

THE MINERAL INDUSTRY OF THE REPUBLIC OF KOREA

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The Republic of Korea, which occupies the southern half of the Korean Peninsula below the 38th parallel, is located east of the Yellow Sea, west of the Sea of Japan (the East Sea), and between the Democratic People's Republic of Korea and Japan. Korea's total area is about 98,480 square kilometers, which is about the size of Indiana. In 2004, the country's population was estimated to be 48.4 million. Korea is a newly industrialized country in East Asia. The country's gross domestic product (GDP) and the GDP per capita based on purchasing power parity were estimated to be \$1,029.8 billion and \$21,305, respectively (International Monetary Fund, 2005¹; U.S. Central Intelligence Agency, 2005).

Korea's mineral resources are limited. According to Korea Resources Corporation (Kores), which is a state-owned company under the supervision of the Ministry of Commerce, Industry and Energy, the country has small reserves of antimony, coal, copper, gold, iron ore, lead, molybdenum, silver, tin, tungsten, and zinc and relatively larger reserves of such industrial minerals as kaolin, limestone, pyrophyllite, silica stone (quartzite), and talc (Korea Resources Corporation, 2004, p. 117). Korea has small reserves of natural gas, but no known reserves of petroleum.

In 2004, Korea was one of the world's leading producers of cadmium and slab zinc and the world's fifth leading steel producer (World Bureau of Metal Statistics, 2005, p. 34; International Iron and Steel Institute, 2005a). The country was a significant producer of cement, refined copper, pyrophyllite, and talc in the Asia and the Pacific region. Korea was one of the region's major consumers and importers of coal, natural gas, and nickel oxide sinter; ores and concentrates of copper, iron, lead, and zinc; and crude petroleum. Because of its limited indigenous mineral resources, Korea relied almost 100% on imports to meet its requirements for bituminous coal; ores and concentrates of copper, iron, lead, rare earths, and zinc; fluorite; natural gas; gypsum; magnesite; crude petroleum; phosphate; and uranium.

Korea's mining and quarrying sector, which encompassed the mining of anthracite coal, ferrous and nonferrous metals, and industrial minerals, was the smallest sector of Korea's economy. According to Government statistics on national accounts, the output of the mining and quarrying sector accounted for only 0.33% of the country's GDP in 2004.

In 2004, the economy as measured by real GDP (in 2000 constant prices) grew by 4.6% compared with 3.1% in 2003 owing mainly to the strong growth in exports despite relatively weaker domestic demand and lower growth in fixed investments (Bank of Korea, 2005, p. 184).

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

Government Policies and Programs

Because of insufficient indigenous mineral resources, heavy reliance on imports, and the lack of a materials stockpile to draw upon in a potential resource crisis, the Government was actively promoting overseas exploration and development of mineral resources and seeking cooperative relations with resource-rich countries. The Government policy directions were (1) to set stable energy supply as a top national agenda, (2) to expand the investment fund for the development of energy and mineral resources, (3) to strengthen energy and mineral resource cooperation with countries of strategic importance, and (4) to strengthen the support base for the business sector in overseas resource development (Ministry of Commerce, Industry and Energy, 2005a, p. 1, 7).

To achieve the policy goal of energy security, the Government established the National Energy Committee to review support measures for overseas resources development and to draft and implement the second ten-year (2004-13) plan for overseas resource development. To achieve the policy goal of expanding the investment fund for the development of energy and mineral resources, new tax incentives were provided, the energy special fund and capital base were increased, the ceiling for the strategic fund of the Korea Export-Import Bank was raised, and the debt guarantee fund was established. To achieve the policy goal of strengthening cooperation with countries of strategic importance, the Government was actively pursuing resource diplomacy with resource-rich countries in Central Asia and Latin America and established a bilateral committee on energy and mineral resource cooperation. To achieve the policy goal of strengthening the support base for the business sector in overseas resource development, the competitiveness of specialized state-owned enterprises in the resource development field was enhanced to facilitate the participation of the private sector in attractive projects (Ministry of Commerce, Industry and Energy, 2005a, p. 11-14).

Production

In 2004, Korea produced a small quantity of a few metallic minerals and a relatively larger quantity of a wider variety of industrial minerals. The mine production of metallic minerals included gold, iron ore, lead, silver, and zinc. The mine production of industrial minerals included barite, feldspar, graphite, kaolin, limestone, mica, pyrophyllite, quartzite, sand, and talc. The country produced about 3 million metric tons (Mt) of anthracite and a small amount of offshore natural gas, but no crude petroleum. Korea manufactured large quantities of cement using domestic raw materials; iron and steel and refined petroleum products using imported raw materials, and moderate

quantities of nonferrous metals, including bismuth, cadmium, copper, gold, lead, nickel, and zinc using mostly imported raw materials (table 1).

Trade

In 2004, total exports increased by 31.0% to \$253.8 billion owing mainly to a 34.5% increase in exports of heavy industry products to \$208 billion, which included mainly chemicals, iron and steel products, industrial machinery and precision equipment, electric and electronic machinery, passenger cars, and ships and boats. Total imports increased by 25.5% to \$224.5 billion owing mainly to a 31.7% increase in imports of crude materials and fuel to \$113.8 billion; these imports included mainly chemicals, light industrial crude materials, fuels, iron and steel products, nonferrous metals, and minerals (Bank of Korea, 2005, p. 108-109).

