



# 2005 Minerals Yearbook

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REPUBLIC OF KOREA

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# 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 (North Korea) and Japan in Eastern Asia. The Republic of Korea's total area is about 98,480 square kilometers, which is slightly larger than Indiana. In 2005, the country's population was estimated to be 48.8 million. According to the International Monetary Fund, the Republic of Korea is a newly industrialized country in East Asia. Its gross domestic product (GDP) and the GDP per capita based on purchasing power parity were estimated to be \$994.4 billion and \$20,590, respectively, in 2005 compared with \$934.2 billion and \$19,429, respectively, in 2004 (International Monetary Fund, 2006<sup>1</sup>; U.S. Central Intelligence Agency, 2006<sup>2</sup>).

According to Korea Resources Corporation (Kores), which is a state-owned company under the supervision of the Ministry of Commerce, Industry and Energy, the Republic of Korea has small reserves of antimony, copper, gold, iron ore, lead, molybdenum, silver, tin, tungsten, and zinc. The country's reserves of coal and offshore natural gas were also small. Reserves of such industrial minerals as kaolin, limestone, pyrophyllite, silica stone (quartzite), and talc, however, were larger than other identified minerals in Korea (Korea Resources Corporation, 2004, p. 117).

In 2005, the Republic of Korea was the world's fifth ranked steel producer and one of the world's leading producers of cadmium and slab zinc (World Bureau of Metal Statistics, 2006, p. 34, 129; International Iron and Steel Institute, 2006a<sup>3</sup>). The country was one of the major producers of cement, refined copper, pyrophyllite, talc, and zeolite in the Asia and the Pacific region and was one of the region's significant 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, the Republic of 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 rock; and uranium.

The mining and quarrying sector, which was the smallest sector of the Republic of Korea's economy, produced anthracite coal, ferrous and nonferrous metals, and industrial minerals. According to the Bank of Korea, the output of the mining and quarrying sector accounted for only 0.27% of the country's GDP in 2005. In 2005, the country's GDP in current prices was Won (W) 806,621.9 billion (\$796.3 billion<sup>2</sup>), and in 2000 constant prices was W721,491.4 billion (\$712.2 billion). The economy as

measured by the real GDP in 2000 constant prices grew by 4.0% in 2005 owing mainly to a 7% growth in the manufacturing sector. The mining and quarrying sector had a negative growth rate of 1.5% in 2005 (Bank of Korea, 2006, p. 192).

## Government Policies and Programs

On October 20, 2005, the Republic of Korea played host to the second meeting of the Asia-Pacific Economic Cooperation (APEC) Ministers responsible for mining in Gyeongju (Kyongju) near Pohang, which is about 350 kilometers (km) southeast of Seoul. With the theme "Towards the future of mining," the Ministers from 18 APEC member countries agreed to join forces to fight the major issues facing the mining sector and adopted the Gyeongju Joint Statement through which they agreed to make concerted efforts to enhance market transparency; facilitate mineral exploration, development, and trade; and promote sustainable development of mining. At the meeting, the participants established a common view on the need for the following: active information sharing to ensure market transparency, the removal of trade barriers to facilitate trade, enhanced cooperation between the public and private sectors to promote and facilitate mineral exploration and development, and increased technology cooperation on resources development. At the end of the meeting, the Ministers agreed to establish the APEC Forum on Energy and Mining to promote information exchange between the APEC business sector and the Government, to enhance the database of mineral-related information on member economies, and to promote environmentally friendly resource development and technology cooperation to prevent mining pollution (Korea.net, 2005<sup>4</sup>).

At the meeting of the APEC Forum on Energy and Mining in Gyeongju, the Republic of Korea proposed that APEC members take part in inter-Korea projects to develop mines in North Korea. The Republic of Korea said that cooperation between the Republic of Korea and North Korea could combine the Republic of Korea's capital and technology with the North Korea's rich natural resources, such as gold, iron ore, magnesite, and silver, and recommended that the APEC members take part in joint resources development in North Korea (Agence France Presse, 2005).

According to the Republic of Korea's Ministry of Unification, the Republic of Korea and North Korea reached agreement in July 2005 on a new way of undertaking economic cooperation projects. Under the new agreement, the Republic of Korea and North Korea will combine their assets, such as resources, capital, and technology, to balance the development of their national economies. Under the agreement, the Republic of Korea will provide North Korea with raw materials for the production of daily goods, such as clothes, shoes, and soap, and North Korea will guarantee the Republic of Korea's investment and production of such mineral resources as coal, magnesite, and zinc (Yonhap News, 2005<sup>5</sup>).

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

<sup>2</sup>Values have been converted from Korean Won (W) to U.S. dollars (US\$) at a rate of W1,013.0 = US\$1.00 in 2005.

