THE MINERAL INDUSTRY OF

JAPAN

By John C. Wu

Japan's reserves of limestone, pyrophyllite, and silica are quite large. Japan has considerable reserves of coal and iodine, but its reserves of natural gas and crude petroleum are very small. As a result of exploration conducted in the past 5 years by the Metal Mining Agency of Japan (MMAJ), a semigovernment agency under the Ministry of International Trade and Industry (MITI), reserves of gold, lead, and zinc had been extended (Metal Mining Agency of Japan, 1998a), but Japan's reserves of ferrous and nonferrous minerals are small. Japan relied on imports to meet more than 95% of its raw material requirements for energy, ferrous metals, and nonferrous metals for its mineral-processing and mineral-related manufacturing sectors. Japan also relied on imports to meet between 10% and 25% of its requirements for refined nonferrous metal products, industrial mineral products, and refined petroleum products. To secure a stable long-term supply of its raw materials requirements, Japan has been actively participating in major exploration and development projects of mineral fuels, ferrous, and nonferrous metals in the Asia and Pacific, North America, South America, and Middle East regions since the early 1990's.

In 1998, Japan was the world's largest producer of cadmium metal, and electrolytic manganese dioxide. It was the world's second largest producer of iodine, pig iron, selenium metal, tellurium metal, and titanium sponge metal. Japan was the world's third largest producer of cement, copper metal, diatomite, limestone, nickel metal, pyrophyllite, crude steel, and zinc metal. Japan was one of the world's top consumers and importers of primary aluminum, cadmium metal, chromite, coal, cobalt metal, copper ore and metal, diamond, ferrochromium, ferronickel, fluorspar, gallium metal, iron ore, ilmenite and rutile, indium metal, industrial salt, lead ore and metal, liquefied natural gas (LNG), lithium metal, manganese ore, nickel ore and metal, crude petroleum, potash, phosphate rock, precious metals, rare earths, silicon, steel, zinc ore and metal, and zircon. Japan was one of the world's major producers and exporters of cement, mineral-related chemicals and fertilizer materials, iodine, electrolytic manganese dioxide, high-purity rare metal products, steel products, and titanium sponge metal and mill products.

According to the Government's Economic Planning Agency (Economic Planning Agency, 1998, p. 125), the output of the mining sector contributed less than 0.2% to Japan's gross domestic product (GDP). However, Japan's mineral-processing sector contributed more than 5% to Japan's GDP and played a major role in supplying the primary materials for the construction and manufacturing sectors of the Japanese economy. Japan's mineral processing sector also played an important role in supplying the ferrous and nonferrous metals, fabricated metal products, and industrial mineral products to the construction and manufacturing industries of China, including Hong Kong, Indonesia, the Republic of Korea, Malaysia, Singapore, Thailand, and Taiwan.

For the first time since the end of World War II, the Japanese economy went into a severe recession in 1998 after 5 years of slow growth in the 1990's. According to the Economic Planning Agency and MITI, Japan's economy, as measured by GDP in 1990 constant yen, contracted 2.8% in 1998. Restructuring in the financial, manufacturing, and other sectors had resulted in a substantial increase in unemployment, which reached a record rate of 4.1% in 1998. The depressed real estate and stock markets had caused the major banks to carry a heavy load of bad loans, with limited funds available for making loans to companies facing financial difficulty. As a result, the number of corporate bankruptcies reached a record high at 18,988 in 1998. Because of the economic down turn, Japan's imports dropped sharply by 10.5% and trade surplus reached a 5-year high at $106.8 billion in 1998. However, inflation, as measured by the Consumer Price Index, remained low at 0.6% in 1998 (Ministry of International Trade and Industry, 1999b, p. 3-5).

Government Policies and Programs

To continue its longstanding national policy of securing a stable supply of raw material requirements for its national security and growing economy, MITI released the outlines of a new mining policy. The policy outlines, as recommended by the Mines Committee of the Mining Industry Council, included MMAJ (1) to assist overseas exploration, (2) to promote grassroots exploration and regional diversification, (3) to provide fiscal incentives to support overseas exploration, and (4) to promote recycling of nonferrous metals (Nikkan Sangyo Shimbun, 1998a).

To implement this new mining policy, the Government, through MMAJ, is to assist Japan's nonferrous metals mining industry in overseas exploration by providing basic mineral resources information, such as geologic data, mining law and regulations, data and analysis of satellite images, and the environment of overseas mineral development in every country. The Government, through MMAJ's overseas geologic surveys, is to promote high-risk grassroots exploration in various regions. The Government is to provide fiscal incentives, such as depletion allowances (tax credit) and investment loss reserve fund for overseas mineral development projects. The Government is to promote the Japanese nonferrous metals

industry to actively participate in recycling of metals from waste products, such as waste household electrical appliance and automobiles, by developing new technology and equipment for recycling and new method of waste disposal (Goto, 1999).

The MITI's ongoing research and development program to develop new technology for recycling nonferrous metals was started in 1993. The program had been focused on development of advanced smelting and refining technology and recycling technology for aluminum, copper, rare metals, and zinc. To find the most efficient recycling technology for the nonferrous metals scrap, MITI planned to spend about $29 million in the next 4 years to test newly developed technologies, such as purification of scrap solution, removal of silicon, iron and zinc using vacuum distillation and dross ash. For fiscal year 1999, MITI planned to spend about $12 million for the recycling technology testing project (Nikkan Sangyo Shimbun, 1998b).

In domestic exploration, the Government, through MMAJ, conducted detailed geologic surveys in the Hokkaido-Hokubu, the Hida, the Kyushu-Chubu, and the Hokusatsu areas in 1997. After drill holes, geophysical surveys, and tunneling, mineralization of gold in the Hokusatsu area and mineralization of silver and zinc in the Hida area had been confirmed. In July 1998, MMAJ announced that a potential zinc deposit had been located in the Sakonishi area, east of the existing Kamioka Mine in Gifu Prefecture. Kamioka Mining and Smelting Co. Ltd., the operating company of the Kamioka Mine, was expected to undertake further exploration to estimate ore reserves in the areas with strong support of Mitsui Mining and Smelting Co. Ltd., the parent company of Kamioka Mining and Smelting. MMAJ planned to continue its exploration in the southern Takahatayama area north of the Sakonishi (Tekko Shimbun, 1998a).