In minerals trade, Korea was a net importer of mineral commodities owing to its large imports of coal, natural gas, and crude petroleum; ore and concentrates of copper, iron, lead, and zinc; and ferrous and nonferrous metal products. In 2004, imports of mineral fuels totaled \$49.4 billion, of which \$29.9 billion was crude petroleum. Imports of nonfuel mineral products, which included iron ore; and ore and concentrates of copper, lead, zinc, and other minerals, totaled \$7.5 billion. Imports of iron and steel products totaled \$13.3 billion. Imports of nonferrous metals totaled \$7.8 billion. Exports of crude materials and fuels totaled \$13.1 billion, of which \$10.3 billion was refined petroleum products. Exports of iron and steel products totaled \$18.6 billion (Bank of Korea, 2005, p. 108-109).

Structure of the Mineral Industry

Korea's mining and quarrying sector consisted of small mining industries of coal, and ferrous and nonferrous metals and a relatively larger mining industry of industrial minerals. The mineral-processing sector, which consisted of the industries of ferrous and nonferrous metals, cement, and refined petroleum products, was much larger than the mining and quarrying sector (table 2). The mining and quarrying sector employed about 10,750 workers, of which about 6,600 were coal miners; about 4,010, industrial minerals miners; and about 140, metallic minerals miners. Most of the mining and quarrying companies and the ferrous and nonferrous metal processing companies were owned and operated by private companies incorporated in Korea. The larger coal mining, natural gas, petrochemical, and petroleum refining companies, however, were state-owned and under the supervision of the Ministry of Commerce, Industry and Energy.

In 2004, Korea Zinc Co. Ltd. completed construction of the 55-metric-ton-per-year (t/yr) indium-refining plant in Onsan. The plant was expected to start commercial operation in 2005. Korea's refined-gold production capacity increased to 110,000 kilograms per year (kg/yr) from 50,000 kg/yr owing to the inclusion of the 60,000-kg/yr-capacity gold refinery in Onsan that was operated by LG-Nikko Copper Inc. The country's primary zinc-refining capacity increased to 710,000 t/yr from

600,000 t/yr owing to the inclusion of the 30,000-t/yr-capacity expansion by Korea Zinc in Onsan and the 80,000-t/yr-capacity expansion by Young Poong Corp. in Sukpo. In 2004, Korea Zinc also increased its refined copper production capacity to 20,000 t/yr from 4,000 t/yr in Onsan.

Commodity Review

Metals

Aluminum.—Korea relied entirely on imports to meet its requirements for primary aluminum. In 2004, imports of primary aluminum increased by 10.8% to 1,197,062 metric tons (t), of which 943,413 t was primary aluminum ingot and 253,649 t was primary aluminum alloys. The major suppliers of primary aluminum ingots and alloys were China (42%), Russia (22%), Australia (17%), South Africa (5%), and Canada and United Arab Emirates (4% each) (World Bureau of Metal Statistics, 2005, p. 25).

According to Korea Nonferrous Metal Association, domestic demand for primary aluminum increased by 10.7% to 1.14 Mt, of which primary aluminum ingot increased by 12.3% to 930,900 t and primary aluminum alloys increased by 4.2% to 210,111 t in 2004. The major consumers were Alcan Thihan Aluminum Ltd., Aluminum of Korea Ltd., Choil Aluminum Manufacturing Co. Ltd., and Seoul Metal Co. Ltd. for the production of aluminum plates, sheets, electric wire, and aluminum alloy extrusion; Daihan Eunpakgy Industrial Co. Ltd., Dong II Aluminum Co. Ltd., Lotte Aluminum Co. Ltd., and Sam-A Aluminum Co. Ltd. for the production of foil products; Dooray Air Metal Co. Ltd. for the production of aluminum wheels for automobiles and other casting products; and Chang Sung Corp. for the production of aluminum metal powders (Joo Ho Kim, Vice Chief, Korea Nonferrous Metal Association, oral commun., May 11, 2005).

Copper.—Korea was not a producer of mined copper, but was the third leading producer of refined copper in the Asia and the Pacific region. Korea relied 100% on imports of copper ore and concentrate to meet the raw material requirements for its Onsan copper smelter, which was located in Ulsan. The smelter was operated by LG-Nikko Copper Inc., which was formed in September 1999 by Korea's LG Group (50%) and Japan Korea Joint Smelting Co. (50%). Japan Korea Joint Smelting was owned 80% by Nippon Mining and Metals Co. Ltd. and 10% each by Marubeni Corp. and Mitsui Mining & Smelting Co. Ltd. In 2004, Korea imported about 1.31 Mt of copper ore and concentrates, which was valued at about \$1.18 billion, from Argentina, Australia, Chile, Guinea, Indonesia, and Peru (Ministry of Commerce, Industry and Energy, 2005b, p. 304).

