



# 2005 Minerals Yearbook

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## MADAGASCAR

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# THE MINERAL INDUSTRY OF MADAGASCAR

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The Republic of Madagascar is an island located about 420 kilometers (km) east of Mozambique in the Indian Ocean. Madagascar had an area of 587,040 square kilometers (km<sup>2</sup>) and a population of more than 18 million in 2005. Its mining industry was chiefly noted for the production and export of chemical- and metallurgical-grade chromite ore, high-quality crystalline flake graphite, and precious, semiprecious, and ornamental gemstones. In addition to these minerals, small quantities of beryllium and gold and such industrial mineral commodities as cement, feldspar, quartz, and salt were produced. Madagascar was also known to have resources of bauxite, coal, cobalt, copper, lead, manganese, nickel, platinum, tin, titanium, zinc, and zirconium.

In 2005, Madagascar's nominal gross domestic product (GDP) based on purchasing power parity amounted to about \$16.2 billion. Madagascar's real GDP increased by 4.6% in 2005 compared with 5.3% in 2004. The manufacturing sector accounted for about 10% of the real GDP; energy, 1%; and mining and construction materials, less than 1% (Ministère de l'Economie, des Finances et du Budget, 2005, p. 131; International Monetary Fund, 2006<sup>§1</sup>).

In 2005, real output in the mining sector was estimated to have grown at a rate of 4% compared with 8% in 2004 and 10% in 2003. The construction materials sector grew by 6% in 2005, and the energy sector, by 5% (Ministère de l'Economie, des Finances et du Budget, 2005, p. 102).

## Government Policies and Programs

In February 2005, the Government enacted legislation that permitted foreign buyers to purchase and export gemstones from Madagascar. Under the new legislation, a business license was required to be purchased at a cost of \$100 to export gemstones. Export taxes on rough gemstones were 2%; cut gemstones could be exported tax free. Prior to the passage of the legislation, it was illegal for foreign buyers to purchase gemstones without forming a locally registered company (Colored Stone, 2005).

## Commodity Review

### Metals

**Chromium.**—The state-owned company Kraomita Malagasy (KRAOMA) produced chromite concentrates with a content of between 48% and 49% Cr<sub>2</sub>O<sub>3</sub> and lumpy ore with a content of between 42% and 43% Cr<sub>2</sub>O<sub>3</sub> from its mines at Ankazotaolana and Bemanevika. The company exported its output to China, Japan, and Sweden. In 2005, chromite production increased to an estimated 140,000 metric tons (t) compared with 77,386 t in

2004 and 45,040 t in 2003 because of increased demand from China. KRAOMA restarted production at the Bemanevika Mine in October 2005 because of the impending resource depletion at Ankazotaolana. Reserves at Bemanevika and Ankazotaolana were estimated to be 3 million metric tons (Mt) and 750,000 t of ore, respectively (Andrianatenaina, 2005b).

**Cobalt and Nickel.**—The Ambatovy nickel laterite deposits are located in eastern Madagascar. In March 2005, Dynatec Corp. of Canada and its joint-venture partner Phelps Dodge Corp. of the United States completed a feasibility study on developing the Ambatovy nickel and cobalt project. Starting by the end of 2008, the companies planned to mine two deposits that had combined reserves of 125 Mt at grades of 1.04% nickel and 0.1% cobalt. After the end of the 20-year life of the mine, Dyantec and Phelps Dodge expected to process 39.4 Mt of additional stockpiled ore at grades of 0.69% nickel and 0.064% cobalt (Mining Journal, 2005a).

Laterite slurry from the ore-processing plant was to be transported by a 195-km pipeline to a pressure-acid-leaching plant at Toamasina. The plant was expected to produce a sulfide product that contained 55.2% nickel and 4.2% cobalt. The sulfide product would be 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. The capital cost of the mine, pipeline, processing plants, refinery, power supply, and port facilities was estimated to be \$2.25 billion (Mining Journal, 2005a).

Dynatec agreed in early 2005 to acquire Phelps Dodge's interest in Ambatovy. Impala Platinum Holdings Ltd. (Implats) of South Africa agreed in June to form a joint venture with Dynatec to develop the Ambatovy project, and Sumitomo Corp. of Japan joined the partnership in August. Dynatec and Implats each held 37.5% of the project, and Sumitomo, 25%. In December, Implats withdrew from the project because of rising costs in the mining industry. Dynatec and Sumitomo were expected to seek new joint-venture partners for the project (Mining Journal, 2005b).

