

## THE MINERAL INDUSTRY OF

# MADAGASCAR

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The Republic of Madagascar, which is the world's fourth largest island, is about 420 kilometers (km) east of Mozambique in the Indian Ocean. 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, and rare earths have been produced, as well as industrial mineral commodities, which included cement, feldspar, ornamental stones, precious and semiprecious gemstones, quartz, and salt. Madagascar was also known to have deposits of bauxite, coal, copper, lead, manganese, nickel, platinum, tin, titanium, zinc, and zirconium.

In 2001, Madagascar's gross domestic product (GDP) amounted to about \$17.5 billion at purchasing power parity, and per capita income was about \$1,100. At current market prices, the GDP was \$4.6 billion. Industry accounted for about 12% of the GDP in 2001. Madagascar's GDP increased by 6.7% in 2001 after rising by 4.8% in 2000, 4.7% in 1999, and 3.9% in 1998 (International Monetary Fund, 2002, p. 174; 2003, p. 46; 2002a§<sup>1</sup>-c§).

Output in the mining sector has been volatile in recent years. In 1997, 1999, and 2001, the mining sector contracted by 10.7%, 39.7%, and 0.6%, respectively. In 1998 and 2000, output increased by 16.8% and 45.3%, respectively. The volatility in mining sector output was probably the result of fluctuating production of chromite and graphite (table 1). In 2001, the sharp decline in chromite and graphite production was mostly offset by rising output of ruby and sapphire. From 1996 to 2001, the mining sector contracted by an average of about 1.9% per year. During the same period, the construction materials sector grew by 5.8% per year (International Monetary Fund, 2003, p. 53).

### Government Policies and Programs

In 2001, the International Monetary Fund and the World Bank announced plans to assist Madagascar in reforming its mining sector. The proposed 5-year reform program would increase supervision of the artisanal mining sector, assist gemstone cutting and polishing centers, and update geologic data. The reforms would also set up special economic activity zones to supervise the sale of gemstones, to decentralize the management of mineral resources to provinces and municipalities, and to encourage foreign assistance by backing pilot projects. A World Bank loan for the project could be approved by June 2002 (Africa Mining Intelligence, 2001c).

Reforms to Madagascar's mining laws enacted in 1999 and 2000 arrange stepwise permitting. The first step is the

prospecting permit, which is valid for 3 months and does not allow drilling or pitting. The next step is the exclusive exploration permit, which is valid for 3 months and guarantees an exploration license upon request. Exploration licenses are exclusive licenses granted for 10 periods and are renewable once for an additional 5 years. A closure plan, an environmental study, a reclamation plan, and other steps are required with the application for an exploration license. Mining permits are valid for 40 years with time limits to bring the property into production and are renewable several times in 20-year increments. Royalties of 2% are charged on production, and import duties are 10% of the value of the item imported (Cope, 2002).

In December 2001, the National Assembly passed legislation aimed at attracting large-scale mining projects. The import duty on capital goods was cut to 1% from 10%. The corporate income tax was cut to 25% from 35% and to 10% if value is added to a product. The property tax was also reduced and an investment tax credit was enacted (Cope, 2002).

### Commodity Review

#### Metals

**Beryllium.**—Madagascar's largest beryl deposits are found at Ambatofinadrahana, Ampandramaika Malakialina, and Tsaratanana. Other deposits include Betafo Antsirabe, Miandrivazo, and Itrongay. Madagascar's production of beryllium fell sharply in 2000 and 2001 (table 1); this decline reflected the 50% decrease in world beryllium production from 1998 to 2001 (Cunningham, 2002).

**Cobalt and Nickel.**—Substantial resources of cobalt and nickel are found at the Ambatovy lateritic deposit. Extensive nickel laterites also occur on the east coast between Fenoarivo and Mananjary. Phelps Dodge Corp. planned to develop Ambatovy into a 36,000-metric-ton-per-year (t/yr) nickel and 3,000-t/yr cobalt mine and to refine the nickel and cobalt by high-pressure acid leaching. Capital expenses, which included infrastructure and power supply, to develop the Ambatovy deposit were estimated to be \$1.1 billion. At the end of 2001, the project awaited higher metal prices, the finalization of funding, and the resolution of permitting and regulatory issues (Cope, 2002; Phelps Dodge Corp., 2002, p. 11).