To promote trade through partnerships and to enable businesses to deal directly across their mutual border, the Republic of Korea and North Korea opened their first joint office of Inter-Korea Economic Cooperation near Kaesong, which is located about 10 km north of the Demilitarized Zone, on October 28, 2005. The new office was staffed by 14 economic officials from the Republic of Korea and 12 from North Korea (Reuters, 2005§).

## Production

The Republic of Korea's mine production of metallic minerals included mainly gold, iron ore, and silver. Mined production of copper, lead, and zinc was very small. The mine production of industrial minerals included barite (no production in 2005), diatomite, feldspar, graphite, kaolin, limestone, mica, pyrophyllite, quartzite, salt, sand, talc, and zeolite. The country also produced anthracite coal and a small amount of natural gas from an offshore gasfield, but no crude petroleum. In 2005, mine production of metallic minerals was very small. The mine production of most industrial minerals except pyrophyllite, talc, and zeolite, declined. In 2005, anthracite coal production decreased by 9.5% to below 3 million metric tons (Mt) for the first time in the post-World War II period.

The Republic of Korea manufactured large quantities of iron and steel and refined petroleum products using entirely imported raw materials, and moderate quantities of nonferrous metals, including bismuth, cadmium, copper, gold, lead, nickel, and zinc, also using mostly imported raw materials. In 2005, metal production of copper, gold, lead, silver, and crude steel increased, and that of pig iron, nickel, and zinc decreased. Manufactured cement, for which mostly domestic raw materials were used, decreased by 10% to 51.4 Mt in 2005 because of reduced domestic demand, and production of refined petroleum products increased by 4% to 922.6 Mbbl in 2005 because of increased overseas demand (exports) (table 1).

## Trade

In 2005, the Republic of Korea's total exports increased by 12% to \$284.4 billion owing mainly to a 13.6% increase in exports of heavy industry products to \$236.2 billion, which included mainly chemicals, electric and electronic machinery, industrial machinery and precision equipment, iron and steel products, passenger cars, and ships and boats. The country's total imports increased by 16% to \$261.2 billion owing mainly to a 24.2% increase in imports of crude materials and fuels to \$141.4 billion; these imports included mainly chemicals, fuels, iron and steel products, light industrial crude material, minerals, and nonferrous metals (Bank of Korea, 2006, p. 114-115).

In minerals trade, the Republic of Korea was a net importer of mineral commodities owing to its large imports of coal, natural gas, and crude petroleum; iron ore and ore and concentrates of copper, lead, and zinc; and ferrous and nonferrous metal products. In 2005, imports of fuels totaled \$66.5 billion, of which \$42.6 billion was crude petroleum. Imports of iron and steel products totaled \$13.3 billion. Imports of minerals, which included iron ore and ore and concentrates of copper, lead, zinc, and other minerals, totaled \$9.4 billion. Imports of nonferrous

metals totaled \$8.6 billion. Exports of crude materials and fuels totaled \$18.7 billion, of which \$15.5 billion was refined petroleum products. Exports of iron and steel products totaled \$22.5 billion (Bank of Korea, 2006, p. 114-116).

## Structure of the Mineral Industry

The Republic of Korea's mining and quarrying sector consisted of small mining industries of coal and ferrous and nonferrous metals and a relatively larger industry of industrial minerals. The mineral-processing sector, which consisted of cement, ferrous and nonferrous metals, and refined petroleum products industries, 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, quarrying, and ferrous and nonferrous metal processing companies were owned and operated by private companies incorporated in the Republic of 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 (Korea Resources Corporation, 2004).

In 2005, LS-Nikko Copper Inc. (formerly LG-Nikko Copper Inc.) completed its expansion of copper refining capacity to 510,000 metric tons per year (t/yr) from 450,000 t/yr in 2004 in Onsan. LS-Nikko Copper also raised its refined-silver production capacity to about 370,000 kilograms per year (kg/yr) in 2005 from 330,000 kg/yr in 2004 in Onsan (Korea Nonferrous Metal Association, 2006).

## Commodity Review

### Metals

**Aluminum.**—Korea relied entirely on imports to meet its requirements for primary aluminum. In 2005, imports of primary aluminum increased by 2.8% to 1,230,643 metric tons (t), of which 985,220 t was primary aluminum ingot, and 245,423 t, primary aluminum alloys. The major suppliers of primary aluminum ingots and alloys were China (41.9%), Russia (24.3%), Australia (16.9%), South Africa (4.9%), the United Arab Emirates (4.1%), and Canada (2.9%). The country also imported about 298,200 t of aluminum and aluminum alloy scrap in 2005 (World Bureau of Metal Statistics, 2006, p. 25).