As part of the Japanese Government Official Development Assistance Program, the Government continued to provide financial and technical assistance, through MMAJ and the Japan International Cooperation Agency (JICA), to mineral-rich developing and newly developed countries for technical cooperation and joint mineral exploration in 1998. On July 7, MMAJ and JICA reached an agreement with the Brazilian Department of Mine and Power for a 3-year technical cooperation for copper and gold exploration in the Alta Floresta region. The exploration area, north of the Mato Grosso Province, is about 1,200 kilometers (km) north of Brasilia, the National Capital. A survey team of MMAJ arrived in the area in September and began collecting and analyzing existing data during the first year of cooperation, followed by geochemical and geophysical surveys and drilling program (Tekko Shimbun, 1998b).

On July 24, MMAJ and JICA reached an agreement with the Ministry of Petroleum and Mineral Resources of the Kingdom of Saudi Arabia for a 3-year technical cooperation for copper and gold exploration in the Umm al-Damar area of western Saudi Arabia. The exploration in the Umm al-Damar covers a 100-square-kilometer (km^2) area, about 300 km northeast of the city of Jeddah in the western part of Saudi Arabia. The survey team dispatched by MMAJ arrived in October 1998. Under the agreement, MMAJ would collect and analyze the existing geologic data, followed by geologic surveys and a drilling program during 1998-2001 (Nikkan Kogyo Shimbun, 1998a).

To maintain economic stability in the event of an emergency or long-term supply disruption, the Government (through MMAJ) and the private sector (through the Japan Rare Metal Association) had been building their strategic stockpile of chromium, cobalt, manganese, molybdenum, nickel, tungsten, and vanadium since 1983. According to MMAJ, the total amount of national stockpile was equivalent to 32.8 days of consumption or about 78.1% of the stockpile target in 1997 (Metal Mining Agency of Japan, 1998a). The 60-day stockpile target constituted 42 days of national stockpile and 18 days of private stockpile.

MMAJ released by auction a total of 96.9 metric tons (t) of vanadium (in ferrovanadium) from its national stockpile to steel producers and other end users twice in 1998. MMAJ was authorized by the Government to release the national stockpile, in the event of supply disruption caused by strike, shipping accident, and war or prolonged high market price. The monthly average price of vanadium rose sharply to more than double (1.5 times) the normal average price of vanadium during the month of April and again in June 1998. MMAJ decided to release the stockpile because the market condition in April and June met the legal requirements (Metal Mining Agency of Japan, 1999).

Environmental Issues

To save the costs of preventing mine pollution caused by the abandoned mines, MITI, through MMAJ, had been conducting research on how to save energy cost at various mine drainage treatment plants located in different parts of the country. The 7-year program was started in 1994 and two energy-saving technologies had been developed by 1997. The energy-saving technologies included the use of high-density neutralized sludge and a fast-reacting neutralizer at the mine drainage treatment plant. According to MMAJ, use of high-density neutralized sludge had resulted in energy saving of up to 60% at the Ashio copper mine in Tochigi Prefecture and 80% at the Oei manganese mine in Hokkaido Prefecture. Energy savings of up to 90% had been achieved at the Tsuchihata copper mine in Iwate Prefecture, when the fast-reacting neutralizer was used. In 1998, MMAJ's research focused on development of a new energy-saving thickener (Tekko Shimbun, 1998c).

In the private sector, Mitsubishi Materials Corp. had developed the recycling technologies to produce a solid fuel from sewage sludge, household garbage, and waste appliances. The solid fuel made from sewage sludge has been used as one of the energy sources at a cement plant in Karita, Fukuoka Prefecture. Recycling technology to remove copper and aluminum from resin plates of air conditioners, refrigerators, television, and washer for making fuel had been developed by Mitsubishi Materials but the technology was still under experiment (Nikkan Kogyo Shimbun, 1998b).

In compliance with the Government's new recycling policy to eliminate the use of lead in home and office appliances, such as cellular phone, computer, and television, Hitachi Ltd., Toshiba Corp., and Matsushita Electric Industries Co. Ltd. separately

had developed lead free solder that uses either tin and silver or tin and zinc. In March, Hitachi announced that it would reduce the use of lead solder up to 50% by 1999, with reduction to begin in 1998. Toshiba planned to use its tin-zinc solder to make its electronic products, especially in electronic parts for the cellular phone beginning in 2000. Matsushita Electric Industries planned to use tin-silver solder to make parts for its electronic products beginning in 1998 (Nikkei Shimbun, 1998).

Production

Mine production of most nonferrous metals, industrial minerals, and construction-related materials was at a lower level than that of 1997 owing to a weaker domestic demand and lower raw materials prices. Coal mine output decreased to another record low and the output of crude petroleum decreased for the first time in 5 years, while the output of natural gas increased slightly in 1998.

In the mineral-processing sector, metal production of nonferrous metals, except cobalt, indium, lead, palladium, selenium, silver, and zinc, decreased because of reduced domestic demand. Production of iron and steel and cement decreased considerably because of lower domestic and overseas demand owing to the downturn in the regional economy. For the same reason, production of most refined petroleum products except gasoline declined for the first time since 1995. (*See table 1.*)

Trade

Japan was a major world importer of mineral fuels, nonfuel minerals, and nonferrous metals and was a major world exporter of processed minerals and metal products, mineral-related chemicals, and fertilizer materials. It was, however, a net importer of minerals with a mineral trade deficit of $43.3 billion in 1998 because of its large import bill for mineral fuels.

According to Government trade statistics, imports of minerals totaled $74.3 billion and accounted for 26.6% of the total imports, which were valued at $279.8 billion in 1998 (Ministry of Finance, 1998, import portion p. 9-41). Of the total minerals imports, $43.2 billion was for mineral fuels, including coal, LNG, crude and partially refined petroleum, refined petroleum products, and other mineral fuels; $6.1 billion for ores and concentrates of ferrous and nonferrous minerals, slag, scrap, and ash of iron and steel, other metals, and metal compounds; and $1.4 billion for industrial minerals, including salt, sulfur, earths and stone, plastering materials, lime, and cement. Imports of processed minerals, mineral-related chemicals, and metals totaled $23.6 billion, of which $3.5 billion was for mineral-related chemicals and fertilizers; $12.4 billion for products of iron and steel, nonferrous metals, rare metals and other base metals; $5.3 billion for precious and semiprecious stones and precious metals; and $2.4 billion for products of asbestos, cement, ceramics, glass, mica, and stone.