To secure a long-term stable supply of copper concentrate and refined copper, state-owned Kores and LG-Nikko Copper signed a joint-venture agreement with Chariot Resources Ltd. of Canada in October 2004 for the development of the proposed Marcona copper project in Peru. Under the joint-venture agreement, the Marcona copper project would be 70% owned by Chariot Resources and 30% owned jointly by Kores and LG-Nikko Copper, which agreed to offtake annually 90% of copper concentrate production from the Marcona project and 70% of

Marcona copper cathode production from the Target Area I and the Rio Tinto Plc claims (Mining Journal, 2004).

In November 2004, LG-Nikko Copper reportedly was expected to buy 60,000 t/yr of copper concentrate from Cia Vale do Rio Doce (CVRD) of Brazil from December 2004 to the end of 2011. According to Kores, LG-Nikko Copper and CVRD were expected to sign a memorandum of understanding (MOU) to develop the copper mine jointly (Bloomberg.com, 2004§; Yahoo! Inc., 2004b§). In November, LG-Nikko Copper extended its previous agreement with Wheaton River Minerals Ltd. to buy 120,000 t/yr of copper concentrate from the Alumbreira Mine in Argentina for 4 more years. The 4-year purchase agreement was worth about \$400 million (JoongAng Daily, 2004§).

In 2004, the 420,000-t/yr Onsan copper smelter reportedly produced about 390,000 t of blister and anode copper. To feed the 450,000-t/yr Onsan copper refinery and the 60,000-t/yr Changhang copper refinery, Korea imported an additional 53,453 t of blister and anode copper and 205,427 t of copper and copper alloy scrap in 2004. Korea produced about 496,000 t of refined copper, of which about 60,000 t was secondary. To meet the domestic refined copper requirements, Korea also imported about 487,700 t of refined copper and about 2,700 t of copper alloys in 2004 (World Bureau of Metal Statistics, 2005, p. 70).

According to Korea Nonferrous Metal Association, domestic demand for copper cathode totaled 901,099 t in 2004. The country exported 46,145 t of copper cathode and imported 455,190 t of copper cathode in 2004. Most copper cathode was consumed by the semimanufacturers of brass, cable, plates, sheet, strip, tube, and wire. The major semimanufacturers of copper rod for electric wire, copper and copper alloy pipe, sheet, strip, and tube were Sun Jin Metal Co. Ltd. and Poongsan Corp. (Joo Ho Kim, Vice Chief, Korea Nonferrous Metal Association, oral commun., May 11, 2005)

Gold.—Ivanhoe Mines Ltd. of Canada began its gold mining operation in April 2002 at the Silver Hill Mine (Seongsan-Eunsan) in South Cholla Province (Chollanam Do) in southwest Korea. The Eunsan prospect is a low-sulfidation epithermal gold-silver prospect and was estimated to contain inferred resources of 252,800 t of ore at a grade of 15 grams per metric ton (g/t) gold and 83.8 g/t silver. Mine production of gold from the Silver Hill Mine was 233 kilograms (kg) in 2004, 207 kg in 2003, and 310 kg in 2002 [Lee, Kyung-Han, Principal Researcher, Mineral Economics Team, Korean Institute of Geoscience and Mineral Resources (Kigam), written commun., July 6, 2005].

In November 2004, CanAustra Resources Inc. of Canada agreed to acquire a 100% interest in a skarn gold prospect in Korea from an unnamed vendor (the mining title owner) for an undisclosed price. The gold prospect at an undisclosed location reportedly has extensively developed skarn host rocks with volume that has the potential to host a substantial outcropping gold deposit with significant copper and silver mineralization in four separate skarn zones. To determine the size and grade of the system, CanAustra planned to undertake a work program beginning in the first quarter of 2005 that would include a systematic data compilation, mapping, surface sampling, detailed soil sampling to delineate zones with anomalous gold,

and drill testing of anomalous zones to determine the grade and width (ArriveNet.com, 2004§).

According to the Ministry of Commerce, Industry and Energy, Korea produced 32,449 kg of refined gold in 2004, of which 1,371 kg was produced from domestic raw materials, which included scrap. In 2004, domestic demand for refined gold was 91,093 kg. Imports of refined gold totaled 268,518 kg, which was valued at \$3.49 billion; and exports of refined gold totaled 232,744 kg, which was valued at \$2.98 billion (Ministry of Commerce, Industry and Energy, 2005b, p. 272, 294, 304). The major end users of refined gold were the manufacturers of coins, dental products, electrical communication parts, jewelry, materials for semiconductors, and other uses.

Indium.—Korea Zinc Co. Ltd., which was one of the world's leading producers of refined zinc, was expected to produce indium for the first time in Korea to meet the growing demand for liquid crystal display (LCD) panels. According to a company official, the company invested about \$3.8 million to build an indium plant at its Onsan nonferrous metal smelting and refining complex. Construction of the indium plant was completed in December 2004. The initial plant capacity was 55 t/yr and would gradually increase to 100 t/yr if demand for indium were to continue to grow. The indium plant, which was scheduled to begin operation in January 2005, was expected to produce 34 t of indium in 2005. Indium is a byproduct of zinc refining that is used mainly to produce indium-tin oxide, which is an essential material in the manufacturing of LCD and plasma display panels (PDP) for flat-panel screens in computers, mobile phones, and televisions (Yahoo! Inc., 2004a§; C. K. Choi, Vice Chairman, Korea Zinc Co. Ltd., oral commun., May 12, 2005; Joo Ho Kim, Vice Chief, Korea Nonferrous Metal Association, oral commun., May 11, 2005).