Domestic demand for primary aluminum increased by 3.8% to 1.2 Mt, of which primary aluminum ingot increased by 5.1% to 978,500 t but primary aluminum alloys decreased by 3.1% to 203,600 t. The major consumers were the manufacturers of aluminum sheet, plate, and coil; aluminum extrusion; aluminum foil; aluminum wheels for automobiles and other casting products; and aluminum metal powders (Joo Ho Kim, Vice Chief, Korea Nonferrous Metal Association, written commun., June 8, 2006). In 2005, Korea exported 42,151 t of aluminum alloys, 16,347 t of aluminum scrap, and 6,449 t of primary aluminum. The major buyers were China and Japan (World Bureau of Metal Statistics, 2006, p. 25).

**Copper.**—Mined production of copper was very small and insignificant compared with the country's requirements for copper ore and concentrate, which amounted to about 1.4 Mt in 2005. The Republic of Korea was the fourth leading producer of refined copper after China, Japan, and India in the Asia and the Pacific region. The country relied on imports of copper ore and concentrate to meet the raw material requirements for its copper smelters, which were located in Changhang and Onsan. In 2005, the Republic of Korea imported about 1.4 Mt of copper ore and concentrates, which was valued at about \$1.73 billion (Ministry of Commerce, Industry and Energy, 2006, p. 310).

In 2005, the Republic of Korea's copper smelters produced about 475,900 t of blister and anode copper (International Copper Study Group, 2006, p. 13). To meet raw material requirements for the Changhang and the Onsan copper smelters and refineries, the country also imported 32,752 t of blister and anode copper and 205,945 t of copper and copper alloy scrap in 2005. The Republic of Korea produced about 520,000 t of refined copper. To meet the domestic refined copper requirements, the country also imported about 428,049 t of refined copper and about 920 t of copper alloys (World Bureau of Metal Statistics, 2006, p. 71).

In January 2005, the joint venture of Chariot Resources Ltd. of Canada and LS-Nikko Copper Inc. (formerly LG-Nikko Copper Inc.) and Korea Resources Corporation of the Republic of Korea formally acquired the Marcona copper project, which is located about 500 km south of Lima from Rio Tinto plc and Shougang Hierro Peru S.A.A. The cost was \$33.5 million plus up to an additional \$10 million if the known mineral resources at the time of mining are larger than the 2004 estimated inferred mineral resources. Under an agreement reached in 2004, the Marcona copper project was 70% owned by Chariot Resources and 15% each by Korea Resources and LS-Nikko Copper (Chariot Resources Ltd., 2005§).

According to the Ministry of Commerce, Industry and Energy, about 200 Mt of new copper resources reportedly were discovered in 2005 at the Marcona copper project, where about 218 Mt of copper resources already had been found. As a result of this new discovery, Chariot Resources, Korea Resources, and LS-Nikko Copper reportedly would start development of the Marcona copper mine; production was planned to begin in the third quarter of 2009. The Ministry indicated that this newly discovered resource would help the Republic of Korea secure a more stable supply of copper in a time of surging copper prices (Metals Place, 2005a§).

Domestic demand for copper cathode decreased by 8.7% to 822,518 t from 901,099 t in 2004. Exports of copper cathode, however, increased sharply by 86.5% to 86,069 t from 46,145 t in 2004, and imports of copper cathode decreased by 14.3% to 390,230 t from 455,190 t in 2004. In the domestic market, most copper cathode was consumed by the manufacturers of brass, cable, plates, sheet, strip, tube, and wire. In 2005, the major manufacturers of copper rod for electric wire, copper and copper alloy sheet, strip, pipe, and tube were Daechang Industrial Co. Ltd., Lee Ku Industrial Co. Ltd., and Poongsan Corp. (Korea Nonferrous Metal Association, 2006, p.1).

**Gold.**—According to Korea Institute of Geoscience and Mineral Resources, mined production of gold increased by 14%

to 265.7 kilograms (kg) from 233.3 kg in 2004 (Choi, Gurl, Senior Researcher, Mineral Economics Team, Korean Institute of Geoscience and Mineral Resources, written commun., June 11, 2006). Mine production of gold was by Ivanhoe Mines Ltd. of Canada at the Silver Hill Mine (Seongsan-Eunsan) in South Cholla Province (Chollanam Do) in the southwest part of the Republic of Korea. The Eunsan prospect is a low-sulphidation epithermal gold-silver prospect estimated to contain inferred resources of 251,800 t of ore at grades of 15 grams per metric ton (g/t) gold and 83.8 g/t silver (Ivanhoe Mines Ltd., 2002§).