Japan's export earnings from minerals, mineral-related chemicals, and processed minerals products totaled $31.1 billion and accounted for 8% of Japan's total exports, which were valued at $386.6 billion in 1998 (Ministry of Finance, 1998, export portion, p. 9-41). Exports of iron and steel products, nonferrous metals, rare metals, and other base metals totaled $22.3 billion. Exports of processed mineral products of asbestos, cement, ceramics, glass, mica, and stone amounted to $3.9 billion. Exports of salt, sulfur, earths and stone, plastering materials, lime, cement, mineral fuels, and nonferrous minerals were $1.6 billion. Exports of mineral-related chemicals and fertilizer were $1.6 billion. Exports of precious and semiprecious stones and precious metals were $1.6 billion. (*See table 4.*)

Structure of the Mineral Industry

In terms of the number of establishments, employment, and gross value of production, Japan's mineral industry consisted of a small nonferrous metal mining sector, a small coal mining sector, a large industrial minerals mining sector, and a large ferrous metals, nonferrous metals, and industrial minerals processing sector. Mining and mineral-processing businesses were owned and operated by private companies incorporated in Japan. To be more competitive in the world market, the minerals industry continued its restructuring in 1998.

In the mining sector, coal was produced from two major mines and several small-scale mines in Honshu (main island), Hokkaido, and Kyushu with a total capacity of about 4.2 million metric tons per year (Mt/yr) and a workforce of 1,970. The number of operating nonferrous metal mines decreased further to 14 from 17 in 1997, but employment increased to 1,151 from 1,149 in 1997. The number of operating industrial minerals mines declined to 539 from 543 in 1997, and employment declined to 11,709 from 11,810 in 1997 (Ministry of International Trade and Industry, 1999a, p. 7). According to Government statistics, the number of persons employed by the mining industry remained unchanged at 60,000, accounting for 0.09% of the Japanese labor force of 67.9 million (Ministry of International Trade and Industry, 1999b, p. 247).

In the mineral processing sector, the steel industry continued to cut its employment to 214,190 from 226,361 in 1997. The industry's production capacity of pig iron decreased slightly to 95.2 Mt/yr from 95.5 Mt/yr in 1997, while the production capacity of crude steel remained unchanged at 149.8 Mt/yr in 1998. Despite the economic downturn and a weaker domestic and overseas demand in 1998, Japan's copper refining capacity had been expanded at Sumitomo Metal Mining Co. Ltd.'s Besshi facilities and was expanding at Nippon Mining and Metals Co. Ltd.'s Saganoseki and Hitachi facilities. Japan's lead refining capacity had been expanded at Toho Zinc Co. Ltd.'s Chigirishima facilities. The zinc refining capacity had been expanded at Akita Smelting Co. Ltd.'s Iijima facilities and was expanding capacity at Hachinohei Smelting Co. Ltd.'s Hachinohei facilities. (*See table 2.*) The copper smelting and refining industry's workforce decreased to 3,822 from 3,872 in 1997. The workforce in the lead and zinc smelting and refining industries was 822 and 1,389, respectively, in 1998.

Commodity Review

Metals

Aluminum.—Production of primary aluminum remained small and insignificant. Virtually all of Japan's annual requirement for primary aluminum was met by imports. According to Government trade statistics, Japan imported 2,551,804 t of primary aluminum, of which 131,277 t was high-purity (99.9% or more) primary aluminum, 1,728,544 t was regular-grade (less than 99.9%) primary aluminum, and 691,983 t was primary aluminum alloys (Ministry of Finance, 1998, import portion, p. 626). The import bill for primary aluminum in 1998 amounted to $3.8 billion. Despite Japan's wide diversification of its overseas sources of primary aluminum in about 50 countries, Australia, Brazil, Canada, China, Indonesia, New Zealand, Russia, South Africa, the United States, and Venezuela accounted for more than 80% of the total primary aluminum imports in 1998. Of the 15 suppliers of high-purity primary aluminum, the top 5 were New Zealand, 33%; the United Arab Emirates, 27%; Indonesia, 18%; the United States, 9%; and Russia, 8%. Of the 28 suppliers of regular-grade primary aluminum, the top 10 were Australia, 31%; Russia, 15%; Brazil, 13%; New Zealand and South Africa, 8% each; Venezuela, 7%; Bahrain and Indonesia, 4% each; the United States and China, 3% each. Of the 47 suppliers of primary aluminum alloys, the top 10 were Canada, 17%; Russia, 15%; Taiwan, 13%; Australia, 10%; China and the United Arab Emirates, 9% each; New Zealand, 5%; the United States, 4%; Bahrain and Ukraine, 3% each. Under an agreement with the World Trade Organization (WTO), the tariff on primary aluminum was 0.2% in 1998 and will be free in 1999 (Japan Tariff Association, 1998, p. 797-98).

About 40% of primary aluminum imports was from nine overseas aluminum smelter projects in which the Japanese aluminum and major trading companies held major or substantial portion of equity. These overseas aluminum smelter projects were the Portland and Boyne smelters in Australia, the Aluminio Brasileiro smelter in Brazil, the Alpac and Alouette smelters in Canada, the Asahan smelter in Indonesia, the New Zealand Aluminum smelter in New Zealand, the Alumax smelters in the States of Maryland and Washington in the United States, and Venalum smelter in Venezuela (Sato, 1997).

In May, Mitsubishi Corp., a major trading company, announced that it will acquire 25% interest in Mozambique Aluminum Co. in Mozambique. The aluminum smelter project will be capitalized at $516 million, of which 47% will be provided by Billiton Plc of the United Kingdom, 25% by Mitsubishi Corp., 24% by Industrial Development Corp. of South Africa, and 4% by the Government of Mozambique. The 250,000-Mt/yr aluminum smelter, which will cost $1.3 billion, was scheduled to begin operations in 2001. Mitsubishi Corp. will take about 60,000 metric tons per year (t/yr) for export to Japan, Southeast Asia, and the United States (Nikkei Weekly, 1998).

According to Government minerals and nonferrous metals statistics, domestic demand for primary aluminum dropped 15.4% in 1998 to 1,995,571 t, of which 1,712,161 t was for aluminum rolling; 84,326 t for aluminum casting; 60,936 t for wire and cable; 54,943 t for secondary smelting; 26,309 t for steel deoxidization; 23,083 t for aluminum diecasting; and 33,813 t for other uses. The yearend stocks of primary aluminum decreased to 418,689 t from 438,462 t in 1997; 293,981 t was held by dealers; 109,349 t, consumers; and 15,359 t, the single primary aluminum producer (Ministry of International Trade and Industry, 1998d, p. 160). According to Government trade statistics, Japan's exports of primary aluminum, including aluminum alloys, totaled 7,153 t and were valued at $15.1 million. The major buyers were China, including Hong Kong, 39%; the Republic of Korea, 24%; the Philippines, 11%; Indonesia, 6%; and Germany, 4% (Ministry of Finance, 1998, export portion, p. 593-594).