**Gold.**—Numerous deposits of gold, which include those at Ampanihy, Andavakoera, Farafangana, Maevatanana, and Miandrivazo, occur in Madagascar. About 100,000 artisanal miners produced gold from small high-grade deposits that have not yet attracted the interest of major mining companies. Officially reported gold production declined to insignificant

<sup>1</sup>References that include a section twist (§) are found in the Internet References Cited section.

levels in 2001 (table 1); the country's actual gold production has been estimated to be from about 3 to 4 t/yr (Crankshaw, 2001).

**Titanium and Zirconium.**—Madagascar is known to have substantial deposits of titanium and zirconium. Phelps Dodge engaged in exploration for titanium and zirconium at an ilmenite deposit at Ankafero in the Toamasina region. In November 2001, the Government granted QIT-Madagascar Minerals SA (QMM) an environmental permit for the Mandena, the Petriky, and the Ste. Luce deposits near Tolagnaro; QMM's plans to mine these deposits have been controversial for environmental reasons. The company planned to produce about 700,000 t/yr of ilmenite and 33,000 t/yr of zircon. QMM planned to start the 3-year construction process after completing a final feasibility study. The cost to bring the project to production was expected to be \$350 million (Africa Mining Intelligence, 2001b; Premoli, 2001; Cope, 2002).

### *Industrial Minerals*

**Cement.**—Holcim Group held a 90% share in SOMACIM, which operated a cement plant with a clinker grinding capacity of 150,000 t/yr at Ibity. SA Nouvelle Cimenterie Amboanio (66% owned by Lafarge Group) operated a plant at Mahajanga with a clinker grinding capacity of 40,000 t/yr. National cement production increased to 50,938 metric tons (t) in 2000 from 36,217 t in 1997 (tables 1, 2). In recent years, Madagascar has imported cement from Malaysia and Oman.

**Chromite.**—Kraomita Malagasy (KRAOMA) produced concentrates (49% chromite) and lumpy ore (42% chromite) from the mine at Ankazotaolana. The company planned to reopen its mine at Bemanevika owing to resource depletion at the Ankazotaolana mine by mid-2004. In 2001, production fell to 51,900 t from 118,750 t in 2000 (table 1); the decrease may have attributable to weakness in the market for stainless steel. Madagascar's chromite exports fell to 91,800 t in 2000 from 110,100 t in 1996 (Indian Ocean Newsletter, 2001; International Monetary Fund, 2001, p. 71).

**Gemstones.**—Madagascar is known to have deposits of many types of gemstones, such as emerald at Mananjary, ruby at Andilamena and Vatoman-dry, sapphire at Ilakaka and Manditsara, and tourmaline at Anjanabonoina. Such semiprecious stones as amethyst, aquamarine, citrine, garnet, and sphene and such ornamental stones as agate, aragonite, jasper, labradorite, and rose quartz were also produced. Most of Madagascar's gemstones were produced by artisanal miners. In 2001, the production of amethyst, aquamarine, garnet, sphene, and tourmaline fell because miners stopped work on these gemstones and moved to the newly discovered ruby deposits at Andilamena and Vatoman-dry (Henricus, 2001).

In the first half of 2001, between 30,000 and 40,000 miners were estimated to be working at Andilamena, which is in north-central Madagascar. Most of the ruby recovered at Andilamena was exported to Sri Lanka and Thailand. The rubies produced at the Vatoman-dry deposit, which is near the east coast of Madagascar, were higher quality than those at the Andilamena

deposit (Henricus, 2001; Leuenberger, 2001).

In February 2001, the Government closed the Vatoman-dry deposit to mining to prevent the environmental, health, and smuggling problems that resulted from unregulated mining at Ilakaka in 1999 and 2000. Enforcement of the closure has been partially successful. The Government planned to have a mixture of artisanal and commercial mining at Vatoman-dry, which it divided into claims that covered 6.25 square kilometers each. The minimum bid was to be about \$30,000, and candidates would be required to perform a 6- to 10-month environmental impact study before starting mining operations (Africa Mining Intelligence, 2001a; Henricus, 2001; Leuenberger, 2001).

In 2001, the Canadian company North Fork 14 Investment Group entered into a joint venture with Platinum Works Inc. and Société Les Pierres Precieuses de Madagascar to mine sapphires and other gemstones in the Ilakaka area. The mine was expected to have a life of 10 years (Stone, 2001§). Other companies mining sapphire included Compagnie des Gemmes de Madagascar and Société Mining Discovery.

