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The Mineral Industry of Madagascar

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In 2011, 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 5%, and rutile and zirconium, about 1% each. Other domestically significant minerals produced included chromite, gemstones, and ornamental stones. Madagascar was not a globally significant consumer of minerals in 2011 (Gambogi, 2012a, b).

Minerals in the National Economy

Based on provisional data for 2011, the manufacturing sector accounted for 11% of the gross domestic product, and the mining and construction materials sectors combined, 1.6%. In 2010 (the latest year for which data were available), the mining sector grew by an estimated 228%. Employment in gemstone mining at Ilakaka and Sakaraha was estimated to be about 50,000 workers (Pardieu, 2010; Ministry of the Economy, Commerce, and Industry, 2011, p. xiv, xvi).

Production

In 2011, the production of cobalt increased by an estimated 203%; nickel, by an estimated 195%; zircon, by an estimated 77%; mica and rutile, by 65% each; ilmenite, by an estimated 64%; and labradorite and salt, by an estimated 13% each. Chromite production decreased by 50% in 2011, and quartz, by 47%. 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 SA (KRAOMA) was the country's only chromite producer. Table 2 lists major mineral industry facilities in Madagascar.

Commodity Review

Metals

Bauxite and Alumina and Gold.—Aziana Ltd. explored for bauxite at Manantenina and for gold at Alakamisy, Anosivolo, Antakasina, Antandrokazo, Grigri, and Marovato in 2011. The company planned a drilling program at Alakamisy in 2012 (Aziana Ltd., 2011).

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. By the end of 2011, the companies had mined 948,083 metric tons (t) at a grade of 0.83% nickel and 0.07% cobalt. In November 2011, reserves at Ambatovy were estimated to be about 170 million metric tons (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., 2012, p. 17).

Starting in mid-2011, lateritic slurry from the Ambatovy ore-processing plant was to be processed at 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 mine was expected to reach full capacity in 2013. In June 2011, Sherritt revised its estimate of the capital costs at Ambatovy to $5.5 billion and delayed the opening of the leaching plant and refinery to the first quarter of 2012 (Mining Journal, 2005, 2011).

Copper and Platinum-Group Metals.—Sunridge Gold Corp. of Canada drilled at its Besakoa copper-gold-zinc property in 2011. Malagasy Minerals Ltd. (MML) of Australia conducted stream sampling at the Ampanihy nickel-copper property and drilling at the Vohibory copper-silver property in 2011. The company planned further soil sampling at Ampanihy in the first quarter of 2012 (Malagasy Minerals Ltd., 2012).

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 2011, QMM planned to increase its ilmenite production to 473,000 t from 287,000 t in 2010. The company also planned to increase its output of zirsill, which is composed of quartz, sillimanite, and zircon, to 22,000 t in 2011 from 12,600 t in 2010. By 2013, QMM planned to reach its full capacity of 750,000 t/yr of ilmenite and 40,000 t/yr of zirsill. The ilmenite, which was exported to Canada for smelting, had a grade of 60% titanium dioxide (Clarke, 2010; Anglo-Malagasy Society Newsletter, 2011).

In 2011, World Titanium Resources Ltd. (WTR) purchased the undeveloped Ranobe mineral sands deposit, which had resources of 710 Mt that contained about 30 Mt of ilmenite, 2.5 Mt of zircon, and 0.85 Mt of rutile. Depending on the results of its feasibility study on a new mine at Ranobe, WTR planned to mine 400,000 t/yr of ilmenite and 43,000 t/yr of rutile and zircon concentrate. Production was expected to start in 2014. The life of the mine was estimated to be at least 20 years (Mentiplay, 2012).

Vanadium.—In 2011, Energizer Resources Inc. of Canada was engaged in a prefeasibility study 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 (Cornish, 2011; Grace, 2011).

In December 2011, MML signed a joint-venture agreement with Energizer to explore for vanadium and numerous industrial minerals. MML engaged in chip sampling at the Fotadrevo vanadium prospect, which was on the Ampanihy property. In 2012, Energizer planned to drill at Fotadrevo (Malagasy Minerals Ltd., 2012).

Industrial Minerals

Gemstones.—In recent years, Madagascar was a globally significant producer of gemstones that included emerald, ruby, and sapphire. Emerald was produced near Mananjary; ruby, at Andilamena and Vatomandry; and sapphire, at Ilakaka, Manombe, Marosely, and Sakaraha.

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 mid-2010, an estimated 50,000 workers were directly or indirectly employed in gemstone mining at Ilakaka and Sakaraha compared with about 100,000 in 2005. Mining has declined because of the depletion of near-surface deposits, the ban on rough gemstone exports from February 2008 to July 2009, and the global economic crisis. Most production at Ilakaka and Sakaraha was attributable to artisanal miners; only three large-scale mechanized mining companies were in operation in 2010. Large-scale operations were hampered by high fuel costs and an inability to enforce mining rights (Pardieu, 2010).