Diamond Fields International Ltd. of South Africa held 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. The company also engaged in exploration at its recently acquired Jango property, which is located northwest of Antananarivo, and ceased exploration activities at other properties in 2005 (Diamond Fields International Ltd., 2006, p. 11).

**Copper and Platinum-Group Metals.**—In 2005, Jubilee Platinum plc of the United Kingdom signed an agreement with BHP Billiton Ltd. of Australia to conduct a geophysical survey of Jubilee's Ambodilafa copper-nickel sulfide property. The company also conducted a geophysical survey at the Lanjanina copper property. In the second half of 2005, Jubilee started drilling at the Antsahabe and the Lavatrafo copper-nickel-platinum-group-metals properties, which make up the Londokomanana project. Drilling was expected to start at Ambodilafa and Lanjanina in 2006 (Jubilee Platinum plc, 2006).

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

**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. Golden Deeps Ltd. of Australia explored for gold at the Kelimaizina gold prospect in north-central Madagascar. In November 2005, Golden Deeps acquired the Antanimbary property, which is located about 200 km northwest of Antananarivo. The company engaged in soil sampling at Antanimbary. Pan African Mining Corp. of Canada explored at its Mountain of Gold property in the Dabolava region of the Central-West Plateau; the company planned to start a drilling program in January 2006 (Pan African Mining Corp., 2005b; Golden Deeps Ltd., 2006).

**Titanium and Zirconium.**—In August 2005, Rio Tinto plc of Australia announced plans to proceed with its mineral sands joint-venture project at Mandena in southeastern Madagascar [QIT Fer et Titane of Canada (a subsidiary of Rio Tinto plc), 80%, and the Government of Madagascar, 20%]. Following the startup of construction in the fourth quarter of 2005, ilmenite shipments were expected to begin in the third quarter of 2008. Rio Tinto planned to produce 750,000 t/yr of ilmenite by 2012; production could rise to 2 million metric tons per year in future phases of the project. The construction cost of the mine and processing facilities was estimated to be \$440 million, and of a new port at Eholo, \$145 million. The company also planned to spend \$190 million to upgrade its plant at Sorel in Quebec, where the ilmenite from Mandena would be smelted. Reserves at Mandena were 75 Mt of contained ilmenite with a TiO<sub>2</sub> content of 60%; the life of the mine was expected to be at least 40 years (Mining Journal, 2005c).

Kumba Resources Ltd. of South Africa and Tigor Ltd. of Australia were engaged in a feasibility study on the Toliara mineral sands deposit. The companies planned to complete the study by the end of 2006 at a cost of about \$5 million. The life of the proposed mine was estimated to be more than 30 years if the feasibility study yielded favorable results; ilmenite from Toliara would be exported to South Africa for smelting (Tigor Ltd., 2005).

### *Industrial Minerals*

**Cement.**—National cement production increased to an estimated 180,000 t in 2005 from 51,882 t in 2001. In spite of higher production, cement prices increased sharply from 2003 to 2005 because of increases in demand. In 2004, Madagascar's consumption of cement increased to nearly 500,000 t compared with 424,000 t in 2003. Higher consumption was attributable to such public works projects as schools and roads (Andrianatenaina, 2005a; Rakotomalala, 2005a).

Holcim (Madagascar) S.A. and Nouvelle Cimenterie Amboanio, which was 66% owned by the Lafarge Group of France, operated two cement plants with capacities of 150,000 t/yr and 40,000 t/yr, respectively (table 2). Holcim planned to increase the capacity at the Ibity plant to 200,000 t/yr by February 2007 (Rampanjato, 2005a).

Madagascar Long Cimenterie (MLC) of China planned to complete a new cement plant at Ambohimambola by

June 2006 that would produce 250,000 t/yr. MLC initially planned to produce cement from imported clinker; the company indicated that a limestone quarry could be opened at Antsirabe in the future (Rakotomalala, 2005b).

**Diamond.**—Majescor Resources Inc. of Canada and its joint-venture partner Madagascar Mining Development of Madagascar explored for diamond at the former company's properties in the northeastern and southeastern parts of the country. In late 2005, the companies discovered kimberlites on Majescor's properties; further exploration was planned for 2006. Pan African also explored for diamond. Diamond Fields ceased its diamond exploration activities in Madagascar in 2005 (Majescor Resources Inc., 2005; Diamond Fields International Ltd., 2006, p. 11).