In August 2001, Madagascar established diplomatic relations with Sri Lanka. Officials from the two Governments discussed the possibility of Sri Lanka providing lapidary training to trainees from Madagascar. In September, the Sri Lankan company Radiant Gems International Ltd. began assisting in cat's eye, ruby, and sapphire mining operations in Madagascar. The company planned to cut large volumes of gemstones from its mines starting in December (Aboosally, 2001; Jewellery News Asia, 2001a).

Most of Madagascar's precious gemstone exports were rough stones; small quantities of emerald, ruby, and sapphire were cut locally by such companies as Société GERADDEX and Société Gem's Desing S.A.R.L. Large quantities of ornamental stones, which included black tourmaline, blue calcite marble, celestite geodes, jasper, labradorite, opaque blue corundum, rock crystal, rose quartz, and smoky quartz, were cut in Madagascar. Madagascar Treasures cut ornamental stones in Antananarivo (Laurs, 2000).

**Graphite.**—Substantial deposits of graphite occurred in the Ambatolampy, the Ampanihy, and the Manampotsy districts. The country's largest producer of graphite was Etablissements Gallois, which had three mines in Ambalafotaka, Antsirakambo, and Marovintsy and a plant in Toamasina. Other companies mining graphite included Etablissements Izouard, Etablissements Rostaing, Société Louys, and Société Minière de la Grande Ile. Madagascar's graphite exports fell to 13,700 t in 2000 from 14,300 t in 1996 (International Monetary Fund, 2001, p. 71).

**Mica.**—The Ampandrandava mica deposit was mined by Société des Mines D'Ampandrandava S.A., and the Maniry Miary deposit, by Exploitation Minière DELORME. Madagascar's production of mica declined sharply in 1999 and only recovered slightly in 2000 and 2001 (table 1). The decrease in production was partially attributable to improved technology in other mica-producing countries, such as Canada and the United States, and the development of substitutes for mica in electronic applications (Fonds d'Appui au Secteur

Prive, 2001§).

**Quartz.**—Deposits of industrial quartz occurs at Kandreho, Mananara, and Maroantsetra; the Kandreho deposit was mined by Rollmine S.A.R.L. and the Mananara and the Maroantsetra deposits were mined by Prospection & Exploitation Minère S.A. Rose quartz was found at Ampandramaika, Andrianampy, and Samiresy. Exports of quartz and quartzite increased to 586 t in 1999 from 79 t in 1995 (International Trade Center and United Nations Statistics Division, 2001).

**Salt.**—Madagascar's production of salt declined to 25,530 t in 2000 from 36,763 t in 1997 (table 1). Salt producers included Compagnie Saliniere De Madagascar, Grand Salins Du Menabe, Salin Du Menabe, Salines D'Ifaty, Sel De Belo Sur Mer, and Sels Marins D'Ampataka.

### **Mineral Fuels**

**Petroleum.**—Madagascar did not produce crude petroleum and relied on imports for its refinery. The value of petroleum imports amounted to \$125 million in 2000. From 1996 to 2000, petroleum imports increased to 19.2% of total imports from 14% of total imports. During the same period, exports of petroleum increased to 163,200 t from 121,800 t (International Monetary Fund, 2001, p. 71).

Madagascar's petroleum refinery had a capacity of 15,000 barrels per day and was operated by Galana International, Groupe Trimeta, Gulf Oil Corporation, and Petroleum India International. In July 2000, this group of companies took over operations from Solitary Malagasy, which was a state-owned company (Africa Energy Intelligence, 2001d). From 1997 to 2000, the refinery operated at an average of 60% of its rated capacity (tables 1, 2).

In March 2001, Vanco Madagascar (a subsidiary of Vanco Energy Company) signed a production-sharing agreement (PSA) with the Office National des Mines et des Industries Stratégiques (OMNIS). Vanco will explore for petroleum in the Majunga block, which is off the northwestern coast of Madagascar. Madagascar Hunt Oil Company and Xrponet Resources Inc. also had PSAs with OMNIS (Africa Energy Intelligence, 2001c; Oil & Gas Journal, 2001).

### **Infrastructure**

The International Monetary Fund (2003, p. 59) estimated that Madagascar produced 833.9 gigawatthours (GWh) of electricity in 2001; this was an increase from 779.8 GWh in 2000 and 616.3 GWh in 1997. Hydroelectric power sources provided 67.6% of the country's electricity and fossil fuel sources accounted for the remaining 32.4%. From 1997 to 2001, consumption of electricity increased to 644.2 GWh from 485.4 GWh.