Iron and Steel.—Korea relied on imports to meet more than 99% of its iron ore requirements in 2004. Imports of iron ore totaled more than 44 Mt and was valued at about \$1.4 billion. The major suppliers were Australia (62%), Brazil (28%), and India (5%). The average import price of iron ore rose to \$31.15 per metric ton in 2004 from \$25.18 per metric ton in 2003. To secure a long-term stable supply of iron ore, Pohang Iron and Steel Co. Ltd. (POSCO) signed a 10-year purchase (sales) contract with CVRD (the world's leading producer of iron ore) for the supply of up to 103 Mt of iron ore fines from April 2005 to March 2015. The contract, which was worth \$2.1 billion, was for CVRD to supply POSCO 8.5 Mt of iron ore in 2005; this amount would increase to 10.5 million metric tons per year (Mt/yr) in 2008 and remain at that level until the end of the contract. According to POSCO, its previous purchase, which totaled 36 Mt of iron ore under a 5-year contract with CVRD, will expire in March 2005 (Bloomberg.com, 2004§; Yahoo! Inc., 2004b§).

The iron and steel industry consumed 46.98 Mt of iron ore and produced about 28 Mt of pig iron in 2004. The industry consumed about 30 Mt of pig iron, of which about 2 Mt was imported; and consumed about 24 Mt of steel scrap, of which about 7 Mt of was imported. About 98% of pig iron was consumed for steelmaking, and 2%, for foundry use. Crude steel production increased to a record-high level of 47.5 Mt in 2004, of which about 56% was produced by basic oxygen furnaces (BOF) and 44%, by electric arc furnaces (EAF). At

the end of 2003, the industry steelmaking capacity totaled about 49.3 Mt/yr, of which 27.4 Mt/yr-capacity was BOF and 21.9 Mt/yr-capacity was EAF (Korea Iron and Steel Association, 2004, p. 5-6, 8-9, 103, 122-23, 251, 258-259; Ministry of Commerce, Industry and Energy, 2005b, p. 106).

In 2004, Korea was the world's fifth ranked steel-producing country. The country's crude steel output accounted for about 4.5% of the world's total in 2004. Korea's two leading steelmakers—POSCO, which produced about 30.2 Mt, and INI Steel Co. Ltd., which produced about 7.6 Mt, ranked as the world's 5th and 28th leading steel-producing companies, respectively, in 2004 (International Iron and Steel Institute, 2005b§). The 2004 record-high level of steel production was mainly owing to a 4.5% increase in output by POSCO that was driven by stronger domestic demand for steel by the automobile and ship-building industries and by higher steel exports to China and Japan (Metal Bulletin, 2004b).

In August, POSCO signed a contract with Voest-Alpine Industrieanlagenbau (VAI) of Austria to build a FINEX plant at its Pohang works. FINEX is a new environmentally friendly ironmaking technology that has improved upon the Cores process developed by VAI. According to VAI, the \$44 million contract was to build FINEX-processing facilities for large-scale production at the Pohang works. The FINEX plant would have the capacity to produce 1.5 Mt/yr of pig iron. FINEX simplifies the ironmaking process by direct application of fine iron ore. As a result, the emissions amount to only 10% of that generated when using conventional blast furnaces. The first commercial-scale FINEX ironmaking plant at POSCO's Pohang Works was scheduled to begin operations by the end of 2006 (Vatech.at, 2004§).

In August, POSCO planned to join with BHP Billiton Ltd. to build a new 10-Mt/yr slab plant in the State of Rissa in Eastern India. The joint-venture plan would involve the construction of a coke plant to process imported coal to be supplied by BHP Billiton and the development of a port, which would be undertaken by Tata Iron & Steel Co. of India. The exact location of the slab plant was yet to be determined (Metal Bulletin, 2004a).

Nickel.—Korea relied 100% on imports of nickel oxide sinter to meet the raw material requirements for the production of utility nickel (97% nickel content). In 2004, the major suppliers of nickel oxide sinter, which contained 75% to 76% nickel were, in decreasing order of volume, Japan (42%), Russia (24%), Canada (19%), and Australia (14%). Korea Nickel Corp., which was a joint venture of Korea Zinc Co. Ltd. (56%), Inco Ltd. of Canada (25%), and POSCO Steel Services and Sales Co. Lt. (19%), was the sole nickel refining company in Korea. The combined capacity of Korea Nickel's two nickel refineries in Onsan was 48,000 t/yr of utility nickel. The older plant, which had a 16,000 t/yr capacity, had not been in operation since 1999. The newer plant, which had a 32,000 t/yr capacity, was completed and began operations in October 1999. In 2004, because of a refractory brick problem in the main furnace, the main operating plant (the newer plant) reportedly was shut down from June to mid-December, and nickel refining was switched to the company's older standby plant. As a result, the 2004 production of utility nickel decreased to 27,200 t compared

with 31,340 t in 2003 (Australia Paydirt, 2004; World Bureau of Metal Statistics, 2005, p. 116; Korea Zinc Co. Ltd., 2004§; Platts.com, 2004a§).