CanAustra Resources Inc. of Canada, which acquired a skarn gold prospect in Korea in 2004, announced in March 2005 that it was to conduct an exploration program at the Geodo project, which is located about 10 km from Taebaek City in Kangwon Province. The exploration program included a systematic surface exploration across the known skarn outcrop to delineate zones with known anomalous gold-copper-silver and to identify new zones. A detailed review of the past data followed by drill testing of anomalous zones was to be conducted to determine the width and grade of the identified system, and additional drilling would be done to establish size constraints at the Geodo prospect. According to the company, grab samples from the site have yielded a range of values that suggest the presence of massive to disseminated mineralization over a combined strike of more than 5,000 meters in length and a width of several tens of meters. In addition, high grade zones and veins occur on the property and were possibly enriched in the retrograde phase of mineralization. In August 2005, the company consolidated its share capital on a basis of two old shares for every one new share, and the name of the company was changed to Oriental Minerals Inc. from CanAustra Resources Inc. (ArriveNet.com, 2005§).

According to the Ministry of Commerce, Industry and Energy, Korea produced 42,485 kg of refined gold in 2005, of which 1,853 kg was produced from domestic raw materials, which included scrap. In 2005, domestic demand for refined gold decreased by 13.4% to 78,889 kg; imports of refined gold dropped sharply by 78.9% to 56,742 kg, which was valued at \$804.5 million; exports of refined gold also dropped sharply by 91.4% to 19,935 kg, which was valued at \$262.3 million (Ministry of Commerce, Industry and Energy, 2006, p. 278, 288, 300, 310). The major end users of refined gold were the manufacturers of coins, dental products, electrical communication parts, jewelry, materials for semiconductors, and other uses.

**Iron and Steel.**—The Republic of Korea relied 99.5% on imports to meet its iron ore requirements in 2005. Imports of iron ore totaled 43.46 Mt and were valued at about \$1.93 billion. In 2005, Australia and Brazil were the two dominant suppliers and accounted for 60% and 31%, respectively, of total iron ore imports. Other important suppliers of iron ore were Chile, India, and South Africa. The average import price of iron ore rose by 42.4% to \$44.37 per metric ton from \$31.15 per metric ton in 2004 (Ministry of Commerce, Industry and Energy, 2006, p. 310).

To secure a long-term stable supply of iron ore, Pohang Iron and Steel Co. Ltd. (POSCO) signed a 10-year (from April 2007

to March 2017) purchase contract with two leading Australian iron ore producers—Hamersley Pty Ltd (100% owned by Rio Tinto plc) and Robe River Associates (53% owned by Rio Tinto plc)—on August 25, 2005, for the supply of a total of 128 Mt of iron ore over 10 years (Metals Place, 2005b§; Rio Tinto plc, 2005§). POSCO also invested in Murchison Metals Ltd. of Australia, reportedly acquiring an initial 5.5% equity interest in Murchison in September 2005 for \$3 million, which was equal to 10 million shares and 30 million options at an exercise price of 50 cents per share. POSCO's equity interest can increase to 12% and could eventually reach the target 19.9% when more options are exercised, which would enable POSCO to secure a directorship on Murchison's Board of Directors. Through this equity participation, POSCO reportedly had secured the right to buy up to 10 Mt/yr of iron ore during 25 years from Murchison, which owns the Jack Hill iron ore deposit, which is located east of Meekatharra in Western Australia. The Jack Hill mine was expected to begin iron ore production within the first three months of 2006 (Southeast Asia Iron and Steel Institute, 2005a§).

In June 2005, POSCO signed a memorandum of understanding (MOU) with the government of the State of Orissa, India, to invest a total of \$12 billion to build a 12-Mt/yr-capacity four-blast-furnaces steel plant in Paradip and for an iron ore project in Orissa. The steel plant was slated to begin production by June 2010. Under the agreement, POSCO was to export up to 30% of the iron ore from the iron ore mine that the State of Orissa planned to lease (Southeast Asia Iron and Steel Institute, 2005b§).

In 2005, the iron and steel industry consumed 43.66 Mt of iron ore and produced about 27.3 Mt of pig iron. For crude steel production, according to the Korean Iron and Steel Association, the industry also consumed about 27.6 Mt of ferrous scrap in 2005 compared with 25.9 Mt in 2004. About 7.3 Mt of the ferrous scrap consumed in 2005 was imported. Crude steel production reached a record-high level of 47.8 Mt in 2005, of which about 63.8% was produced by POSCO; 17.6%, by Hyundai INI Steel Co.; 5.7%, by Dongkuk Steel Mill Co.; 2.2%, by Korea Iron and Steel Co.; and the remaining 10.7%, by more than 7 other smaller steel companies (Ministry of Commerce, Industry and Energy, 2006, p. 278; TEX Report, The, 2006b).