Arsenic.—Production of high-purity arsenic was by Furukawa Co. Ltd. at its Iwaki Works in Iwaki, Fukushima Prefecture and Sumitomo Metal Mining at its Niihama facilities in Ehime Prefecture. According to Rare Metal News, Furukawa was the major producer of high-purity arsenic with a production capacity of 9 metric tons per month and produced 7 metric tons per month in 1998 (Rare Metal News, 1999b). Sumitomo Metal Mining had suspended production of high-purity arsenic at the end of December 1998 (Rare Metal News, 1999a). According to a report by the Sangyo Shimbun, Sumitomo Metal Mining would suspend production of high-purity arsenic at its Niihama copper refinery by the end of 1998 because of the higher environmental protection standard and regulations. The Niihama plant, with an annual capacity of 12 t, was operating at about 50% of its capacity in 1998 (Metal Bulletin, 1998c).

In late 1997, Furukawa announced that it would expand the production capacity of its Iwaki Works by 30% to 78 t/yr. The $3-million expansion program, which was scheduled for completion by the summer of 1998, involved installation of a diesel power generator for the heating facilities and a distillation column for impurity removal. Furukawa imported raw materials—arsenic trioxide mainly from China. At the Iwaki Works, impurity was first removed from arsenic trioxide then circulate the compound through hydrogen to produce the crystal with a purity of more than 99.9999% arsenic (Nikkei Sangyo Shimbun, 1997).

Chromium.—Japan relied on imports to meet all its chromium requirements for its iron and steel industry. According to Government trade statistics, Japan's imports of chromium ore and concentrate, including metallurgical and refractory grades, decreased by 28% to 416,665 t and were valued at $41.5 million in 1998 (Ministry of Finance, 1998, import portion, p. 161). The major suppliers were South Africa, 58%; India, 20%; Iran, 8%; Madagascar, 6%; and Turkey, 4%. Consumption of chromite by the iron and steel industry decreased by 21% to 378,246 t, of which 291,322 t was consumed by the ferroalloy industry and 86,924 t by others.

Because of weak demand and reduced production capacity, production of ferrochromium decreased by 23% to 142,931 t in 1998. Imports of ferrochromium also decreased by 23% to 628,260 t. The top five suppliers of ferrochromium were South

Africa, 65%; India, 10%; Zimbabwe, 8%; Kazakhstan, 7%; and China, 6%. Imports of ferrochromium were valued at $358 million (Ministry of Finance, 1998, import portion, p. 589). Consumption of ferrochromium for steelmaking dropped by 17.3% to 749,765 t, of which 708,735 t was high-carbon ferrochromium and 41,030 t was low-carbon ferrochromium. Exports of ferrochromium were 700 t, of which 71% went to the United States, 15% to Thailand, and 5% to the Republic of Korea. Exports of ferrochromium were valued at $1.7 million (Ministry of Finance, 1998, export portion, p. 507).

Production of high-purity chromium metal was by Nippon Denko Co. Ltd. at its Oshima plant in Toyama Prefecture with a capacity of 1,000 t/yr. Japan Metals and Chemical Co. Ltd. (JMC), which had suspended operations of its Oguni plant in Yamagata Prefecture in 1996, resumed operation in January 1998. The Oguni plant has a capacity of 100 t/yr (Roskill's Letter from Japan, 1998). Imports of chromium metal totaled 2,365 t. France and the United States each supplied 27%; China, 23%; the United Kingdom, 10%; and Russia, 8%. Imports of chromium metal were valued at $23.6 million in 1998 (Ministry of Finance, 1998, import portion, p. 634-635).

Cobalt.—Japan relied on imports to meet the raw material requirements for its cobalt metal production. Domestic metal production of cobalt using imported raw materials (cobalt matte) was by Sumitomo Metal Mining at its Niihama cobalt refinery in Ehime Prefecture with a rated capacity of 500 t/yr. The refining facilities produced cobalt metal and cobalt salts, such as cobalt oxide and cobalt sulfate. To meet the overall demand for cobalt, Japan depended heavily on imports of cobalt ingot, cobalt powder, flakes, cobalt salts, and other cobalt chemicals.

According to Government trade statistics, imports of cobalt mattes and other intermediate products of cobalt, cobalt ingot, waste and scrap, powder, and flakes totaled 6,787 t. The major suppliers were Australia, 18%; Canada, 17%; the Democratic Republic of the Congo, Norway, and, Zambia, 14% each; Belgium, 8%; and Finland, 6%. Japan also imported 1,512 t of cobalt oxides and 240 t of hydroxides. The major supplier of cobalt oxides was Belgium, accounting for 94%; and the top two suppliers of cobalt hydroxides were Finland and Belgium, accounting for 58% and 36%, respectively. Import bills for cobalt metals and chemicals were valued at $293 million and $73 million, respectively, in 1998 (Ministry of Finance, 1998, import portion, p. 633-634).

According to Government minerals and nonferrous metals statistics, domestic demand for cobalt metal decreased by 16.9% to 2,376 t, of which 27.9% was for manufacturing of specialty steel; 17.9%, pipe, plate, rod, and wire; 14.1%, ultra-hard tool steel (cemented carbides); 13.8%, magnetic materials; 8.3%, catalysts; and 17.9%, other end uses. The decreased demand for cobalt was most significant in the polyester catalyst sector, which registered a 37% drop in 1998 (Ministry of International Trade and Industry, 1998d, p. 180). Additionally, consumption of cobalt for the manufacturing of batteries was estimated at about 2,800 t in 1998.

Copper, Lead, and Zinc.—Mine production of copper, lead, and zinc was by the Kamioka Mining and Smelting Co. Ltd. at the Kamioka Mine in Gifu Prefecture and the Toyoha Mining Co. Ltd. at the Toyoha Mine in Hokkaido Prefecture. Copper has been produced as a byproduct of lead and zinc mining operations at the Kamioka and the Toyota Mines since 1987. Mine output of copper and lead increased slightly, while the mine output of zinc reached a new low in 1998. According to Government minerals and nonferrous metals statistics, the quantity of domestic mine output of copper, lead, and zinc was equivalent to 0.08%, 2.72%, and 11.13%, respectively, of Japan's raw material requirements for its nonferrous metals smelting and refining industry in 1998 (Ministry of International Trade and Industry, 1998d, p. 31- 33, p. 53-55).