**Gemstones.**—Madagascar was one of the world's leading producers of sapphire; most domestically mined sapphire was produced by artisanal miners at Ilakaka, Manombe, and Sakara in the south-central part of the country. In July 2004, new mines were opened at Moramanga, which is located 46 km east of the Andilamena ruby deposits. Small amounts of sapphire were produced at Diego Suarez in northern Madagascar. Exports of sapphire decreased to an estimated 4,700 kilograms (kg) in 2005 compared with 5,890 kg in 2004 and 9,326 kg in 2002. The decline in production was attributable to the depletion of easily mined deposits near the surface at Ilakaka. Sapphire was discovered at depths of about 26 meters, but mining at that depth would require the use of machinery unavailable to artisanal miners (Henricus, 2005; Rampanjato, 2005b; Pardieu and Wise, 2006a, b).

Most sapphire and other gemstones were exported in rough form because of the lack of a significant domestic lapidary industry. The value of reported gemstone exports was also limited by high rates of smuggling. Illegal exports of sapphire to Thailand were estimated to be about 2,600 kilograms per year (kg/yr), and those to other countries, about 500 kg/yr. The value of undeclared gemstone exports was estimated to be \$100 million. The World Bank Group planned to increase Madagascar's reported gemstone exports to between \$40 million and \$80 million per year mostly by expanding the domestic lapidary industry (Moscato, 2004; Gazette de la Grande Ile, 2005; Mercia, 2005).

Ruby was mined near Andilamena in north-central Madagascar and Vatomandry on the east coast. Exports of ruby were estimated to be 920 kg in 2005 compared with 741 kg in 2004 and 889 kg in 2002. The decline in production in 2004 was attributable to continued uncertainty about ownership of claims. Production increased in 2005 because of the discovery of a new deposit near the village of Tananarivekely, which is located near Andilamena. More than 15,000 miners and traders were working at Andilamena in mid-2005. Ruby mining reportedly led to environmental damage to the forest near Andilamena (Henricus, 2005; Rakotomalala, 2005b; Rampanjato, 2005b; Pardieu and Wise, 2006a).

Emerald was mined at Mananjary near the east coast. Exports of emerald rose to an estimated 60 kg in 2005 from 53 kg in 2004 and 31 kg in 2002. The increase in production may be attributable to a new find of high-quality emerald (Henricus, 2005; Rampanjato, 2005b).

Alexandrite, amethyst, aquamarine, garnet, and morganite were also produced at Ilakaka and Sakara. In recent years, almandine, grossularite, pyrope-spessartine, rhodolite, and spessartine garnet have been mined in Madagascar. A new mine in Vangainrano also produced aquamarine and green beryl. The supply of morganite, which is a type of beryl that obtains its pink color from inclusions of manganese, fell because of a cave-in at the most productive mine. Small amounts of pink tourmaline were produced from a new mine near Antsirabe (Henricus, 2005).

A wide variety of ornamental stones that included agate, labradorite, and rose quartz were also mined in Madagascar. In early 2004, cutting and polishing facilities employed about 1,000 workers, about 80% of whom were involved in cutting ornamental stones (Moscato, 2004).

**Graphite.**—The leading producer of graphite was Etablissements Gallois, which had mines at Ambalafotaka, Antsirakambo, and Marovintsy on the east coast. The company produced about 10,000 t/yr of graphite. Etablissement Izouard, Etablissement Rostaing, Société Louys, and Société Minière de la Grande Ile (a subsidiary of Société Participation Industrielle et Minières of France) also mined graphite. In 2005, exports of graphite were estimated to be 9,600 t at a value of \$4.8 million, or nearly 1% of total exports (Ministère de l'Economie, des Finances et du Budget, 2005, p. 111).

### *Mineral Fuels and Related Materials*

**Petroleum.**—Galana Petroleum Ltd. of Mauritius managed Madagascar's only petroleum products refinery at Toamasina. The company relied on imports to supply its refinery; Madagascar did not produce crude petroleum in 2005. National imports of petroleum and petroleum products amounted to \$108 million in 2005, or 19% of total imports (Ministère de l'Economie, des Finances et du Budget, 2005, p. 112).