In 2005, the Republic of Korea was the world's fifth ranked steel-producing country. The country's crude steel output accounted for about 4.22% of the world's total in 2005. The Republic of Korea's two leading steelmakers—POSCO, which produced about 30.2 Mt, and Hyundai INI Steel Co. Ltd. (or INI Steel Co. Ltd.), which produced about 8.2 Mt, were the world's 4th and 31st ranked steel-producing companies, respectively, in 2005 (International Iron and Steel Institute, 2006b§). According to a report by the Korea Iron and Steel Association, because of a steady expansion in the country's automobile, electronic, and shipbuilding industries in recent years, the per capita steel consumption had reached 969 kg and ranked as the world's highest followed by Taiwan, with 944 kg, and Japan, with 613 kg in 2005 (Digital Chosun, 2006§).

In December 2005, POSCO announced that it would invest about \$157 million to raise the output of high-grade steel products from its Pohang Works. The investment would be made

during the period between January 2006 and October 2007 and would enable the company to expand the output of high-grade steel by 300,000 t/yr. The company also stated that its integrated steel works in the State of Orissa, India, would have a capacity of 4 Mt/yr during the first phase, which was expected to be completed by 2010. In June 2005, POSCO signed an agreement to build a 12 Mt/yr steel plant in Orissa (Southeast Asia Iron and Steel Institute, 2005c§).

According to Korea Iron and Steel Association, the Republic of Korea's domestic demand for steel was estimated to be 46.93 Mt in 2005 and was projected to grow by 1% to 47.4 Mt in 2006 because of the growing demand of the automobile, machinery, and shipbuilding industries. Exports of steel products were projected to increase by 3.1% to 16.5 Mt in 2006, and imports of steel products from China, to decrease by 0.7% to 18.7 Mt in 2006. In past years, imports of steel products had been rising because of low-priced Chinese imports and a backlog of inventories. The association stressed that the Republic of Korea's iron and steel industry was expected to produce more value-added products and to quickly establish an advance sales system in 2006 to prevent a possible increase in Chinese imports (Metals Place, 2005c§).

**Nickel.**—The Republic of Korea relied 100% on imports to meet its nickel requirements. In 2005, the country imported 126,147 t of ferronickel (in gross weight), 41,580 t of refined nickel, 38,631 t of nickel oxide sinter (in gross weight), and 4,520 t of nickel powder and flake. The major suppliers of nickel oxide sinter, which contained 75% to 76% nickel, were Japan (56.1%), Australia (15.6%), Russia (14.0%), and Canada (12.9%). The major suppliers of refined nickel were Australia (47.4%), Russia (28.1%), Canada (10.5%), and Norway (3.2%) (World Bureau of Metal Statistics, 2006, p. 116).

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. Ltd. (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, which contained 97% nickel. The older plant (16,000 t/yr capacity) had not been in operation since 1999. The newer plant (32,000 t/yr capacity) was completed and began operations in October 1999. Both plants used imported nickel oxide sinter as raw material (Korean Nonferrous Metal Association, 2006).

Demand for nickel ingot in the domestic market decreased by 3.7% to 116,260 t. Nickel ingot exports decreased by 41.9% to 1,368 t in 2005. On the supply side, the supply of nickel ingot from domestic sources decreased by 3.5% to 27,130 t; the supply of refined nickel from imports also decreased by 3.5% to 42,562 t and ferronickel from imports, by 5.8% to 47,936 t (in nickel content) (Korea Nonferrous Metal Association, 2006).

**Zinc.**—The Republic of Korea relied on imports for almost all the raw materials requirements for its zinc-refining industry. In 2005, imports of zinc ore and concentrate, in gross weight, increased by 2.4% to 1,283,183 t and were valued at \$584.0 million. The three dominant suppliers were Australia (47.8%), the United States (19.1%), and Peru (13.3%). In 2005, consumption of zinc ore and concentrate decreased by 1.5% to 1,250,366 t (Ministry of Commerce, Industry and Energy, 2006, p. 278, 310).

In 2005, production of zinc slab decreased by 3.6% to 645,000 t, of which 409,400 t was produced by Korea Zinc Co. Ltd. at Onsan, and 235,600 t, by Young Poong Corp. at Sukpo. A worldwide shortage of raw materials in 2005 that limited the supply of zinc ore and concentrate resulted in a decline in Korea's overall production of slab zinc. Korea Zinc remained one of the world's leading producers of slab zinc in 2005, however, and produced about 900,000 t of slab zinc from its plants in Korea and from its wholly owned subsidiaries—Sun Metals Corp. Pty., Ltd. in Australia and Big River Zinc Corp. in the United States (Korean Zinc Co. Ltd., 2006§).

Domestic demand for primary zinc (including unwrought zinc and zinc alloys, zinc bars, and rods, and other primary zinc products) increased by 8.0% to 422,838 t in 2004. In 2005, exports of primary zinc dropped by 15.9% to 315,083 t, and imports of primary zinc decreased by 16.1% to 91,890 t (Korea Nonferrous Metal Association, 2006).