To secure a steady supply of most raw material requirements for Japan's nonferrous metals smelting and refining industry, the major Japanese nonferrous metals mining and trading companies have been actively seeking a long-term supply of nonferrous minerals and metals from overseas through direct investment (equity participation) in joint exploration and development of major nonferrous metals mining projects with foreign partners since the early 1990's. (*See table 5.*)

In addition to the nine major overseas nonferrous metals mine projects listed in table 5, Dowa Mining Co. Ltd. was involved in exploration and development of a koroko-type ore deposit at the Tizapa in the Arceris district of Mexico in early 1990's. The deposit was first discovered by MMAJ in 1987, followed by a series of detailed exploration and feasibility studies by MMAJ and Dowa Mining. The development of an underground mine began in May 1992. The mining and milling operations started in May 1994. The total development cost of the project was $38.2 million, of which Japanese companies provided $35.1 million. The project was owned 39% by Dowa Mining, 10% by Sumitomo Corp., and 51% by Industrias Penoles S.A. de C.V. of Mexico. Ore reserves at the Tizapa Mine were estimated 4.1 million metric tons (Mt) with an average ore grade of 0.7% copper, 1.64% lead, 7.9% zinc, plus 314 grams per ton (g/t) of silver and 2.0 g/t of gold. The mine has a capacity of 360,000 t/yr of crude ore. The Tizapa Mine shipped about 21,200 t of zinc and 11.5 kilograms (kg) of silver in concentrate to Japan annually (Ministry of International Trade and Industry, 1999a, p. 216).

Following further exploration and extension of ore reserves in the area, an expansion program at the Tizapa Mine was started by Dowa Mining in early 1997 and completed in early 1998. The expansion program involved boosting the mining capacity to 480,000 t/yr from 360,000 t/yr and raise the mill capacity to produce about 22,900 t/yr of lead concentrate, 51,000 t/yr of zinc concentrate, and 4,300 t/yr of copper concentrate. Most output was shipped to Dowa Mining affiliated nonferrous metals smelting and refining facilities at Iijima and Kosaka in Akita Prefecture (Nippon Kogyo Shimbun, 1998).

Japan remained the world's largest importer of copper ore and concentrate and one of the world's major importers of lead and zinc ores and concentrates. According to Government trade statistics, Japan's imports of copper concentrate increased by 3.6% to 3,973,934 t and were valued at $1,876.3 million in 1998 (Ministry of Finance, 1998, import portion, p. 161). The

top six suppliers of copper concentrate were Chile, 34.5%; Indonesia, 21.1%; Canada, 14.6%; Australia, 10.1%; Papua New Guinea, 6.3%; and Argentina, 5.4%. Japan's imports of lead and zinc concentrates were 182,810 t and 941,644 t and were valued at $59.3 million and $230.5 million, respectively, in 1998. The major suppliers of lead concentrate were Australia, 39.6%; the United States, 18.8%; Peru, 13.1%; and China, 8.2%. The major suppliers of zinc concentrate were Australia, 50.2%; Peru, 13.8%; the United States, 12.8%; and Canada, 7.7%.

Metal production of copper and lead decreased slightly, but metal production of zinc increased slightly in 1998, because of a weaker demand for copper, lead, and zinc in the domestic market. Increased exports of copper, lead, and zinc had helped the nonferrous metals smelting and refining industry to maintain high capacity utilization rates of 97.9% for copper, 83.1% for lead, and 87.3% for zinc in 1998.

In anticipation of the growing demand for nonferrous metals in the Asian markets and to become more competitive in the world market, Japan's major nonferrous metals companies continued to expand and renovate their smelting and refining facilities in 1998. Nippon Mining and Metals, which was expanding the copper smelting capacity at its Saganoseki plant to 420,000 t/yr from 350,000 t/yr, had revised the capacity expansion to 450,000 t/yr from the original 420,000 t/yr in September 1998 (Japan Metal Review, 1998b). Nippon Mining and Metals was to complete expansion of the refining capacity to 240,000 t/yr from 220,000 t/yr by installing 80 new cells at its Saganoseki plant in Oita Prefecture and 72 new cells at its Hitachi plant in Ibaraki Prefecture by September 1998 (Metallurgical & Mineral Processing Development, 1998). Sumitomo Metal Mining had completed capacity expansion of its Toyo copper smelter to 300,000 t/yr from 276,000 t/yr, and the copper refinery capacity at its Besshi complex to 234,000 t/yr from 210,000 t/yr in 1998. Kosaka Smelting and Refining Co. Ltd., a wholly owned subsidiary of Dowa Mining, planned to raise the refining capacity to 120,000 t/yr from 72,000 t/yr at its Kosaka Plant in Akita Prefecture with the actual construction to begin in 2000 (Japan Metal Review, 1998a). In 1998, copper smelting capacity at the Onahama complex in Fukushima Prefecture had been raised by Onahama Smelting and Refining Co. Ltd., to 258,000 t/yr from 247,200 t/yr.

Hachinohei Smelting Co. Ltd., a joint venture of Mitsui Mining and Smelting, Dowa Mining, Nippon Mining and Metals, Mitsubishi Materials, and two other companies, started an expansion project to raise its zinc-refining capacity to 112,000 t/yr from 108,000 t/yr at the Hachinohei complex in Aomori Prefecture in July and completed expansion in August 1998 (Platt's Metals Week, 1998). Akita Smelting, a joint venture of Dowa Mining, Nippon Mining and Metals, Sumitomo Metal Mining, and Mitsubishi Materials, completed expansion of its zinc-refining capacity to 186,000 t/yr from 156,000 t/yr at the Iijima complex in Akita Prefecture in October 1997. In November, Dowa Mining, the major shareholder of Akita Smelting, announced that another expansion program would be carried out to raise the zinc refining capacity by 10,000 t/yr to 196,000 t/yr by September 1999 (Metal Bulletin, 1998a).

In major overseas copper smelters projects, Furukawa and its partners, Itochu Corp., Nittetsu Mining Co. Ltd., and Nissho Iwai Corp. were expanding and renovating the Port Kembla copper smelter-refinery complex, which they acquired from Southern Copper Ltd. in 1996. Construction was started in September 1997, and operation of the 120,000-t/yr smelter-refinery complex was expected to start in June 1999. The copper smelter-refinery complex is owned by Furukawa, 52.5%; Nittetsu Mining, 20%; Nissho Iwai, 17.5%; and Itochu, 10%. (See table 5.)

Mitsubishi Materials and its partners in a joint venture with P.T. Freeport Indonesia started construction of the $738 million copper smelting and refining complex at Gresik, East Java, Indonesia in July 1996. The 200,000-t/yr copper smelter had been completed and the test operations started in December 1998. The first year's copper production is expected to be about 150,000 t in 1999 and 180,000 t in 2000, then reach full capacity in 2001 (Mining Journal, 1999).