The Majunga Offshore concession was held by a joint venture of Exxon Mobil Corp. of the United States (40%), Norsk Hyrdo ASA of Norway (30%), and Vanco Energy Company of the United States (30%). ExxonMobil also held an exploration license that covered 36,500 km<sup>2</sup> off Cape St. Andre. Sterling Energy plc of the United Kingdom held the Ambilobe and the Ampasindva licenses, which were located to the north of the Majunga Offshore. In July 2005, Sterling signed a joint-venture agreement with ExxonMobil; the latter company agreed to pay for an exploration program in return for a 70% interest in Ambilobe and Ampasindva. Madagascar Oil (a subsidiary of Vuna Energy Ltd. of the United Kingdom) held production-sharing contracts for the exploration and development of natural gas and crude petroleum in six onshore blocks that included the bituminous sands at Tsimiroro and bituminous clay at Bemolanga (Sterling Energy plc, 2005).

**Uranium.**—In November 2005, Pan African entered into a joint-venture agreement with the Government agency L'Office des Mines Nationales et des Industries Strategiques (OMNIS) to explore, develop, and mine uranium at Faratsiho, Folakara, Makay, and Tranomaro. Pan African held an 80% interest in the joint venture and OMNIS, 20%. OMNIS approved the company's exploration program in July; an environmental

protection agreement was signed with L'Institut des Sciences et Techniques Nucleaires in September. Pan African planned to spend as much \$3.92 million on each of the properties, depending on the results of the initial four stages of exploration through preliminary feasibility study (Pan African Mining Corp., 2005a).

### **Infrastructure**

Jiro Sy Rano Malagasy (JIRAMA) was the Government-owned utility that produced most of Madagascar's electricity. In April 2005, Lahmeyer International of Germany took over management of JIRAMA. The utility was experiencing severe financial difficulties; all its facilities were reported to be in disrepair (Africa Energy Intelligence, 2005).

In May 2005, domestic demand for electricity amounted to 155 megawatts (MW) of capacity; JIRAMA's effective capacity was 142 MW. The 58-MW Andekaleka hydroelectric power station supplied more than 50% of Madagascar's electricity. Heavy rainfall in the summer of 2004 washed substantial amounts of sand down the Andekaleka River into one of the plant's turbines; effective capacity was reduced to 29 MW. The European Investment Bank provided Alstom of France with funds to repair the Andekaleka plant starting in August 2005 (Africa Energy Intelligence, 2005).

Madagascar had a road network of more than 50,000 km, of which 11% was paved; the rehabilitation of 14,000 km of the road network was underway. The rail network amounted to 1,135 km, most of which was in the vicinity of Antananarivo.

### **Outlook**

The International Monetary Fund (2006§) predicted that Madagascar's GDP would rise by 5.7% in 2006 and 6.3% in 2007. High rates of GDP growth may lead to increased domestic 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 domestic political stability; the same held true for such undeveloped mineral commodities as nickel, titanium, and zirconium. The depletion of placer sapphire deposits at Ilakaka and changes in the mining code designed to encourage large-scale capital investment could lead to an increase in mechanized sapphire mining operations (Pardieu and Wise, 2006b).

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TABLE 1  
MADAGASCAR: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Kilograms unless otherwise specified)