### *Industrial Minerals*

**Cement.**—The Republic of Korea was the world's fifth ranked cement producer after China, India, the United States, and Japan. Portland cement production decreased by 10% to 51.39 Mt from 56.96 Mt in 2004 because of weaker domestic demand that resulted mainly from a further decline in construction of private dwellings and commercial buildings in 2005 (Korea Development Bank, 2006, p. 185). Production of clinker decreased to 43.3 Mt from 48.3 Mt in 2004. Exports of clinker increased sharply to 1.9 Mt from 1.4 Mt in 2004. Exports of cement also increased sharply to 4 Mt from 2.6 Mt in 2004. The country did not import any clinker in 2005 but imported 3.4 Mt of cement in 2005 (Korea Cement Industrial Association, 2006§).

The country'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 (Korea Cement Industrial Association, 2006§). During the period from 2000 through 2003, the country'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; beginning in 2004, however, the per capita cement consumption trended downward from 1,130 kg in 2004 to about 950 kg in 2005 owing to the slowdown in new construction of private dwellings and commercial buildings (Bank of Korea, 2006, p. 150).

### *Mineral Fuels*

**Coal.**—Anthracite coal production decreased by 12.5% in 2005 as the Government continued to restructure the country's coal industry. 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. 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 country's coal requirements mainly for the cement, iron and steel, and utility industries in 2005, the Republic of Korea imported 4.6 Mt of anthracite coal valued at \$429.0 million from China (59.7%), Australia (28.4%), and Vietnam (7.8%); 16.1 Mt of coking coal valued at \$1.8 billion from Australia (57.2%), Canada (23.1%), China (11.3%), the United States (4.9%), and Russia (2.9%); and 56.1 Mt of thermal (steam) coal (of which about 95% was bituminous coal) valued at \$3.1 billion from Australia (36.7%), China (29.0%), Indonesia (27.4%), and Russia (5.4%). Coal imports totaled 76.76 Mt and were valued at \$5.3 billion compared with 78.97 Mt valued at \$4.2 billion in 2004 (TEX Report, The, 2006a, c).

In 2005, demand for coking coal by the country's iron and steel industry was estimated to be about 16.3 Mt, of which 16.1 Mt was imported. The total demand for steam coal (mainly bituminous coal) was estimated to be 74 Mt in 2005, of which about 10 Mt was consumed by the cement industry; 44 Mt, by the utility (electricity-generating) industry; and 20 Mt, by the iron and steel industry (Korea Resources Corporation, 2004, p. 49).

**Natural Gas and Petroleum.**—The Republic of Korea began producing a small amount of offshore natural gas from the Donghae-1 field at the rate of about 2.124 million cubic meters per day in November 2004. In March 2005, the state-owned Korea National Corp. (KNOC) announced that it had discovered new gas reserves estimated to contain about 1.13 billion cubic meters in a gasfield located about 5 km southwest of the Donghae-1 gasfield, which is located 58 km offshore Ulsan along the country's east coast. According to KNOC, the new discovery could support production of 800,000 t of liquefied natural gas (LNG). In 2005, the Republic of Korea was the world's second ranked importer of LNG. The country relied on imports of LNG to meet most of its natural gas requirements (Platts.com, 2005§). In the energy-supply mix, the natural gas share increased to 12.9% in 2004 from just 3.2% in 1990, although Korea's imports of LNG decreased only slightly to 21.9 Mt or 32.8 billion cubic meters in 2005 from 22.2 Mt or 33.2 billion cubic meters in 2004 (Petroleum Economist, 2006).

In 2005, the Republic of Korea consumed about 31.6 billion cubic meters of natural gas, of which about 29.89 billion cubic meters in the form of LNG were imported mainly from, in decreasing order of amount imported, Qatar, Indonesia, Malaysia, and Oman, and a smaller amount from Australia and Brunei (Hydrocarbon Engineering, 2005§; U.S. Energy Information Administration, 2006§). According to Korea Gas Company (KOGAS), under the 7th long-term natural gas supply and demand plan, which was announced by the Ministry of Commerce, Industry and Energy in January 2005, natural gas demand was projected to grow at an annual average rate of 3.93% to reach 31.7 Mt, or 47.4 billion cubic meters, in 2017; city gas (residential gas) demand was projected to grow at an annual average rate of 5.36% to reach 24.9 Mt, or 37.3 billion

cubic meters, in 2017; and power generation demand was projected to grow at an annual average rate of 0.32% to reach 6.8 Mt, or 10.1 billion cubic meters, in 2017 (Korea Gas Company, 2005\$).