According to Korea Nonferrous Metal Association, demand for nickel metal totaled 123,112 t in 2004, of which 120,757 t was for domestic consumption mainly by the iron and steel industry and 2,355 t was exported mainly to China. To meet the overall demand for nickel, Korea imported 44,117 t of refined nickel and 50,885 t of nickel contained in ferronickel in 2004 compared with 38,826 t of refined nickel and 45,856 t of nickel contained in ferronickel in 2003. The increased imports of nickel in 2004 were a result of reduced domestic production and stronger demand for nickel by the iron and steel industry for stainless steel production (Joo Ho Kim, Vice Chief, Korea Nonferrous Metal Association, oral commun., May 11, 2005).

Zinc.—In 2004, Korea produced an insignificant amount of mined zinc and relied on imports for virtually all raw materials requirements for its zinc-refining industry. Imports of zinc ore and concentrate totaled, in gross weight, 1,253,051 t and were valued at \$410.7 million. The major suppliers were Australia (30.6%), Peru (21.9%), and the United States (21.5%). Consumption of zinc ore and concentrate totaled 1,269,374 t in 2004 compared with 1,250,015 t in 2003 (Ministry of Commerce, Industry and Energy, 2005b, p. 272, 282, 304; World Bureau of Metal Statistics, 2005, p. 143).

Production of primary zinc totaled 669,000 t in 2004, of which 425,000 t was produced by Korea Zinc at Onsan, and 243,000 t, by Young Poong Corp. at Sukpo. In 2004, Korea, which was the world's leading producer of slab zinc, produced more than 940,000 t of slab zinc, of which 669,000 t was from the Onsan and the Sukpo plants in Korea, and 279,000 t, from two wholly owned subsidiaries of Korea Zinc (Sun Metals Corp. Pty., Ltd. in Australia, and Big River Zinc Corp in the United States).

According to Korea Nonferrous Metal Association, domestic demand for primary zinc (including unwrought zinc and zinc alloys, zinc bars, and rods, and other primary zinc products) decreased by 10.2% to 391,430 t in 2004. Exports of primary zinc in 2004 increased to 374,579 t from 363,983 t in 2003, and imports of primary zinc decreased to 109,572 from 147,369 t in 2003. Imports of primary zinc from North Korea in 2004 were 16,000 t compared with 37,000 t in 2003 and 23,000 t in 2002 (C. K. Choi, Vice Chairman, Korea Zinc Co. Ltd., oral commun., May 12, 2005; Joo Ho Kim, Vice Chief, Korea Nonferrous Metal Association, oral commun., May 11, 2005). According to the World Bureau of Metal Statistics, Korea consumed 420,013 t of slab zinc in 2004. It imported 71,633 t of slab zinc, of which 88% was from China, and exported 320,076 t of slab zinc, of which 25% went to Taiwan; 15%, to India; 9% each, to Indonesia and Vietnam; and 8%, to Malaysia in 2004 (World Bureau of Metal Statistics, 2005, p. 143).

Industrial Minerals

Cement.—Korea was the world's fifth leading cement producer in 2004 after China, India, the United States, and Japan. According to Korea Cement Industrial Association, the country's clinker output decreased to 48.3 Mt from 51.6 Mt in

2003, and cement output decreased to 54.3 Mt from 59.2 Mt in 2003 because of weaker domestic demand that resulted mainly from a slowdown in the construction of private housing in 2004. Exports of clinker increased to 1.4 Mt from 535,000 t in 2003, and exports of cement held steady at about 2.6 Mt. Exports of clinker went mainly to the United Arab Emirates (41%), Ghana (22%), and Vietnam (9%). Exports of cement went mainly to the United States (67%) and Japan (30%). The country imported only 22,000 t of clinker from Japan and imported 3.4 Mt of cement mainly from China (65%) and Japan (35%) (Korea Cement Industrial Association, 2005; 2005§).

Korea's cement industry comprised 11 companies that operated 51 kilns at 12 kiln plant sites and 26 grinding plants. The industry's total capacity was 70.2 Mt/yr. The industry's total number of employees was about 7,300. During the past 5 years, Korea's per capita cement consumption trended upward from 1,021 kg in 2000 to 1,217 kg in 2003 because of the continued growth in private housing construction; in 2004, however, the per capita cement consumption turned down to about 1,100 kg owing to the slowdown in new apartment construction (Korea Cement Industrial Association, 2004).