The electric power industry was dominated by Jiro Sy Rano Malagasy, which was Madagascar's state-owned electric utility. In 2001, the Government announced that power generation would be opened to the private sector; transmission and distribution would remain under state control (Africa Energy Intelligence, 2001a).

In 2001, the Government announced invitations to tender for the construction of four hydroelectric plants at Ambositra, Antsirabe, Mahajanga, and Toamasina. Hydelec S.A.R.L. won contracts to build and operate five small hydroelectric stations with a combined capacity of 24.3 megawatts (MW) and a wind energy facility with a capacity of 1.2 MW. Hydelec hoped to raise the \$34.2 million needed for this project by the end of 2003 (Africa Energy Intelligence, 2001b).

Madagascar had about 50,000 km of roads, of which approximately 5,800 km was paved; the rail network covered nearly 900 km. The country's infrastructure was in need of major repairs and expansion; its inadequacy has been a key factor in preventing the development of Madagascar's bauxite, coal, and iron ore deposits.

### **Outlook**

Demand for cement and other construction materials depended on the strength of the domestic economy. The International Monetary Fund (2002, p. 174) predicted that Madagascar's GDP would decline by 10% in 2002 and increase by 10% in 2003; the civil unrest in the wake of the disputed presidential election was expected to have substantial effects upon the economy in 2002.

Madagascar's domestic instability could also have an effect upon the production of the beryl, chromite, gemstone, gold, graphite, and mica industries, which depend heavily upon world market conditions. In 2003, world beryllium consumption was expected to rise by 2%. The demand for chromite is tied to the stainless steel market, which was expected to show little growth in 2002 and to grow by 5% to 6% in 2003. In general, gemstone sales were expected to remain stable or to show a slight increase in 2002. Modest decreases in gold mine production by 2003 were likely to be offset by falling demand (Jewellery News Asia, 2001b; Metal Bulletin, 2001; SG Securities Ltd., 2001, p. 22; Cunningham, 2002).

Demand for Madagascar's unexploited mineral commodities will also depend upon world market conditions. Nickel prices were likely to rise; demand was expected to increase by 11% from 2001 to 2003, and mine capacity, by 5%. Global demand for rare-earth oxides was expected to increase to 100,000 t in 2005 from 74,000 t in 1999. Demand for titanium dioxide (TiO<sub>2</sub>) pigment is expected to increase by about 3% to 4% per year from 2002 to 2006. About 95% of all titanium minerals are consumed to produce TiO<sub>2</sub> pigment (Gambogi, 2001; SG Securities Ltd., 2001, p. 18; Chegwiddden and Kingsworth, 2002).

### **References Cited**

- Aboosally, Sharm, 2001, Sri Lankan polishers assist in mining in Madagascar: Jewellery News Asia, no. 206, October, p. 60.
- Africa Energy Intelligence, 2001a, Madagascar—End to power monopoly: Africa Energy Intelligence, no. 299, May 23, p. 7.
- Africa Energy Intelligence, 2001b, Madagascar—Major outlay for power plants: Africa Energy Intelligence, no. 299, May 23, p. 6.
- Africa Energy Intelligence, 2001c, Madagascar—New exploration push: Africa Energy Intelligence, no. 300, June 6, p. 3.
- Africa Energy Intelligence, 2001d, Madagascar—Solima privatized at last: Africa Energy Intelligence, no. 300, June 6, p. 3-4.
- Africa Mining Intelligence, 2001a, Madagascar—New precious stones license: Africa Mining Intelligence, no. 15, May 30, p. 1.