Blue sapphire was also mined at several primary deposits by small groups of artisanal miners near Andranondambo. Nantin Ltd. of Malaysia and about 200 artisanal miners produced sapphire at Ankazoabo, which is located north of Andranondambo. Société d'Investissement Australien à Madagascar of Australia and other mining companies shut down operations in recent years; many buyers were considering relocation to the ruby mines in Mozambique (Pardieu, 2010).

EUROMAD S.A. of Italy, Marbres et Granits de Madagascar SARL (MAGRAMA) of Italy, and SQNY International of India had royalty agreements with MML 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 October (Norcross Madagascar Group, undated).

Graphite.—Madagascar had four graphite mining companies that produced more than 16,000 t/yr in the late 1990s. National graphite production declined to an average of about 5,000 t/yr between 2005 and 2010 because of competition from Chinese producers, world market conditions, and the increasing costs of petroleum products used for drying. Processing costs also increased because of declining grades at local graphite deposits as higher grade materials were depleted. Etablissements Gallois S.A. was the only remaining company that regularly mined and exported graphite by 2010 (National Institute of Statistics, 2000, p. 12; Feytis, 2010; Industrial Minerals, 2012).

Societe Malagache du Graphite SARL (Somagra) planned to reopen its mine in eastern Madagascar in late 2011; the mine was shut down in the early 2000s. The company planned to produce 1,500 t in the first year of operation, 2,500 t in the second year, and the mine's full capacity of 4,000 t/yr starting in the third year. Somagra had two graphite deposits with combined resources of between 8 and 10 Mt that contained between 300,000 and 350,000 t of recoverable graphite (Industrial Minerals, 2012).

In late 2011, Energizer Resources discovered several graphitic zones at its Green Giant vanadium project. The company planned to complete the drilling necessary for a resource assessment by August 2012 (Industrial Minerals, 2012).

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 was estimated to be heavy rare earths (Tantalus Rare Earths AG, 2011).

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 consume 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 the United States completed a revised resource assessment in September 2011. Resources were estimated to be about 1.69 billion barrels of petroleum. Madagascar Oil planned to start production at Tsimiroro in July 2017; output was expected to reach the peak of 150,000 barrels per day by 2029. The life of the project was estimated to be about 50 years. Madagascar Oil and Total S.A. of France engaged in exploration at the Bemolanga tar sands project, which was located in Block 3102. The companies planned to spend $6 million on exploration at Bemolanga in 2012 (Madagascar Oil Ltd., 2011, p. 4, 6; Oil & Gas Journal, 2012).

Outlook

Madagascar's mineral industry is likely to grow significantly because of increased cobalt, graphite, ilmenite, nickel, rutile, and zircon production from 2011 to 2014, and the startup of vanadium production in 2014. Further growth in the mineral industry could result from the development of the Bemolanga and the Tsimiroro petroleum projects and the Sakoa coal project. The development of the Sakoa project was expected to decrease costs significantly for the Green Giant project. The development of the mineral industry will depend, however, on world market conditions and domestic political stability.

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TABLE 1
MADAGASCAR: PRODUCTION OF MINERAL COMMODITIES[1]

(Metric tons unless otherwise specified)

Commodity[2]		2007	2008	2009	2010[e]	2011[e]
METALS						
Beryllium, beryl in quartz concentrates[e]	kilograms	12,000	12,000	12,000	12,000	12,000
Chromium, marketable output:[3]		54,698 [r]	112,613 [r]	133,000 [r]	134,500 [r]	66,700
Cobalt, mine output, Co content		--	--	--	165 [r]	500
Gold, mine output, Au content[e, 4]	kilograms	50	72 [3]	70	70	-- [3]
Nickel, mine output, Ni content		--	--	--	2,000 [r]	5,900
INDUSTRIAL MINERALS						
Cement, hydraulic[e]		270,000 [5]	460,000	370,000	410,000	410,000
Gemstones:[e, 6]						
Amethyst[7]	kilograms	920	600	20,000	20,000	20,000
Cordierite	do.	160	30	60	80	80
Emerald	do.	672 [3]	34 [r, 3]	10 [r, 3]	2 [r]	2
Garnet	do.	600	100	200	300	300
Ruby	do.	78 [3]	1 [r, 3]	2 [r, 3]	90 [r]	90
Sapphire	do.	5,124 [3]	660 [r, 3]	428 [r, 3]	2,300 [r]	2,300
Tourmaline[7]	do.	68,000	54,000	43,000	48,000	48,000
Graphite, all grades[3]		5,351	4,922	3,437	3,783	3,573
Gypsum[e]		500	300 [r]	156 [r, 5]	127 [r, 5]	130
Kaolin		NA	NA	90	259 [5]	260
Mica, phlogopite[3]		1,349	1,233	358	2,069	3,411
Ornamental stones:[e, 6]						
Agate	kilograms	25,000	13,000	1,500	6,000	6,000
Labradorite		4,200	4,200	4,700	6,200	7,000
Quartz[3]		1,677	887	104	407	214
Salt, marine[e, 8]		75,000	75,000	75,000	75,000	85,000
Stone:						
Granite		975 [3]	1,999 [3]	1,239 [3]	990	1,000
Limestone[e, 9]		350,000	400,000	320,000	360,000	360,000
Marble		224 [r, 3]	2 [r, 3]	3 [r, 3]	--	--
Other		1,671 [3]	2,401 [3]	2,445 [3]	670	670
Titanium:						
Ilmenite concentrate		--	--	160,000	287,000 [5]	470,000
Rutile concentrate		--	--	3,200 [e]	5,700	9,400
Zirconium concentrate		--	--	5,300 [e]	9,600	17,000
MINERAL FUELS AND RELATED MATERIALS						
Petroleum, crude	thousand 42-gallon barrels	--	2	2 [e]	--	--

