

THE MINERAL INDUSTRY OF FINLAND

By Chin S. Kuo

Finland's industrialized market economy experienced growth in the gross domestic product (GDP) of 3.7% in 2004. The country's economic well-being was evident in its per capita GDP based on purchasing power parity of \$29,305, which was the second highest in the Scandinavian region. Inflation was well under control at 0.1%. The metals industry, which included mainly smelting and refining of nonferrous metals, was one of the key components of the economy. Finland imported mostly raw materials, such as concentrate, matte, and ore, and crude oil and petroleum products. Exploration activities were focused on diamond, gold, and platinum-group-metal (PGM) deposits. The country was noted for its use of advanced technology for underground mining, mineral processing, and metallurgy (International Monetary Fund, 2005§¹).

Outokumpu Oyj and Boliden AB of Sweden finalized a transaction in March 2004 whereby Boliden acquired Outokumpu's copper and zinc mining and smelting operations and sold its fabrication and technology sales operations to Outokumpu. The total transaction was valued at \$842 million. As a result, Outokumpu owned 49% of all Boliden shares, and Boliden owned 2.8% of all Outokumpu shares (Metal-Pages, 2004§).

Outokumpu Chrome Oy operated the Kemi Mine, which had 132 employees, and the Tornio ferrochrome plant, which had 175. The mine and plant are located at the far northern end of the Gulf of Bothnia. As of January 2004, ore reserves at the mine totaled 52 million metric tons (Mt) at a grade of 29% Cr₂O₃; mineral resources at the mine were 90.8 Mt at a grade of 25% Cr₂O₃. The underground mine capacity was 2.7 million metric tons per year (Mt/yr) of ore. Mining in the open pit was expected to be completed around 2007. The ore-concentrating plant's recovery rate was 80% of chromite, and its capacity was 1.2 Mt/yr. The ferrochrome plant produced 260,000 metric tons per year (t/yr) of ferrochrome (Mining Technology, 2004§).

In February 2004, Northern Lion Gold Corp. of Canada began diamond drilling on its Haveri gold project, which is located 35 kilometers (km) northwest of Tampere in southwestern Finland. The Haveri claims encompassed an area of widespread gold and copper mineralization in a volcanogenic massive sulfide environment. The company was fully funded to acquire a 70% interest in the Haveri claims. The program also would explore a high-priority target area located in its 100% owned Ansomaki claim. A minimum of 8,000 meters (m) (30 holes) of drilling was planned for the Ansomaki and the Haveri claims (Northern Lion Gold Corp., 2004).

Tertiary Minerals plc of the United Kingdom planned to drill the Kaaretselka gold prospect in the Lappland gold belt, which is located in northern Finland. The company expected to move

a drill rig to Kaaretselka in mid-February to define the resources in known zones of mineralization. Significant gold values were reported from all three target zones (Lampi, Tienvarsi, and Vanha). Results showed a high-grade intersection of 11 grams per metric ton (g/t) gold over 4.9 m at Vanha and 13.5 g/t gold over 2.75 m at Tienvarsi. At the Vanha zone, the potential for depth extension of high-grade gold mineralization was suggested by a down-hole depth of 74.8 m (Tertiary Minerals plc, 2004b).

Scandinavian Gold Ltd. of Canada began metallurgical testing of a nickel-PGM core sample from its Keivitsa nickel-copper-cobalt-platinum project in northern Finland. The tests were conducted at the metallurgical research center of the Geological Survey of Finland. According to Scandinavian Gold, a smeltable nickel-PGM flotation concentrate might be produced from this mineralization type. If the program were to prove successful, then the company intended to conduct a scoping study to outline economic parameters for mining the zone (Scandinavian Gold Ltd., 2004).

Dragon Mining NL of Australia's Jokisivu project in southern Finland defined a high-grade gold resource of 1.25 Mt at a grade of 7.7 g/t gold that contained 9,610 kilograms (kg) of gold. The project plan included an open pit mine followed by underground development and mining. Ore would be shipped to the company's 600,000-t/yr Vammala plant, which is located 40 km to the northeast. Production and treatment of ore began in late 2004. Gold mineralization consisted of high-grade veins in two zones (Arpola and Kujankallio), which are located 200 m apart. Further infill and extension drilling and a feasibility study were undertaken during the first half of 2004 (Dragon Mining NL, 2004).