Commodity <sup>2</sup>	2001	2002	2003 <sup>c</sup>	2004 <sup>c</sup>	2005 <sup>c</sup>
<b>METALS</b>					
Beryllium, beryl in quartz concentrates, industrial and ornamental <sup>c</sup>	1,000	1,000	1,000	1,000	1,000
Chromium, marketable output:					
Chromite concentrate, gross weight metric tons	6,599	2,700 <sup>c</sup>	12,000	21,000	35,000
Chromite ore, lumpy do.	17,038	8,000 <sup>c</sup>	33,000	56,000	105,000
Total do.	23,637	10,700	45,040 <sup>3</sup>	77,386 <sup>3</sup>	140,000 <sup>3</sup>
Gold, mine output, Au content <sup>4</sup>	(5)	-- <sup>c</sup>	10 <sup>3</sup>	5 <sup>6</sup>	5 <sup>6</sup>
<b>INDUSTRIAL MINERALS</b>					
Abrasives, natural (industrial only) <sup>c</sup>	1,300	1,300	1,300	1,300	1,300
Cement, hydraulic <sup>c</sup> metric tons	51,882 <sup>3</sup>	30,000 <sup>r</sup>	80,000 <sup>r</sup>	130,000	180,000
Clay, kaolin <sup>c</sup> do.	170	170	170	170	170
Feldspar <sup>c</sup> do.	3	3	3	3	3
Gemstones: <sup>6,7</sup>					
Amethyst <sup>8</sup>	383	617	620	620	620
Cordierite	4,241	158	160	160	160
Emerald	(5)	31	40	53 <sup>6</sup>	60
Garnet	2,092	599	600	600	600
Ruby	941	889	800	741 <sup>6</sup>	920
Sapphire	8,470	9,326	6,000	5,890 <sup>6</sup>	4,700
Tourmaline <sup>8</sup>	78,971	63,722	64,000	64,000	64,000
Graphite, all grades: metric tons	2,013	2,000 <sup>c</sup>	15,000	15,000	15,000
Mica, phlogopite do.	90	90 <sup>c</sup>	90	90	90
Ornamental stones: <sup>7</sup>					
Agate <sup>c</sup>	25,000	20,000	25,000	25,000	25,000
Labradorite metric tons	797	4,183	6,600	8,000	8,000
Quartz <sup>6</sup> do.	574	423	430	430	430
Salt, marine do.	25,928	17,000	26,000	26,000	26,000
Stone:					
Dimension <sup>c</sup> do.	200	200	200	200	200
Marble do.	5,600	5,600 <sup>c</sup>	5,000	5,000	5,000
<b>MINERAL FUELS AND RELATED MATERIALS</b>					
Petroleum refinery products:					
Gasoline thousand 42-gallon barrels	488	237	500	500	500
Kerosene and jet fuel do.	332	163	350	350	350
Distillate fuel oil do.	600	357	750	750	750
Residual fuel oil do.	578	317	670	670	670
Liquefied petroleum gas do.	41	14	30	30	30
Total do.	2,039	1,088	2,300	2,300	2,300

<sup>c</sup>Estimated; estimated data are rounded to no more than three significant digits; may not add to totals shown. <sup>r</sup>Revised. -- Zero.

<sup>1</sup>Table includes data available through September 13, 2006.

<sup>2</sup>In addition to the commodities listed, modest quantities of crude construction materials (other clays, sand and gravel, and stone) and industrial calcite presumably are produced, but output was not reported quantitatively, and available information is inadequate to make reliable estimates of output.

<sup>3</sup>Reported figure.

<sup>4</sup>Does not include smuggled artisanal production, which is estimated to be from 1,000 to 2,000 kilograms per year.

<sup>5</sup>Less than 1/2 unit.

<sup>6</sup>Reported exports.

<sup>7</sup>Does not include smuggled artisanal production.

<sup>8</sup>Includes both gem and ornamental quality.

TABLE 2  
MADAGASCAR: STRUCTURE OF THE MINERAL INDUSTRY IN 2005

(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	150,000 cement; 120,000 clinker.
Do.		SA Nouvelle Cimenterie Amboanio (LaFarge Group, 66%, and Moustansir Ibaramdy Family, 34%)	Plant at Mahajanga	40,000 cement; 40,000 clinker.
Chromium		Kraomita Malagasy (Government, 100%)	Mine at Ankazotaolana	250,000 run of mine.
Do.		do.	Mine at Bemanekiva	40,000 run of mine.
Gemstones:				
Emerald	kilograms	Artisanal and small-scale miners	Mines at Mananjary	60. <sup>c</sup>
Labradorite		Marbres et Granits de Madagascar	Mines at Ambatofinandrahana and Bekily	4,200. <sup>c</sup>
Ruby	kilograms	do.	Mines at Andilamena and Vatomandry	1,000. <sup>c</sup>
Sapphire	do.	do.	Mines at Ilakaka and Sakara	5,000. <sup>c</sup>
Graphite		Etablissements Gallois	Artsirakambo Mine near Brickaville	4,800.
Do.		do.	Marovinsty Mine near Vatomandry	3,600.
Do.		do.	Ambalafotaka Mine	NA.
Do.		Société Minière de la Grande Ile (Société Participation Industrielle et Minières, 100%)	Ambatomitamba Mine near Tamatave	6,000.
Do.		Etablissements Izouard	Faliarno Mine near Moramanga	2,000.
Do.		Etablissements Rostaing and Société Louys	NA	NA.
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	Refinery at Toamasina	5,475.

<sup>c</sup>Estimated; estimated data are rounded to no more than three significant digits. NA Not available.