Madagascar. In 2002, the value of semiprecious stone production was \$1.4 million compared with \$810,000 in 2001 and \$570,000 in 1998 (Mining Journal, 2004).

In November 2002, a deposit of pezzottaite, which is a type of lithium- and cesium-rich beryl, was discovered at Sakavalana in the central highlands. By late 2003, as much as 150 kg of pezzottaite had been produced at Sakavalana, but most of the resources were depleted by July. About 700 kg of smoky quartz, 280 kg of tourmaline, and 25 kg of spodumene were also mined at this deposit (Laurs and others, 2003, p. 286-289).

In July 2003, a new deposit of tsavorite was discovered near Edjeda in southern Madagascar. Small amounts of grossular garnet were mined in the Antsongombato region in the central part of the country, and color-change garnet, at Bekily. Dark red tourmaline was mined in the Antsongombato region, and carving-quality tourmaline was produced in Fianarantsoa State in central Madagascar. National exports of rough garnet were 599 kg in 2002 compared with 2,092 kg in 2001 and 801 kg in 1998. From 1998 to 2002, exports of rough tourmaline rose to 63,722 kg from 3,642 kg (Ministry of Energy and Mines, 2003, p. 39, 41).

Madagascar produced a wide range of ornamental stones that included agate, aragonite, jasper, labradorite, and rose quartz. The value of production for ornamental stones was reported to be \$9.48 million in 2002 compared with \$4.06 million in 2001 and \$3.26 million in 1998. From 1998 to 2002, national production of rough labradorite increased to 4,184 t from 209 t; exports of cut labradorite rose to 25 t from 3 t. In 2003, Marbres et Granits de Madagascar (MAGRAMA) increased its production of labradorite to 3,500 t from 2,200 t in 2002 and exported most of it mainly to Italy. The company expected to increase production by 20% in 2004 (Ministry of Energy and Mines, 2003, p. 41; Mining Journal, 2004).

Graphite.—The leading producer of graphite was Etablissements Gallois, which had mines at Ambalafotaka, Antsirakambo, and Marovintsy on the east coast. Etablissement Izouard, Etablissement Rostaing, Société Louys, and Société Minière de la Grande Ile also mined graphite. National resources of graphite were estimated to be 960,000 t.

Production had fallen in recent years because of competition from producers in Brazil and China. In 2002, the United States imported 2,030 t of graphite at a value of \$970,000 from Madagascar compared with 2,500 t at a value of \$1.18 million in 2001 (Mining Journal, 2004; Olson, 2004; Banque Centrale du Madagascar, undated, p. 11-12).

Stone, Dimension.—MAGRAMA produced granite, labradorite, and marble. Weak demand in export markets forced MAGRAMA to reduce marble production in favor of labradorite in 2003. Small amounts of marble dimension stone were still produced for domestic consumers. The company's marble quarrying activities have contributed to habitat losses in the Ambatofinadrahana area (Andriantiana, 2003).

Mineral Fuels

Coal.—In 2003, Vuna Energy Ltd. of the United Kingdom signed an agreement with the Government to explore the Sakao coal deposit in southwestern Madagascar. Sakao's resources, which were estimated to be 65 Mt, would be used to supply a new power station (Africa Mining Intelligence, 2004).

Petroleum.—In 2003, Madagascar did not produce crude petroleum and relied on imported petroleum products; the country's only refinery shut down in 2001. Vuna Energy signed an agreement with the Government that gave the company exclusive rights to conduct surveys on the Tsimiroro bituminous sand deposit during a 20-month period. Tsimiroro had estimated reserves of 26 million barrels. In late 2003, Vanco Energy Ltd. announced plans to drill in Madagascar's deep offshore during the next 2 years. Vanco held an exploration license off Mahajanga on the west coast (Africa Energy Intelligence, 2003b; Ford, 2003; Africa Mining Intelligence, 2004).

In 2003, Office Malagache Nationa des Industries Strategiques (OMNIS) reduced the size of exploration zones to 10,000 km² from 20,000 km² to attract petroleum exploration companies. OMNIS also carried out seismic surveys and was planning to conduct a licensing round in December 2003 (Africa Energy Intelligence, 2003a).

Infrastructure

Jiro Sy Rano Malagasy (JIRAMA) was the Government-owned utility that produced most of Madagascar's electricity. About two-thirds of the electricity was generated by hydroelectric power sources. In late 2003, the World Bank encouraged JIRAMA to privatize its management.

Madagascar had a road network of 33,000 km and a rail network of 800 km. The road and rail networks have deteriorated during the past 10 years; the Government planned to rehabilitate 14,000 km of roads. The country also had 6 international and 12 local ports; the most important international port was Toamasina (Ministry of Energy and Mines, 2004b).

Outlook

The International Monetary Fund (2004, p. 206) predicted that Madagascar's GDP would rise by 5.3% in 2004 and 7% in 2005. High rates of GDP growth may lead to increased

demand for such local construction materials as cement, gravel, limestone, and sand. Madagascar's beryl, chromite, gemstone, gold, graphite, and mica industries depended heavily upon world market conditions and political stability; the same held true for such unexploited mineral commodities as titanium and zirconium. In 2003, the market for titanium dioxide was in a state of excess supply. Demand for titanium dioxide was expected to increase by about 110,000 t/yr; the market was likely to be in balance by 2007 (Mining Review Africa, 2003).