Taranis Resources Inc. of the United States acquired a 100% interest in a gold exploration project near Kittila in northern Finland. Diamond drilling outlined a gold-bearing body approximately 300 m long and 50 m wide. The Kettukuusikko property had geologic similarities to Archean-age gold deposits in Canada. The company planned to spend \$250,000 during the first year of exploration to compile exploration data and initiate an early 2005 campaign of overburden drilling followed by a core-diamond drilling (Taranis Resources Inc., 2004).

European Diamonds plc of the United Kingdom bought the Lahtojoki diamond claim in central Finland for a combination of cash and shares. The property is part of the Karelian craton, which is located 350 km northeast of Helsinki, traverses eastern Finland and northern Russia, and contains a known kimberlite pipe. The company carried out a feasibility study later in 2004. Caustic fusion analysis of the first 500 kg of kimberlite from a 1.8-metric-ton (t) drill sample produced a significant number of diamonds. The results gave support to a previous drill sampling of the pipe that reported grades of up to 0.45 carat per metric ton (European Diamonds plc, 2004; Antwerp Facets News Service, 2004§).

¹References that include a section mark (§) are found in the Internet References Cited section.

Work also was scheduled on Tertiary Minerals' new Finnish diamond project. A program of ground magnetic testing was contracted to the Geological Survey of Finland to define the kimberlite pipe and dike. The company also enlarged its diamond search with ground magnetic surveys of additional kimberlite targets. Drill testing of the kimberlite target would follow. A 16-hole drilling program was to define the kimberlite footprint hidden under soil cover. Cores from a 100-m-deep hole were sampled for micro-diamond. The project lies within the Karelian craton, which was considered to exhibit all the characteristics necessary to host and preserve diamondiferous kimberlites (Tertiary Minerals plc, 2004a).

Nordic Diamonds Ltd. of Canada began drilling on its 100% owned Kuopio-Kaavi diamond project on the Karelian craton. The company held full title to 18 of 20 kimberlites; 15 of those held by Nordic contained diamond. Kimberlite No. 21 might possess substantial tonnage potential and a "large-stone" population and was an irregular inclined dike structure. The company planned an extensive summer heavy-mineral sampling program to identify new kimberlites (Nordic Diamonds Ltd., 2004).

Fortum Oil and Gas Oy commissioned ThyssenKrupp Group's engineering unit Uhde GmbH to design and supply equipment for a 4-million-cubic-meter-per-day hydrogen production plant at Porvoo, which is located 30 km east of Helsinki adjacent to the company's 200,000-barrel-per-day refinery. The \$27.5 million facility's output would be used to convert residual oil to sulfur-free transportation fuels. The plant was due to come onstream in late fall 2006 (Oil & Gas Journal, 2004).

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Major Source of Information

Geological Survey of Finland
Betonimiehenkuja 4
02150 Espoo
Finland

TABLE 1
FINLAND: PRODUCTION OF MINERAL COMMODITIES¹

(Thousand metric tons unless otherwise specified)