According to Government trade statistics, imports of refined copper decreased by 22.7% to 273,298 t and were valued at about $487.3 million (Ministry of Finance, 1998, import portion, p. 620, p. 630-631). The major suppliers of refined copper were Chile, 49.2%; Zambia, 13.8%; Peru, 12.7%; the Philippines, 9.0%; and the United States, 6.6%. Imports of refined lead decreased by 16.1% to 27,364 t and were valued at about $18.9 million. Imports of slab zinc decreased by 35.8% to 113,368 t and were valued at about $131.3 million. The major suppliers of refined lead were China, 76.3%; Peru, 10.3%; Australia, 4.6%; the Republic of Korea, 3.7%; and the United Kingdom, 3.3%. The major suppliers of zinc slab were China, 30.3%; the Republic of Korea, 18.7%; Kazakhstan, 14.7%; Thailand, 12.1%; Canada, 7.9%; Peru, 6.3%; and North Korea and Spain, 2% each.

According to Government minerals and nonferrous metals statistics, domestic consumption of refined copper decreased slightly to 1,360,759 t from 1,508,152 t in 1997 (Ministry of International Trade and Industry, 1998d, p. 142). Demand for refined copper in 1998, by sector, was 65.6% for wire and cable, 33.1% for brass mill, and 1.3% for copper alloys, casting, and others. Exports of refined copper increased by 85.7% to 292,918 t and were valued at about $500.4 million. The major buyers of refined copper were Taiwan, 50.5%; China, including Hong Kong, 27.5%; the Republic of Korea, 5.4%; Malaysia, 4.2%; Indonesia, 3.7%; Thailand, 3.2%; and the United States, 2.4%. The overall stocks of refined copper increased by 2.8% to 150,106 at the end of December. In 1998, Japan also exported 34,449 t of copper anodes, mainly to the Republic of Korea accounting for 98% of total and were valued at $96 million.

Domestic consumption of refined lead decreased to 252,336 t from 272,227 t in 1997; of which 72.4% was for storage batteries; 12.8%, for inorganic chemicals; and the remaining 14.8%, for solders and other uses. Exports of primary lead rose sharply to 1,056 t from 62 t in 1997; of which 56.8% went to Indonesia, 16.5% to Burma, and 11.2% to the Philippines. The overall stocks of primary lead rose by 16.6% to 32,239 t at the end of December. Domestic consumption of zinc slab decreased to 550,442 t from 635,437 t in 1997. Demand for

slab zinc in 1998, by sector, was 50.3% for sheet galvanizing; 16.1%, for other plating; 13.4%, for brass mill products; 9.4%, for zinc die-cast products; 5.6%, for inorganic chemicals; and 5.2%, for other uses. Exports of zinc slab increased by 98%, to 46,682 t. The major buyers were Taiwan, 40.4%; the Philippines, 29.2%; and the Unites States, 8.6%. The overall stocks of zinc slab increased by 14.7% to 119,460 t at the end of December.

Gold and Silver.—Mine production of gold and silver increased in 1998. Gold mine production was mainly by Sumitomo Metal Mining from the Hishikari Mine, Kagoshima Prefecture, Kyushu. The company, working on its Honko (main mine), Sanjin, and Yamada deposits in the Hishikari mining area, produced about 8 t/yr of gold. Other small-scale productive gold and silver mines were the Kouryu Mine in the southwestern part of Hokkaido Prefecture, the Kasuga Mine, Akesi Mine, and Iwato Mine in Kagoshima Prefecture. The Kamioka Mine in Gifu Prefecture and the Toyoha Mine in Hokkaido Prefecture produced substantial amount of silver as a byproduct of their lead and zinc operations.

Overseas, Sumitomo Metal Mining and Marubeni Corp. signed a letter of intent with Oxiana Resources NL of Australia to establish a joint venture to explore for precious and base metals in the Sierra Madre and Conwap Carabello areas in northern Luzon, the Philippines. To own a 30% interest in the joint-venture project, Sumitomo Metal Mining and Marubeni Corp. was to spend about $3.2 million for exploration in the next 5 years and Dalton Pacific Resources NL, a wholly owned subsidiary of Oxiana Resources NL, had been exploring for precious metals in the areas since 1996 (Mining Journal, 1998).

Production of refined gold decreased considerably in 1998 because of low prices of gold and weak demand for gold in domestic markets. According to Government minerals and nonferrous metals statistics, gold metal production by raw material sources was imported ore, 72.9%; scrap, 6.0%; domestic ore, 5.2%; and other materials, 15.9%. Production of refined silver increased owing to higher prices of silver in domestic market in 1998. Silver metal production by raw material sources was imported ore, 65.0%; scrap, 13.5%; domestic ore, 2.5%; and other materials, 13.5% (Ministry of International Trade and Industry, 1998d, p. 52-53).

According to Government trade statistics, Japan's imports of gold ingots dropped by another 24%, to 83.5 t, following a 15% drop in the gold imports in 1997 owing to low demand for jewelry, pottery and porcelain, as well as for private investment. Imports of silver ingots and powder decreased by 40.3% to 907.8 t, owing to a higher silver metal production and a weaker demand in the domestic market. The major suppliers of gold ingots were Australia, 33.2%; Switzerland, 14.4%; the United Kingdom, 9.4%; the Republic of Korea, 8.3%; Papua New Guinea, 6.3%; Mongolia, 5.9%; Canada, 5.4%; and the United States, 5.0%. The major suppliers of silver ingots were Mexico, 40%; the United States, 36%; Australia, 7%; Peru and Singapore, 5% each; and Canada, 3%. Import bills for gold ingots, silver ingot and powder were $775.2 million and $137.3 million, respectively, in 1998 (Ministry of Finance, 1998, import portion, p. 583).

The Japanese gold market remained depressed. According to the latest available data provided by the Japan Mining Industry Association, overall demand for gold in 1997 was 323,189 kg, of which 19,958 kg was for dentistry; 185,890 kg for industrial use; 4,590 kg for arts and crafts; 68,194 kg for private investment; and 44,557 kg for other uses. For industrial use, 84,670 kg was for electronics and telecommunications; 70,935 kg for jewelry; 25,108 kg for plating; 2,929 kg for china and porcelain; 910 kg for decoration and badges; 767 kg for clocks and watches; 323 kg for fountain pens; 248 kg for gilding (Bulletin of Japan Mining Industry Association, 1998).

According to the Government minerals and nonferrous metals statistics, domestic demand for silver decreased by 10.5% to 3,084.4 t, of which 52.2% was for silver nitrate for photographic use; 8.1% for silver nitrate for other uses; 8.0% for electric contacts; 4.4% for rolled products; 4.1% for silver branning alloy; 23.2% for electroplating, jewelry, silverware, and other uses (Ministry of International Trade and Industry, 1998d, p. 186).