- Africa Mining Intelligence, 2001b, Madagascar—Way clear for nickel project: Africa Mining Intelligence, no. 15, May 30, p. 2.
- Africa Mining Intelligence, 2001c, Madagascar—World Bank to help 2nd wave of reforms: Africa Mining Intelligence, no. 26, November 21, p. 1.
- Chegwidden, Judith, and Kingsnorth, D.J., 2002, Rare earths supply and demand—A European market focus: *Industrial Minerals*, no. 415, April, p. 52-61.
- Cope, L.W., 2002, Madagascar mining—Open for business: *Engineering & Mining Journal*, v. 203, no. 4, April, p. 24-28.
- Crankshaw, Paul, 2001, Madagascar, *in* Mining annual review 2001: Mining Journal, Ltd. CD-ROM.
- Cunningham, L.D., 2002, Beryllium, *in* Metals and minerals: U.S. Geological Survey Minerals Yearbook 2001, v. 1, p. 11.1-11.7.
- Gambogi, Joseph, 2001, Titanium: *Engineering & Mining Journal*, v. 202, no. 4, April, p. 50-52.
- Henricus, Jennifer, 2001, New Madagascar ruby finds trigger mining rush: *Jewellery News Asia*, no. 202, p. 72-82.
- Indian Ocean Newsletter, 2001, Madagascar—Kraomita Malagasy projects: *Indian Ocean Newsletter*, no. 933, January 13, p. 4.
- International Monetary Fund, 2001, Madagascar—Selected issues and statistical appendix: Washington, DC, International Monetary Fund, December 13, 75 p.
- International Monetary Fund, 2002, World economic outlook—Trade and finance: Washington, DC, International Monetary Fund, September 25, 235 p.
- International Monetary Fund, 2003, Madagascar—Selected issues and statistical appendix: Washington, DC, International Monetary Fund, January 8, 88 p.
- International Trade Center and United Nations Statistics Division, 2001, Trade analysis system on personal computer: New York, International Trade Center and United Nations Statistics Division CD-ROM.
- Jewellery News Asia, 2001a, Formal ties between Sri Lanka and Madagascar expected to benefit gemstone sector, trade says: *Jewellery News Asia*, no. 207, November, p. 82.
- Jewellery News Asia, 2001b, Gemstone sales may be stable or up slightly: *Jewellery News Asia*, no. 208, December, p. 72.
- Laur, Brendan, 2000, Visit to a Malagasy lapidary facility: *Gems & Gemology*, v. 36, no. 3, Fall, p. 267-268.
- Leuenberger, Alexander, 2001, The new ruby deposits in eastern Madagascar—Mining and production: *Gems & Gemology*, v. 37, no. 2, summer, p. 147-149.
- Metal Bulletin, 2001, ISSF told not to expect recovery in demand until 2003: *Metal Bulletin*, no. 8573, May 10, p. 22.
- Oil & Gas Journal, 2001, Quick takes: *Oil & Gas Journal*, v. 99, no. 32, August 6, p. 8-9.
- Phelps Dodge Corp., 2002, Annual report on Form 10-K for the year ended December 31, 2001: Phoenix, Arizona, Phelps Dodge Corp., 91 p.
- Premoli, Camillo, 2001, Madagascar, *in* Mining annual review 2000: Mining Journal, Ltd. CD-ROM.
- SG Securities Ltd., 2001, Quarterly Metals Review—A mountain to climb: London, United Kingdom, SG Securities Ltd., October, 28 p.

## Internet References Cited

- Fonds d'Appui au Secteur Privé, 2001, Mining sector of Madagascar—Gold, precious stones, semi-precious stones, and ornamental stones, accessed July 23, 2001, at URL [http://www.madagascar-contacts.com/fasp/Sec\\_Mines/BDS Mines\\_B2\\_21.htm](http://www.madagascar-contacts.com/fasp/Sec_Mines/BDS Mines_B2_21.htm).
- International Monetary Fund, 2002a (April), Gross domestic product at current prices—All countries, World Economic Outlook Database, accessed August 14, 2002, via URL [http://www.imf.org/external/pubs/ft/weo/2002/01/data/ngdgd\\_a.csv](http://www.imf.org/external/pubs/ft/weo/2002/01/data/ngdgd_a.csv).
- International Monetary Fund, 2002b (April), Selected world aggregates, World Economic Outlook Database, accessed June 10, 2002, via URL <http://www.imf.org/external/pubs/ft/weo/2002/01/data>.
- International Monetary Fund, 2002c (April), Shares of aggregate GDP based on purchasing power parity (PPP) valuation of country GDP—Developing countries, World Economic Outlook Database, accessed June 10, 2002, via URL <http://www.imf.org/external/pubs/ft/weo/2002/01/data>.
- Stone, Martin, 2001, Venture to mine large-scale in Madagascar, accessed April 4, 2002, at URL <http://www.colored-stone.com/stories/sep01/madagascar.cfm>.