To secure additional supply of LNG at lower prices, the state-owned KOGAS signed 20-year sales and purchase contracts worth nearly \$20 billion with Malaysia LNG Tiga (1.5 Mt/yr), Russian Sakhalin Energy (1.5 Mt/yr), and Yemen LNG (1.3 Mt/yr) for supplies of LNG beginning in 2008. KOGAS reportedly also was negotiating an additional 3 to 5 Mt/yr of LNG with potential sellers (Petroleum Economist, 2006).

The Republic of Korea produced no crude petroleum and imported all crude petroleum requirements for its oil refining industry. In 2005, the country imports of crude petroleum increased by 2.1% to 843.2 million barrels (Mbbbl) [an average of 2.31 million barrels per day (Mbbbl/d)], of which 81.8% was from the Middle East region, and 13.3%, from the Asia region. Crude petroleum dependence on the Middle East region in 2005 was the highest since 1981 when the country's oil dependence on the Middle East reached 90.7%. In 2005, the major suppliers of crude petroleum in the Middle East were Saudi Arabia (29.6%) and Kuwait (23.2%). Indonesia was the major supplier of crude petroleum in the Asia region (Petronet, 2005\$).

Demand for crude petroleum in 2005 averaged 2.17 Mbbbl/d compared with 2.14 Mbbbl/d in 2004. In 2005, the Republic of Korea was the ninth ranked crude petroleum consumer and the fifth ranked net crude oil importer in the world (U.S. Energy Information Administration, 2006\$). Because of its total dependence on oil imports, the country had developed a strategic petroleum reserve managed by KNOC. According to the Ministry of Commerce, Industry and Energy, the strategic stockpile normally maintained a 90-day supply of petroleum products at a ratio of 90% crude and 10% refined. Because of concerns over high oil prices, however, the Government planned to raise its strategic oil stockpile to 135 days of supply by 2008. As of February 28, 2005, the strategic oil stockpile totaled 143.738 Mbbbl, which is equivalent to 105 days of supply, of which KONC held 53 days; the remaining 52 days of supply was held by 28 private energy companies, which included 5 refineries, 2 LNG importers, petrochemical companies, and refined products importers (Schlumberger, 2005\$).

In a concerted effort to stabilize the world's oil market in the wake of the Hurricane Katrina disaster, the Government released 2.88 Mbbbl of its strategic petroleum reserve in September 2005. The action was in response to a call by the International Energy Agency for its 26 member countries to release 2 Mbbbl/d for 30 days starting in mid-September. According to the Ministry of Commerce, Industry and Energy, the Republic of Korea released its reserves before September 15. The Republic of Korea's share of 2 Mbbbl/day was 96,000 bbl/d (Korea Times, The, 2005\$).

## Outlook

During the next 2 years, the country's mining sector is expected to hold steady; in the mineral processing sector, however, the iron and steel industry is expected to expand. The country is expected to continue its active involvement in joint-

venture exploration and development of mineral resources, which included coal, copper, lead, zinc, and other nonferrous metals as well as oil and gas in the Eurasian, Latin American, and Southeast Asian countries.

The country's economy as measured by the GDP is projected to grow at a slightly faster pace of 5.5% in 2006 and then to slow down to 4.5% in 2007. The country's inflation was forecasted to be between 2.5% and 3% during the next 2 years (International Monetary Fund, 2006\$).