Iron and Steel.—Japan's iron and steel industry relied on imports to meet virtually all its iron ore requirements. According to Government trade statistics, imports of iron ore, including iron sand, pellet, and sinter, decreased by 4.6% to 120.8 Mt. The major suppliers of iron ore were Australia, 52.7%; Brazil, 21.3%; India, 13.2%; South Africa, 3.8%; the Philippines, 3.0%, and Chile, 2.1%. Imports of pig iron dropped sharply to 304,000 t from 1, 285,200 t in 1997. The major suppliers of pig iron were China, 26.0%; Venezuela, 19.7%; North Korea, 16.7%; Sweden, 13.3%; and Brazil, 13.2%. The import bill of iron ore decreased to $3.0 billion from $3.3 billion in 1997. The average cost, insurance, and freight (c.i.f.) import price per metric ton of iron ore decreased to $25.18 from $25.90 in 1997. The import bill of pig iron decreased to $121 million from $282 million in 1997 because of reduced imports. However, the average c.i.f. import price per metric ton of pig iron increased to $396.72 from $219.39 in 1997 (Ministry of Finance, 1998, import portion, p. 161).

According to the Government iron and steel statistics, consumption of iron ore, including iron sand, pellet, and sinter by blast furnaces by the iron and steel industry, decreased to 123 Mt from 129 Mt in 1997 (Ministry of International Trade and Industry, 1998c, p. 88-90). Pig iron production decreased to 75.0 Mt from 78.5 Mt in 1997, of which 74.3 Mt was for steelmaking and 0.7 Mt was for foundry use. By yearend, the total capacity and number of furnaces, including blast, electric, and other furnaces for pig iron production, decreased slightly to 95.5 Mt/yr and 46, respectively.

According to the International Iron and Steel Institute, Japan ranked as the world's second largest producer of pig iron after China and the world's third largest producer of crude steel after China and the United States, accounting for 14% and 12%, respectively, of the world total in 1998 (Ministry of International Trade and Industry, 1998c, p. 160-161). Nippon Steel Corp., which produced 24.07 Mt of crude steel in 1998, was the second largest steelmaker in the world; NKK Corp., which produced 10.54 Mt, ranked 9th; Kawasaki Steel Corp., which produced 9.74 Mt, ranked 14th; Sumitomo Metal

Industries, Ltd. which produced 9.33 Mt, ranked 15th; and Kobe Steel Ltd., which produced 5.54 Mt, ranked 31th (Metal Bulletin, 1999).

Crude steel output dropped by 10.5% to the lowest level in 27 years, the year before Japan's first oil crisis in 1973. The 11 Mt drop in crude steel production reflected a 14.7% decline in overall domestic demand for ordinary and specialty steels resulting from Japan's first economic downturn in the post war period. Of the total crude steel produced in 1998, 68.1% was processed by basic oxygen furnaces and 31.9% by electric furnaces. In the steelmaking sector, the number of basic oxygen furnaces remained unchanged at 69; the number of electric arc furnaces was reduced by 26 to 432, by yearend, reflecting more efficient operations of electric arc furnaces in 1998. The overall crude steel production capacity remained unchanged at 149.77 Mt/yr. By yearend, the industry cut its labor force by 12,171 to 214,190 workers (Ministry of International Trade and Industry, 1998c, p. 124).

Japan's domestic demand for ordinary steel products and specialty steel products decreased by 14% and 18.7%, respectively, and exports of ordinary steel and specialty steel, however, increased by 1.0% and 3.2%, respectively, in 1998. According to the Japan Iron and Steel Federation (Japan Iron and Steel Federation, 1999, p. 5), domestic demand for ordinary steel products and specialty steel declined in every end-use market classification in 1998. (*See table 6.*)

According to Government iron and steel statistics, exports of iron and steel increased by 17.5% to the highest level in 13 years. Exports of iron and steel products included 2,337,167 t of pig iron; 108,568 t of ferroalloys; 5,637 t of steel ingots; 1,171,044 t of semifinished ordinary steel; 18,961 t of semifinished specialty steel; 19,774,641 t of ordinary steel products; 3,693,570 t of specialty steel products; and 203,069 t of other iron and steel products (Ministry of International Trade and Industry, 1998c, p. 142-143). Export earnings from iron and steel totaled $15.8 billion, of which $9.5 billion was from ordinary steel products, $4.0 billion from specialty steel products, and $2.3 billion from other iron and steel products. Exports of iron and steel products to the Asian markets decreased by 11.8% to 15.6 Mt from 17.6 Mt in 1997 because of financial crisis and economic downturn in the Asian region. However, exports of iron and steel products to all other markets increased, especially to the North America market, where exports to the United States increased by 159.7% to 7.0 Mt from 2.7 Mt in 1997. Imports of iron and steel products decreased by 30.7% to 6.6 Mt from 9.6 Mt in 1997, of which 303,980 t was pig iron; 1,420,605 t, ferroalloys; 3,606 t, steel ingots; 41,946 t, semifinished steels; 4,488,854 t, ordinary steel products; 100,989 t, specialty steel products; and 270,801 t, process steels and other steel products. The decline in imports of iron and steel products was caused by a weak Japanese economy and depreciation of the Japanese yen in 1998. The major suppliers of ordinary steel products to Japan were, in decreasing order, the Republic of Korea, Taiwan, China, and South Africa. (*See table 7.*) The import bill of iron and steel products totaled $3,329.1 million in 1998, of which $1,529.7 million was for ordinary steel products; $992.4 million for ferroalloys; $120.6 million for pig iron; $171.7 million for specialty steel products; and $514.7 million for other iron and steel products.

Manganese.—All of Japan's manganese ore requirements were met by imports. According to Government trade statistics, Japan imported 4,840 t of high-grade manganese dioxide ore, 896,660 t of high-grade manganese ore, 83,132 t of low-grade manganese ore, and 220,235 t of ferruginous manganiferous ore. The major suppliers of high-grade manganese dioxide ore were Gabon, 62% and Australia, 27%. The major suppliers of high-grade manganese ore were South Africa, 62% and Australia, 35%. The major suppliers of low-grade manganese ore were South Africa, 80%, and India, 20%. The major suppliers of ferruginous manganiferous ore were India, 64%; Ghana, 24%; and South Africa, 11%. The total import bill of manganese ore amounted to $115.4 million in 1998 (Ministry of Finance, 1998, import portion, p. 161).