[e]Estimated; estimated data are rounded to no more than three significant digits; may not add to totals shown. [r]Revised. do. Ditto. NA Not available. -- Zero.

[1]Table includes data available through January 10, 2013.

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

[3]Reported exports.

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

[5]Reported production.

[6]Does not include smuggled artisanal production.

[7]Includes both gem and ornamental quality.

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

[9]Cement producers only.

TABLE 2
MADAGASCAR: STRUCTURE OF THE MINERAL INDUSTRY IN 2011

(Metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Cement		Holcim (Madagascar) S.A. (Holcim Group, 90%)	Plant at Toamasina	300,000.
Do.		do.	Plant at Ibity	160,000.
Do.		Madagascar Long Cimenterie (Maloci)	Plant at Ambohimanambola	360,000.
Chromium		Kraomita Malagasy S.A. (Government, 100%)	Mine at Ankazotaolana[1]	250,000.
Do.		do.	Mine at Bemanevika	200,000.[e]
Cobalt		Ambatovy Minerals S.A. (Sherritt International Corp., 40%; Sumitomo Corp., 27.5%; Korea Resources Corp., 27.5%)	Mine at Ambatovy	5,600.
Gemstones:				
Rough:				
Amethyst		Norcross Madagascar Group (NMG)	Mines at Ambatonrazaka	90.[e]
Aquamarine		Small-scale miners	Mine at Tsaramanga	NA.
Emerald	kilograms	Artisanal and small-scale miners	Mines at Mananjary	130.[e]
Garnet		do.	Mines at Antetezambato	NA.
Do.		do.	Mines at Behara	NA.
Labradorite		Marbres et Granits de Madagascar SARL	Mines at Ianapera and Maniry	3,000.[e]
Do.		(MAGRAMA) and EUROMAD S.A.	do.	
Do.		SQNY International	do.	2,000.[e]
Do.		Norcross Madagascar Group	Mines at Maniry	3,600.[e]
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 Vatomandry	1,000.[e]
Sapphire	do.	Various producers, including the following:	Locations:	5,000.[e]
		Artisanal and small-scale miners	Mines at Ilakaka, Manombe, Marosely, and Sakara	
		World Sapphire Group	Mines at Ilakaka	
		Tany Hafa S.A.	Mines at Sahambano	
		Canalta Gems Inc.	Mines at Nose-Be and Andovokonko	
		Nantin Ltd. and artisanal miners	Mines at Ankazoabo	
Tourmaline	do.	Artisanal and small-scale miners	Mines at Alatsinainuy Ibity	NA.
Polished[2]	do.	Dream Stones Trading	Plant in Antananarivo	15.
Graphite		Etablissements Gallois S.A.	Artsirakambo Mine near Brickaville	4,800.
Do.		do.	Marovinsty Mine near Vatomandry	3,600.
Do.		do.	Ambalafotaka Mine	NA.
Gypsum		Compagnie Salinere de Madagascar	Antsahampano	500.
Mica		Societe des Mines d'Ampandranhava	Tolagnaro	2,000 processed.
Nickel		Ambatovy Minerals S.A.	Mine at Ambatovy	60,000.
Petroleum, crude	thousand 42-gallon barrels	Madagascar Oil Ltd.	Tsimiroro[1]	17.[e]
Salt		Compagnie Salinere de Madagascar	Antsahampano	80,000.
Do.		Grand Salines du Menabe	Morondava	5,000.[e]
Titanium minerals		QIT Madagascar Minerals SA (QMM) [QIT Fer et Titane (a subsidiary of Rio Tinto plc), 80%, and Government, 20%]	Mine at Mandena	750,000 ilmenite; 15,000 rutile.
Zirconium		do.	do.	25,000 zircon.

[e]Estimated. Do., do. Ditto. NA Not available.

[1]Not operating at the end of 2011.

[2]Includes amethyst, aquamarine, emerald, sapphire, tourmaline, and other gemstones.