In October, Hanil Cement Co. Ltd., which was the country's sixth leading cement producer and was capable of producing more than 7 Mt/yr of cement, announced that it had signed an MOU with Mitsubishi Materials Corp. of Japan for close cooperation in all aspects of the cement businesses. Under the MOU, Mitsubishi Materials is to transfer technologies for manufacturing and for recycling of industrial wastes, and management "know-how" to Hanil Cement. The two companies also agreed to jointly foster growth in the global market. This was the first time that a Korean cement company had ever made an agreement with a Japanese company to collaborate on all aspects of the cement industry (Hanil Cement Co. Ltd., 2004§).

Mineral Fuels

Coal.—In 2004, anthracite coal production decreased to 3.2 Mt from 3.3 Mt in 2003 as the Government continued to restructure. The ongoing coal industry restructuring program was carried out under the Coal Mining Industry Act of 1988, which subsidized a portion of the expenses for mine closure. Between 1989 and 2000, about 340 coal mines were closed, about 33,400 coal miners lost their jobs, and the total estimated amount of Government subsidies was more than \$400 million. The Government, however, continued to support the relatively more-efficient coal mines with funds to modernize their facilities and revamp their development methods. To balance the supply and demand for domestic coal, the Government constructed two anthracite coal-fired powerplants with a combined capacity of 400,000 kilowatts (kW) between 1989 and 1999 (Korea Resources Corp., 2004, p. 35).

In 2003 (the latest year for which data were available), a total of nine coal mines operated, six of which were privately owned, and three, state-owned; about 37% of coal was produced by the state-owned companies, and 63%, by privately owned companies. To meet the coal requirements for its cement, iron and steel, and utility industries, Korea imported a total of 65.3 Mt of coal, which was valued at about \$2.3 billion. The major

suppliers were Australia, Canada, China, Indonesia, and Russia (Korea Resources Corporation, 2004, p. 47-48). In 2003, Korea's iron and steel industry consumed about 18.9 Mt of coking coal, of which 18.7 Mt was imported. About 60.7% of imported coking coal was from Australia; 16.2%, from Canada; 1%, from the United States; and 22.1%, from other countries (Korea Iron and Steel Association, 2004, p. 108-109, 111).

Demand for bituminous coal totaled 60.3 Mt in 2000 and was projected to be 72.9 Mt in 2005. The main end users of bituminous coal were the cement industry, which consumed about 7.6 Mt in 2000 and was expected to consume 9.7 Mt in 2005; the utility (electricity-generating) industry, which consumed about 33.3 Mt in 2000 and was expected to consume 43.7 Mt in 2005; and the iron and steel industry, which consumed 19.4 Mt in 2000 and was expected to consume 19.5 Mt in 2005 (Korea Resources Corporation, 2004, p. 49).

To secure a long-term supply of coking coal, POSCO reached an agreement with Western Canadian Coal Corp. (WCCC) in December 2004, for the supply of 3 Mt of low-volatile pulverized coal-injection coal and hard-coking coal from WCCC's Burnt River and Perry Creek properties to POSCO's two steel works in Korea over a 6-year period. The long-term purchase and sale agreements, however, were subject to satisfactory trial shipments (Canada NewsWire Group, 2004§).

Natural Gas and Petroleum.—Korea produced a small amount of natural gas, but no crude petroleum; the country, however, was important to the world energy market. In 2004, Korea was the world's second leading importer of natural gas and the fifth leading importer of crude petroleum (U.S. Energy Information Administration, 2005§). In 2004, Korea continued to rely on imports for about 98% of natural gas requirements in the form of liquefied natural gas (LNG) for its utility industries and for all crude petroleum requirements for its petroleum refining industry.

On November 5, state-owned Korea National Oil Corp. (KNOC) began full-scale commercial production of natural gas from the country's first gasfield, Donghae-1, which is located 59 kilometers (km) offshore southeast of Ulsan in the Ulleung Basin. According to KNOC, Donghae-1 was discovered by KNOC in July 1998. The company spent between \$300 million and \$320 million to develop the gasfield, which was estimated to contain about 1.42 billion cubic meters (about 50 billion cubic feet) of high-quality natural gas and condensate reserves. When calculating in LNG, the gasfield has reserves of about 5 Mt. KNOC planned to produce 400,000 t/yr of natural gas over the next 15 years (Korea Gas Corp., 2004d§). Under a sale contract with state-owned Korea Gas Corp. (KOGAS), KNOC would supply up to 2.124 million cubic meters per day (75 million cubic feet per day), which is equivalent to 1,575 metric tons per day of LNG to KOGAS via KOGAS-managed pipelines. A 70-km pipeline that linked the gasfield to a gas treatment plant onshore and to the KOGAS pipeline network had been built by Hyundai Engineering & Construction Co. Ltd. (Platts.com, 2004b§).

Korea consumed between 20 Mt/yr and 21 Mt/yr of imported LNG mainly from, in decreasing order of amount imported, Qatar, Indonesia, Malaysia, and Oman. According to KOGAS, the rapid growth in demand for natural gas by the utility

industry was causing the gap between projected LNG demand and guaranteed supply to grow. The projected shortfall of from 5 to 6 Mt in 2008 could increase to as much as 22 Mt by 2015. To secure sufficient long-term supply to fill the gap, the Government reportedly gave KOGAS the green light in July 2004 to negotiate new purchase contracts for up to 6 Mt/yr of LNG to be supplied over a 20- to 25-year period beginning in 2008, which was worth between \$25 billion and \$30 billion (Far Eastern Economic Review, 2004).