Commodity ²	2000	2001	2002	2003	2004	
METALS						
Aluminum, metal, secondary	metric tons	44,824	34,488	31,076 ^r	32,619 ^r	39,266
Cadmium, metal, refined	do.	683	604	4	--	--
Chromite: ^e						
Gross weight:						
Lump ore		230	215	216	210 ^r	210
Concentrate		390	350	340	329 ^r	330
Foundry sand		10	10	10	10	10
Total		630	575 ³	566	549 ^r	550
Cr ₂ O ₃ content:						
Lump ore		80	75	75	76	77
Concentrate		150	130	125	125	126
Foundry sand		5	5	5	5	5
Total		235	210	205	206	208
Cobalt, metal, powder and salts	metric tons	3,864	3,908	4,292	4,574 ^r	5,246
Copper:						
Concentrate, gross weight	do.	43,062	41,146	50,494	50,875 ^r	52,864
Mine output, Cu content	do.	14,354	13,715	14,400	14,900	15,500
Metal:						
Smelter	do.	155,400	169,300	160,900	176,384 ^r	168,577
Refined	do.	114,035	119,677	127,136	135,160 ^r	132,565
Gold, metal	kilograms	4,951	5,552	4,666	5,409 ^r	5,004
Iron and steel, metal:						
Pig iron		2,983	2,852	2,828	6,000 ^r	1,000
Ferrous alloys, ferrochromium		261	237	248	250 ^e	255 ^e
Steel, crude		4,096	3,938	4,004	4,766	4,833
Semimanufactures, rolled ^c		3,750	3,800	3,850	3,900	3,950
Mercury ^c	metric tons	76	71	51	25 ^r	24
Nickel:						
Mine output, Ni content	do.	10,714 ^r	27,610 ^r	41,797 ^r	39,375 ^r	44,496
Metal, electrolytic	do.	50,087	51,275	49,151	45,417 ^r	40,088
Platinum	kilograms	441	510	508	461 ^r	705
Selenium, metal	do.	36,293	38,913	39,237	49,163 ^r	61,256
Silver, metal	do.	25,364	23,998	29,404	31,115 ^r	37,413
Zinc:						
Mine output, Zn content	metric tons	30,493 ^r	36,253 ^r	61,580 ^r	70,652 ^r	69,333
Metal	do.	222,881	247,179	235,337	265,853 ^r	284,524
INDUSTRIAL MINERALS						
Cement, hydraulic		1,422	1,325	1,198	1,493 ^r	1,691
Feldspar	metric tons	33,200	34,298	46,715	48,353 ^r	57,149
Lime		320	333	350	434 ^r	432
Nitrogen, N content of ammonia	metric tons	75,344	80,000 ^e	87,000	77,100 ^r	60,600
Phosphate rock apatite concentrate:						
Gross weight		3 ^r	15 ^r	19 ^r	26 ^r	40
P ₂ O ₅ content ^c		1 ^r	6 ^r	7 ^r	10 ^r	15
Pyrite, gross weight		706	632	727	677 ^r	702
Sodium sulfate		31	30	30	28 ^r	27
Stone, crushed: ^e						
Limestone and dolomite:						
For cement manufacture		1,300	1,400	1,400	1,450	1,300
For agriculture		1,000	1,000	1,000	1,000	900
For lime manufacture		350	350	400	400	300
Fine powders		350	350	400	400	300
Metallurgical		1	1	1	1	1
Total		3,000	3,100	3,200	3,250	2,800
Quartz silica sand		73	148 ³	148 ³	112 ^{r,3}	100

See footnotes at end of table.

TABLE 1--Continued
FINLAND: PRODUCTION OF MINERAL COMMODITIES¹

(Thousand metric tons unless otherwise specified)

Commodity ²	2000	2001	2002	2003	2004
INDUSTRIAL MINERALS--Continued					
Sulfur:					
S content of pyrite	377	337	340 ^e	340 ^e	336
Byproduct:^e					
Metallurgy	300	300	300	300	301 ³
Petroleum	50	45	50	60	75
Total	727	682	690	700	712
Sulfuric acid	854	923	951 ^r	1,036 ^r	1,141
Talc	--	418 ^r	416 ^r	460 ^r	482
Wollastonite ^e	20,000	20,000	20,000	20,000	20,000
MINERAL FUELS AND RELATED PRODUCTS					
Peat:					
For fuel use	3,932	5,368	6,515 ^r	8,415 ^r	8,159
For agriculture and other uses	1,174	834	759 ^r	929 ^r	905
Petroleum refinery products	thousand 42-gallon barrels	59,015 ^r	42,318 ^r	54,801 ^r	54,956 ^r
		61,037			

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

¹Table includes data available through July 21, 2005.

²In addition to the commodities listed, granite and soapstone are produced, but available information is inadequate to make reliable estimates of output levels.

³Reported figure.