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TABLE 1  
REPUBLIC OF KOREA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	2001	2002	2003	2004	2005
<b>METALS</b>					
Bismuth, metal	106	69	120	156	231
Cadmium, smelter	1,879	1,825	2,175	2,362	2,582
Copper:					
Mine output, Cu content	--	--	--	7 <sup>f</sup>	16
Metal:					
Smelter, primary and secondary	428,500	430,000	460,000	430,000	475,900
Refined, primary and secondary	476,252 <sup>f</sup>	499,116 <sup>f</sup>	509,970	495,952	518,357
Gold:					
Mine output, Au content kilograms	24	310	166 <sup>f</sup>	233	266
Metal, refined do.	28,595	26,181	40,262	32,449	42,485
Iron and steel:					
Iron ore and concentrate:					
Gross weight thousand metric tons	195	365	289	328 <sup>f</sup>	305
Fe content do.	109	164	125	138 <sup>f</sup>	131
Metal:					
Pig iron do.	25,898	26,570	27,314	27,556	27,309
Ferroalloys:					
Ferromanganese	143,525	137,000	141,000	165,525	124,000
Ferrosilicomanganese	101,877	94,000	90,942	82,917	74,000
Other	4,452	--	--	--	--
Total	249,854	231,000	231,942	248,442	198,000
Steel, crude thousand metric tons	43,852	45,390	46,310	47,521	47,770
Lead:					
Mine output, Pb content	988	28	--	40	57
Metal, smelter	162,075 <sup>f</sup>	179,863 <sup>f</sup>	169,297	173,609	180,784
Nickel	26,429	30,337	31,340	27,200	26,300
Silver:					
Mine output, Ag content kilograms	1,316	6,811	11,704	5,059	3,515
Metal do.	664,533	973,140	947,781	1,172,632	1,218,849
Zinc:					
Mine output, Zn content	5,130 <sup>f</sup>	99	--	14	80
Metal, primary	503,315	605,990 <sup>f</sup>	644,218	668,666	644,828
<b>INDUSTRIAL MINERALS</b>					
Barite	200	78	140	50	--
Cement, hydraulic thousand metric tons	52,046	55,514	59,194	56,955 <sup>f</sup>	51,391
Clays, kaolin do.	2,384 <sup>f</sup>	2,831 <sup>f</sup>	3,009	2,780	2,767
Diatomaceous earth	27,530	20,666	15,636	2,441	2,193
Feldspar	389,361 <sup>f</sup>	415,580 <sup>f</sup>	477,012	541,788	508,644
Graphite, all types	238	94	58	247	39
Lime, slaked lime	298,362	216,536	220,000 <sup>e</sup>	210,000 <sup>e</sup>	205,000 <sup>e</sup>
Mica, all grades	109,339	29,870	33,651 <sup>f</sup>	59,238	36,623
Nitrogen, N content of ammonia	385,200	152,600	118,900	163,400	165,000 <sup>e</sup>
Salt	800,000 <sup>e</sup>	800,000 <sup>e</sup>	800,000 <sup>e</sup>	340,828 <sup>f</sup>	378,887
Soda ash, manufactured <sup>c</sup>	310,000	310,000	310,000	310,000	310,000
Stone, sand and gravel:					
Limestone thousand metric tons	81,949 <sup>f</sup>	86,008 <sup>f</sup>	90,626 <sup>f</sup>	85,549 <sup>f</sup>	79,168
Quartzite do.	2,377	3,041	2,966	2,842	2,868
Sand, including glass sand do.	900	891	480	554	461
Sulfur, byproduct: <sup>c</sup>					
Metallurgy do.	665	737	797	796	800
Petroleum do.	690	687	757	879	900
Total do.	1,355	1,424	1,554	1,675	1,700

See footnotes at end of table.

TABLE 1--Continued  
 REPUBLIC OF KOREA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity	2001	2002	2003	2004	2005	
<b>INDUSTRIAL MINERALS--Continued</b>						
Talc and related materials:						
Pyrophyllite	1,101,825	889,961	912,285	827,895	885,559	
Talc	47,712	37,863	47,911	79,313 <sup>r</sup>	83,471	
Zeolite	145,162	149,335	132,760	142,401	173,435	
<b>MINERAL FUELS AND RELATED MATERIALS</b>						
Carbon black	435,285 <sup>r</sup>	459,985	464,941	473,788	471,716	
Coal, anthracite	thousand metric tons	3,817	3,318	3,297 <sup>r</sup>	3,191 <sup>r</sup>	2,832
Fuel briquets, anthracite briquets	do.	1,100 <sup>e</sup>	1,200 <sup>e</sup>	1,191	1,385	1,400 <sup>e</sup>
Petroleum, refinery products	thousand 42-gallon barrels	930,000 <sup>e</sup>	940,000 <sup>e</sup>	796,000	886,415 <sup>r</sup>	922,647

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

<sup>1</sup>Table includes data available through July 14, 2006.

Sources: Ministry of Commerce, Industry and Energy, Korea Institute of Geoscience and Mineral Resources, Current status of minerals supply and demand, 2005; U.S. Geological Survey Minerals Questionnaire 2000-05.

TABLE 2  
REPUBLIC OF KOREA: STRUCTURE OF THE MINERAL INDUSTRY IN 2005

(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.		LS-Nikko Copper Inc.	Changhang	60
Do.		do.	Onsan	510
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.	LS-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
Petroleum, refinery products	thousand 42-gallon barrels per day	SK Corp.	Ulsan	817
Do.	do.	LG-Caltex Corp.	Yocheon (Yosu)	650
Do.	do.	Hyundai Oil Refinery Co.	Daesan and Incheon	589
Do.	do.	S-Oil Corp.	Onsan	520
Silver:				
In concentrate	kilograms	Ivanhoe Mines Ltd.	Haenam, Cholla Province	3,700
Refined	metric tons	Korea Zinc Co. Ltd.	Onsan	1,000
Do.	do.	LS-Nikko Copper Inc.	do.	370
Steel, crude		Pohang Iron and Steel Co. Ltd.	Kwangyang (Gwangyang) Works	15,000
Do.		do.	Pohang Works	13,000
Do.		Hyundai 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.		Korea Iron and Steel Co. Ltd.	Masan and Changwon Works	1,200
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.