In August, KOGAS invited 11 LNG suppliers from 9 countries in the Middle East and the Asia and the Pacific regions to bid for long-term supply contracts to export LNG to Korea beginning in 2008. In October, KOGAS signed two long-term contracts with Brunei and Indonesia and two short-term LNG purchase agreements with Qatar and Malaysia. KOGAS was negotiating Heads of Agreements with the selected suppliers and planned to finalize the agreements by February 2005 (Korea Gas Corp., 2004 a§-c§).

Korea imported all crude petroleum requirements for its oil refining industry. In 2004, the country imports of crude petroleum averaged 2.836 million barrels per day (Mbb/d), of which 2.033 Mbb/d was from the Middle East; 0.046 Mbb/d, from Africa; and 0.132 Mbb/d, from Asia. The major suppliers of crude petroleum were Saudi Arabia (30%), United Arab Emirates (18%), Kuwait (10%), Iran (7%), and Indonesia (5%). Demand for crude petroleum in 2004 averaged 2.149 Mbb/d compared with 2.175 Mbb/d in 2003. Korea's five major oil refineries were located in Ulsan (817,000 bbl/d), Yocheon (633,600 bbl/d), Onsan (520,000 bbl/d), Daesan (310,000 bbl/d), and Incheon (270,000 bbl/d). The country's total crude petroleum refining capacity was about 2.5 Mbb/d in 2004 (U.S. Energy Information Administration, 2005§). The country's second leading refinery, LG Caltex, which was owned jointly by LG Group and ChevronTexaco Corp., was completely shut down in mid-2004 because of a strike. The Incheon refinery, which was owned by Hyundai Oil Bank Co., might be taken over by Sinochem, China's state-owned oil and petrochemical trading company for about \$550 million in 2004 (Petroleum Economist, 2004a, b).

Outlook

During the next 2 to 3 years, Korea's mining sector is expected to remain unchanged; the mineral processing sector, however, is expected to expand slightly in the iron and steel and nonferrous metals (especially in copper and nickel) industries. Korea is expected to more actively seek joint-venture exploration and development of mineral resources overseas, especially in coal, copper, natural gas, iron ore, and petroleum in the Latin American, Southeast Asian, and Eurasian countries.

Korea's economy as measured by the GDP is projected to grow at a slightly slower pace (4.0%) in 2005 and at a slightly faster pace (5.2%) in 2006 than in 2004 (International Monetary Fund, 2005§).

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TABLE 1
REPUBLIC OF KOREA: PRODUCTION OF MINERAL COMMODITIES¹

(Metric tons unless otherwise specified)

Commodity	2000	2001	2002	2003	2004
METALS					
Bismuth, metal	71	106	69	120 ^r	156
Cadmium, smelter	1,911	1,879	1,825 ^r	2,175	2,362
Copper:					
Smelter, primary and secondary	424,100 ^r	428,500 ^r	430,000 ^r	460,000	430,000
Refined, primary and secondary	467,900	473,624	500,300 ^r	509,970	495,952
Gold:					
Mine output, Au content kilograms	45	24	310	207	233
Metal, refined do.	22,608 ^r	28,595	26,181	40,262	32,449
Iron and steel:					
Iron ore and concentrate:					
Gross weight thousand metric tons	336	195	365	289 ^r	496
Fe content do.	188	109	164	125 ^r	214
Metal:					
Pig iron do.	24,938	25,898	26,570	27,314	27,556
Ferroalloys:					
Ferromanganese	146,373	143,525	137,000	141,000	165,525
Ferrosilicomanganese	103,522	101,877	94,000	90,942 ^r	82,917
Other	4,676	4,452	--	--	--
Total	254,571	249,854	231,000	231,942 ^r	248,442
Steel, crude thousand metric tons	43,107	43,852	45,390	46,310	47,521
Lead:					
Mine output, Pb content	2,724	988	28	--	40
Metal, smelter	170,704	161,000	178,722	169,297	173,609
Nickel	29,890	26,429	30,337	31,340 ^r	27,200
Silver, metal kilograms	591,130	664,533	973,140	947,781	1,172,632
Zinc:					
Mine output, Zn content	11,474	5,129	99	--	14
Metal, primary	473,897	503,315	600,027	644,218	668,666
INDUSTRIAL MINERALS					
Barite	30	200 ^r	78 ^r	140 ^r	50
Cement, hydraulic thousand metric tons	51,424	52,046	55,514	59,194 ^r	54,330
Clays, kaolin do.	2,049 ^r	2,306 ^r	2,727 ^r	3,009 ^r	2,780
Diatomaceous earth	34,143	27,530	20,666	15,636	2,441
Feldspar	378,817 ^r	467,161 ^r	519,125 ^r	477,012	541,788
Graphite, all types	65	238 ^r	94	58	247
Lime, slaked lime	269,264	298,362	216,536	220,000 ^e	210,000 ^e
Mica, all grades	65,295 ^r	109,339	29,870	33,645	59,238
Nitrogen, N content of ammonia	386,300 ^r	385,200 ^r	152,600 ^r	118,900 ^r	163,400
Salt ^c	800,000	800,000	800,000	800,000	800,000
Soda ash, manufactured ^c	310,000	310,000	310,000	310,000	310,000
Stone, sand and gravel:					
Limestone thousand metric tons	77,868	79,521	83,767	88,525	85,549
Quartzite do.	2,321	2,377	3,041	2,966	2,842
Sand, including glass sand do.	879	900	891	480	554
Sulfur, byproduct: ^e					
Metallurgy do.	572	665	737 ^r	797 ^r	796
Petroleum do.	679 ^r	690 ^r	687 ^r	757 ^r	879
Total do.	1,251 ^r	1,355 ^r	1,424 ^r	1,554 ^r	1,675
Talc and related materials:					
Pyrophyllite	917,973	1,101,825	889,961	912,285	827,895
Talc	11,344	47,712	37,863	47,911	79,911