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TABLE 1
 MADAGASCAR: PRODUCTION OF MINERAL COMMODITIES¹
 (Kilograms unless otherwise specified)

Commodity ²	1999	2000	2001	2002 ^e	2003 ^e
METALS					
Beryllium, beryl in quartz concentrates, industrial and ornamental ^e	20,000	1,696 ³	1,000	1,000 ^r	1,000
Chromium, marketable output:					
Chromite concentrate, gross weight metric tons	--	24,922	6,599	3,000 ^r	12,000
Chromite ore, lumpy do.	--	106,371	17,038	8,000 ^r	33,000
Total do.	--	131,293	23,637	11,000 ^{r,3}	45,040 ³
Gold, mine output, Au content ⁴	8 ^e	5	(5)	(5) ^r	10 ³
INDUSTRIAL MINERALS					
Abrasives, natural (industrial only) ^e	900	1,300	1,300	1,300 ^r	1,300
Cement, hydraulic metric tons	45,719	50,938	51,882	52,000 ^r	52,000
Clay, kaolin ^e do.	120	170	170	170 ^r	170
Feldspar ^e	3,400	7,300 ³	2,800	2,800 ^r	2,800
Gemstones: ⁶					
Amethyst	100 ^e	156	75	100 ^r	100
Emerald	2 ⁷	6 ⁷	6 ^e	10 ^r	15
Ruby	6 ⁷	3	941	1,000 ^r	1,000
Sapphire	3,810 ⁷	9,536 ^{r,7}	8,470	9,000 ^r	6,000
Tourmaline ^e	1,400	1,989 ³	800	1,000 ^r	1,000
Graphite, all grades, shipments metric tons	16,137	40,328	2,013	2,000 ^r	2,000
Mica, phlogopite do.	54	66	90	90 ^r	90
Ornamental stones: ⁶					
Agate	75,000 ^e	49,675	25,000 ^e	55,000 ^r	70,000
Rose quartz ⁸	30,000 ^e	6,200	10,792	25,000 ^r	35,000
Salt, marine metric tons	26,131	25,530	25,928	17,000	26,000
Stone:					
Dimension ^e do.	138 ⁷	200	200	200 ^r	200
Marble do.	NA	1,222	5,600	5,600 ^r	5,000
MINERAL FUELS AND RELATED MATERIALS					
Petroleum refinery products:					
Gasoline thousand 42-gallon barrels	617	771	807	-- ³	-- ³
Kerosene and jet fuel do.	409	410	472	-- ³	-- ³
Distillate fuel oil do.	749	946	945	-- ³	-- ³
Residual fuel oil do.	1,251	1,420	1,555	-- ³	-- ³
Other do.	61	75	80	-- ³	-- ³
Total do.	3,087	3,622	3,859	-- ³	-- ³

^eEstimated; estimated data are rounded to no more than three significant digits. ^rRevised. NA Not available. -- Zero.

¹Includes data available through September 30, 2004.

²In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (other clays, sand and gravel, and stone) and industrial calcite presumably were produced, but output was not reported quantitatively, and available information was inadequate to make reliable estimates of output levels.

³Reported figure.

⁴Does not include smuggled artisanal production, which was estimated to range from 1,000 to 2,000 kilograms per year.

⁵Less than 1/2 unit.

⁶Does not include smuggled artisanal production.

⁷Reported exports.

⁸In recent years, Madagascar has also produced industrial quartz.

TABLE 2
MADAGASCAR: STRUCTURE OF THE MINERAL INDUSTRY IN 2003

(Metric tons unless otherwise specified)

Commodity	Major operating companies	Location of main facilities	Annual capacity
Cement	Holcim Madagascar S.A. (Holcim Group, 90%)	Ibity	150,000 cement; 120,000 clinker.
Do.	SA Nouvelle Cimenterie Amboanio (LaFarge Group, 66%; Moustansir Ibaramdy Family, 34%)	Mahajanga	40,000 cement; 40,000 clinker.
Chromium	Kraomita Malagasy (Government, 100%)	Ankazotoalana	250,000 run of mine.
Do.	do.	Bemanekiva	40,000 run of mine.
Graphite ¹	Etablissements Gallois	Toamasina	NA.
Do.	Etablissements Izouard	NA	NA.
Do.	Etablissements Rostaing	NA	NA.
Do.	Societe Louys	NA	NA.
Do.	Societe Miniere de la Grande Ile	Ambatomitamba	10,000 processed.
Mica	Societe des Mines d'Ampandranhava	Tolagnaro	2,000 processed.
Petroleum, refined	thousand 42-gallon barrels Galana International, Groupe Trimeta, Gulf Oil Corporation, and Petroleum India International	Toamasina ²	5,475.

NA Not available.

¹Total capacity of graphite is at least 40,000 metric tons per year based on recent production data.

²Shut down in 2001.