TABLE 2
FINLAND: STRUCTURE OF THE MINERAL INDUSTRY IN 2004

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners		Location of main facilities	Annual capacity
Ammonia	Kemira Oyj (Government, 98%)		Plant at Oulu	75
Apatite	Kemira Agro Oy (Government, 98%)		Mine and plant at Siilinjärvi	8,000
Cadmium, metal	Outokumpu Oyj (Government, 40%, and private investors, 12.3%)		Smelter at Kokkola	1
Cement	Finnccement Oy (Irish Cement Ltd., 100%)		Plants at Lappeenranta and Parainen	1,020
Chromite	Outokumpu Oyj (Government, 40%, and private investors, 12.3%)		Mine at Kemi	1,000
Copper:				
Ore, Cu content	Inmet Mining Corp.		Mines at Pyhasalmi, Saattopora, and Hitura	10
Metal	Outokumpu Oyj (Government, 40%, and private investors, 12.3%)		Smelter at Harjavalta	160
Do.	do.		Refinery at Pori	125
Feldspar	SP Minerals Oy (Partek Corp., 50.1%, and SCR-Silbeco SA, 49.9%)		Mine and plant at Kemio	50
Ferrocchrome	Outokumpu Oyj (Government, 40%, and private investors, 12.3%)		Smelter at Tornio	250
Gold:				
Ore, Au content	metric tons	do.	Mine at Orivesi	4
Do.	do.	Scanmining	Pahtavaara Mine near Sodankylä	3
Metal	do.	Outokumpu Oyj (Government, 40%, and private investors, 12.3%)	Smelter at Pori	4
Limestone	Partek Nordkalk Oy (Partek Corp., 100%)		Mines at Lappeenranta, Pargas, and Parainen	1,500
Do.	Rauma-Repola Oy		Mine at Tornio	300
Mercury	metric tons	Outokumpu Oyj (Government, 40%, and private investors, 12.3%)	Smelter at Kokkola	150
Mica	Kemira Oyj (Government, 98%)		Mine at Siilinjärvi	10
Nickel:				
Ore, Ni content	Outokumpu Oyj (Government, 40%, and private investors, 12.3%)		Mine at Hitura	3
Metal	do.		Smelter at Harjavalta	32
Do.	OM Group, Inc.		Refinery at Harjavalta	50
Petroleum products	Fortum Oil and Gas Oy		Plants at Naantali and Porvoo	NA
Phosphate-apatite	Kemira Oyj (Government, 98%)		Mine at Siilinjärvi	700
Do.	Outokumpu Oyj (Government, 40%, and private investors, 12.3%)		Mine at Pyhasalmi	800
Quartz and quartzite	SP Minerals Oy (Partek Corp., 50.1%, and SCR-Silbeco SA, 49.9%)		Mines at Kemio and Nilsia	250
Selenium	metric tons	Outokumpu Oyj (Government, 40%, and private investors, 12.3%)	Smelter at Pori	35
Silver	do.	do.	do.	30
Steel:				
Crude	Rautaruukki Oy (Government, 41.8%)		Plants at Halikko, Hameenlinna, Kankaanpää, and Raahе	2,100
Do.	Fundia AB (Norsk Jenverk AS of Norway, 50%, and Rautaruukki, 50%)		Plants at Aminnefors, Dalsbruk, and Koverhar	850
Do.	Ovako Oy (SKF, 50%; Wartsila, 25%; Fiskas, 20%)		Plant at Imatra	600
Stainless	AvestaPolarit		Plant at Tornio	550
Talc	Mondo Minerals Oy (Western Mining Corp. Holdings Ltd., 50%, and Plüss-Staufe AG, 50%)		Mines at Lahnaslampi, Lipsavaara, and Horsmanaho	500
Wollastonite	Partek Minerals Oy (Partek Corp., 100%)		Mine at Lappeenranta	30
Zinc:				
Ore, Zn content	Inmet Mining Corp.		Mine at Pyhasalmi	25
Metal	Outokumpu Oyj (Government, 40%, and private investors, 12.3%)		Smelter at Kokkola	260

NA Not available.