See footnotes at end of table.

TABLE 1--Continued
 REPUBLIC OF KOREA: PRODUCTION OF MINERAL COMMODITIES¹

(Metric tons unless otherwise specified)

Commodity	2000	2001	2002	2003	2004
MINERAL FUELS AND RELATED MATERIALS					
Carbon black	454,699	438,128	459,985	464,941	473,788
Coal, anthracite	4,174	3,817	3,318	3,312 ^f	3,248
Fuel briquets, anthracite briquets	1,000 ^{r,e}	1,100 ^{r,e}	1,200 ^{r,e}	1,191 ^f	1,385
Petroleum refinery products	911,761	930,000 ^e	940,000 ^e	796,000 ^f	842,000

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

¹Table includes data available through August 26, 2005.

Sources: Ministry of Commerce, Industry and Energy, Korea Institute of Geoscience and Mineral Resources, Current status of minerals supply and demand, 2004; U.S. Geological Survey, Minerals Questionnaire 2000-2004.

TABLE 2
REPUBLIC OF KOREA: 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
Bismuth, metal	metric tons	Korea Zinc Co. Ltd.	Onsan	100
Cadmium	do.	do.	do.	2,000
Cement		Ssangyong Cement Industrial Co. Ltd.	Plants at Tonghae, Kwang Yang, Munhyung, Pukpyong, and Yeongwol	15,040
Do.		Sung Shin Cement Manufacturing Co. Ltd.	Tanyang plant	13,700
Do.		Tong Yang Major Corp.	Plants at Pukpyong and Samchok	11,580
Do.		Lafarge Halla Cement Corp.	Plants at Kwang Yang and Okkye	9,500
Do.		Hyundai Cement Co. Ltd.	Plants at Tanyang and Yongwol	8,600
Do.		Hanil Cement Manufacturing Co.	Plants at Chungbuk and Tanyang	7,200
Do.		Asia Cement Manufacturing Co. Ltd.	Plants at Daegu and Jaechon	4,600
Coal		Korea Coal Corp.	Mines at Changsung, Dogae, and Hwasoon	2,000
Copper, metal, primary		Korea Zinc Co. Ltd.	Onsan	20
Do.		LG-Nikko Copper Inc.	Changhang	60
Do.		do.	Onsan	450
Gas, natural		Korea National Oil Corp.	Ulleung Basin	NA
Gold:				
In concentrate	kilograms	Ivanhoe Mines Ltd.	Haenam, Cholla Province	1,600
Refined	do.	Korea Zinc Co. Ltd.	Onsan	50,000
Do.	do.	LG-Nikko Copper Inc.	do.	60,000
Graphite		Kaerion Graphite Ltd.	Kangwon	NA
Do.		Wolmyong Mining Co.	do.	NA
Indium, metal	do.	Korea Zinc Co. Ltd.	do.	55,000
Lead, metal, primary		do.	do.	200
Nickel, metal		Korea Nickel Corp.	do.	48 ¹
Steel, crude		Pohang Iron and Steel Co. Ltd.	Kwangyang (Gwangyang) Works	15,000
Do.		do.	Pohang Works	13,000
Do.		INI Steel Co.	Incheon Plant	4,800
Do.		do.	Pohang Plant	3,200
Do.		Dongkuk Steel Mill Co. Ltd.	Inchon Works	1,450
Do.		do.	Pohang Works	3,600
Do.		Kia Steel Co. Ltd.	Kunsan	720
Silver:				
In concentrate	kilograms	Ivanhoe Mines Ltd.	Haenam, Cholla Province	3,700
Refined	metric tons	Korea Zinc Co. Ltd.	Onsan	1,000
Do.	do.	LG-Nikko Copper Inc.	do.	330
Talc		Dongyang Talc Mining Co.	Chungju Mine	NA
Zinc, metal, primary		Korea Zinc Co. Ltd.	Onsan	430
Do.		Young Poong Corp.	Sukpo	280

NA Not available.

¹Includes the 32,000-metric-ton-per-year (t/yr) operating plant and the 16,000 t/yr standby old plant.