TABLE 1  
MADAGASCAR: PRODUCTION OF MINERAL COMMODITIES 1/

(Kilograms unless otherwise specified)

Commodity 2/	1997	1998	1999	2000	2001 e/
<b>METALS</b>					
Beryllium, beryl in quartz concentrates, industrial and ornamental	28,287	30,000	20,000 r/ e/	1,696 r/	1,000
Chromium, marketable output:					
Chromite concentrate, gross weight metric tons	45,000	19,000	--	21,600	9,400
Chromite ore, lumpy do.	94,700	85,300	--	97,150 r/	42,500
Total do.	139,700	104,300	--	118,750 r/	51,900 3/
Gold, mine output, Au content 4/	8	12	8 e/	5 r/	(5/) p/
<b>INDUSTRIAL MINERALS</b>					
Abrasives, natural (industrial only) e/	1,314 3/	1,500 r/	900 r/	1,300 r/	1,300
Cement, hydraulic metric tons	36,217	44,327	45,719	50,938 r/	53,500
Clay, kaolin e/ do.	166 3/	200 r/	120 r/	170 r/	170
Feldspar	-- r/	5,600 r/ e/	3,400 r/ e/	7,300 r/	2,800 p/
Gemstones: 6/					
Emerald	1	1	2 7/	6 7/	6
Ruby	21	31	6 7/	3	941 p/
Sapphire	3,957	2,874	3,810 7/	471	8,470 p/
Tourmaline	1,936	1,286	1,400 e/	1,989	800
Graphite, all grades, shipments metric tons	14,107 r/	20,629 r/	16,137 r/	40,328 r/	2,013 p/
Mica, phlogopite: do.	1,529 r/	1,232 r/	54 r/	66 r/	90 p/
Ornamental stones: 6/					
Agate	66,600	117,250	75,000 e/	49,675	25,000
Aragonite	589,050	1,781,550	1,300,000 e/	821,000 e/	343,000
Jasper	78,630	39,070	41,000 e/	43,000 e/	45,700
Labradorite	176,300	208,600	174,000 e/	139,000 e/	103,000
Rose quartz 8/	13,695	127,182	30,000 e/	6,200	10,792 p/
Salt, marine metric tons	36,763 r/	26,746 r/	26,131 r/	25,530 r/	26,000
Semiprecious stones: 6/					
Amethyst	66	57	100 e/	156	75 p/
Citrine	268	78	135 e/	210 e/	100
Garnet	93	14	25 e/	45 e/	20
Sphene	1	7	10 e/	10 e/	5
Stone:					
Dimension stone do.	2,740 7/	1,878 7/	138 r/ 7/	200 r/ e/	200
Marble do.	NA	NA	NA	1,222	5,600 p/
<b>MINERAL FUELS AND RELATED MATERIALS</b>					
Petroleum refinery products:					
Gasoline thousand 42-gallon barrels	647 r/	583	617	771 r/	770
Kerosene and jet fuel do.	480 r/	474	409	410 r/	410
Distillate fuel oil do.	811 r/	697	749	946 r/	950
Residual fuel oil do.	1,300 r/	1,370	1,251	1,420 r/	1,400
Other do.	68 r/	49	61	75 r/	70
Total do.	3,306 r/	3,173	3,087	3,622 r/	3,600

e/ Estimated; estimated data are rounded to no more than three significant digits; may not add to totals shown. p/ Preliminary. r/ Revised. NA Not available. -- Zero.

1/ Includes data available through August 16, 2002.

2/ In 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.

3/ Reported figure.

4/ Does not include smuggled artisanal production, which was estimated to be 3,000 to 4,000 kilograms per year.

5/ Less than 1/2 a unit.

6/ Does not include smuggled artisanal production.

7/ Exports.

8/ In recent years, Madagascar has also produced industrial quartz. The most recently reported production for all types of quartz in 1997 was 166 metric tons.

TABLE 2  
MADAGASCAR: STRUCTURE OF THE MINERALS INDUSTRY IN 2001

(Metric tons unless otherwise specified)

Commodity	Major operating companies	Location of main facilities	Annual capacity
Cement	SOMACIM (Holcim SA, 90%)	Ibity	150,000.
Do.	SA Nouvelle Cimenterie Amboanio (LaFarge Group, 66%; Moustansir Ibarandy Family, 34%)	Mahajanga	40,000.
Chromite	Kraomita Malagasy (Government, 100%)	Ankazotaolana	250,000 run of mine.
Do.	do.	Bemanekiva	40,000 run of mine.
Graphite 1/	Etablissements Gallois	Toamasina	10,000 processed.
Do.	Etablissements Izouard		NA.
Do.	Etablissements Rostaing		NA.
Do.	Societe Louys		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 barrels Galana International, Groupe Trimeta, Gulf Oil Corporation, and Petroleum India International	Toamasina	5,475.

NA Not available.

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