According to Government iron and steel statistics, consumption of manganese ore for production of ferroalloys increased by 1% to 704,574 t and for steelmaking by 27% to 214,108 t (Ministry of International Trade and Industry, 1998c, p. 93). Production of ferromanganese decreased owing to increased imports and decreased consumption for steelmaking. The 1998 ferromanganese production was equivalent to 82% of production capacity of about 407,000 t/yr. The ferromanganese producers were Chuo Denki Kogyo Co. Ltd. in Kashima, Ibaraki Prefecture; JMC in Takaoka, Toyama Prefecture; Kobe Steel Ltd. in Kakogawa, Hyogo Prefecture; and Nippon Denko in Tokushima, Tokushima Prefecture, and in Miyako, Iwate Prefecture.

To produce ferromanganese more economically, Japanese ferroalloy producers had invested in overseas joint-venture projects with the South African ferroalloy producers since 1996. Advalloy Ltd., a joint venture established between JMC (35%), Mitsui & Co. Ltd. (15%), and Samancor Ltd. (50%); and Cato Ridge Alloys Ltd., a joint venture established between Mizushima Ferroalloy Co. Ltd. (40%), Sumitomo Corp. (10%), and Associated Manganese Ltd. (50%); began shipping ferromanganese to Japan in 1998. As a result, imports of ferromanganese increased by 15% to 109,887 t in 1998. The major suppliers were South Africa, 60%; China, 23%; and Australia, 10%. Import bill of ferromanganese were about $48 million in 1998 (Ministry of Finance, 1998, import portion, p. 588).

Ferromanganese consumed for steelmaking decreased by 8% to 367,441 t, of which 298,147 t was high-carbon ferromanganese and 69,294 t, low-carbon ferromanganese. Exports of ferromanganese totaled 26,815 t. The major buyers were Australia, 32%; the United States, 21%; Indonesia, 13%; the Netherlands, 10%; and Taiwan, 6%. Export earnings from ferromanganese were about $20 million in 1998 (Ministry of Finance, 1998, export portion, p. 507).

Japan was the world's largest producer of electrolytic manganese dioxide (EMD). Japan's EMD producers were JMC at Takaoka, Toyama Prefecture; Mitsui Mining and Smelting at Takehara, Hiroshima Prefecture and at County Cork, Ireland and Tosoh Corp. at Hyuga, Miyazaki Prefecture and at Salonika, Greece. Japan's EMD production capacity, including

two overseas plants was raised to 121,000 t/yr from 116,000 t/yr in 1997. Tosoh Corp. increased capacity of its Hyuga plant to 32,000 t/yr from 30,000 t/yr in October 1998 and raised capacity of its Salonika plant in Greece to 18,000 t/yr from 15,000 t/yr in July 1998. As a result, Japan EMD production capacity was raised to 121,000 t/yr from 116,000 t/yr in 1997, which accounted for more than 41% of the world's production capacity of about 282,000 t/yr (Roskill's Letter from Japan, 1999).

Nickel.—Japan was the world's largest importer and consumer of nickel and the third largest producer of nickel metal after Russia and Canada, including ferronickel, nickel oxide, and refined nickel, using imported raw materials. Nickel ores and nickel mattes were imported for production of ferronickel, refined nickel, and nickel oxide sinter. Ferronickel, refined nickel, nickel oxide sinter, nickel powder and flake, and nickel waste and scrap were imported to meet the nickel requirements of the battery, magnetic materials, nonferrous alloys, and specialty steel industries, as well as other end users.

According to Government trade statistics, imports of nickel ore decreased by 5.6% to 4.12 Mt, and were valued at $140 million (Ministry of Finance, 1998, p. 161). The major suppliers were New Caledonia, 50.9%; Indonesia, 26.5%; and the Philippines, 22.6%. Imports of nickel matte, in gross weight, increased by 5.4% to 78,473 t and were valued at $254 million. The major suppliers were Indonesia, 54.8% and Australia, 45.2%. Imports of ferronickel, in gross weight, decreased by 17.5% to 41,066 t and were valued at $71.6 million. The major suppliers were New Caledonia, 69.4%; the Dominican Republic, 18.7%; Indonesia, 9.6%; and Macedonia, 1.4%. Imports of refined nickel dropped by 31.6% to 39,039 t and were valued at $213 million. The major suppliers were Zimbabwe, 16.6%; China, 15.0%; Norway, 13.8%; South Africa, 13.5%; Australia, 8.5%; Canada, 7.1%; the United Kingdom, 6.1%; Brazil, 4.2%; and Finland, 2.7%. Imports of nickel oxide sinter and other intermediate products of nickel metallurgy totaled 2,090 t and were valued at $9.7 million. The major suppliers were Australia, 88.2% and Cuba, 9.8%. Imports of nickel powders and flakes remained steady at 10,052 t and were valued at $85.8 million. The major suppliers were the United Kingdom, 52.1% and Canada, 44.8%. Imports of nickel waste and scrap dropped by 20% to 10,270 t and were valued at $45 million. The major suppliers were Russia, 42.8%; the United States, 15.2%; Zimbabwe, 11.7%; the Republic of Korea, 5.8%; Taiwan, 5.7%; and South Africa, 5.2%. Based on an agreement with WTO, import duty on refined nickel would be reduced from 51.4 yen per kilogram (y/kg) in 1998 to 44 y/kg in 1999. Import duties on ferronickel and nickel oxide sinter would be reduced from 3.9% and 3.8%, respectively, in 1998 to 3.3% and 3.0%, respectively, in 1999. Import duties on nickel ore and nickel mattes were free (Japan Tariff Association, 1998, p. 749, p. 792).

According to Government iron and steel statistics, consumption of nickel ore by the ferroalloy industry for ferronickel production remained unchanged at 3.2 Mt (Ministry of International Trade and Industry, 1998c, p. 95). Production of ferronickel was by Pacific Metals Industry Co. Ltd. in Hachinohei, Aomori Prefecture, Nippon Yakin Kogyo Co. Ltd. at Oeyama near Miyazu, Kyoto Prefecture, and Sumitomo Metal Mining, through Hyuga Smelting Co. Ltd., in Hyuga, Miyazaki Prefecture. Japan's ferronickel production decreased by 2% to 345,772 t containing 69,202 t of nickel. Consumption of ferronickel for steelmaking decreased by 20% to 283,591 t because of a substantial cutback in stainless steel production in 1998. Exports of ferronickel increased by 6.3% to 74,202 t, of which 65% went to Taiwan; and 34.9% to the Republic of Korea.

Production of refined nickel was solely by Sumitomo Metal Mining at its 30,000-t/yr plant in Niihama, Ehime Prefecture using its Matte Chorine Leaching Electrowinning process. The company planned to expand the capacity of its Niihama nickel plant by 20% to 36,000 t/yr in the next 2 years. The expansion plan was based on the planned increase in raw material supply from P.T. Inco of Indonesia, which was undertaking capacity expansion of nickel matte by 50% to 67,500 t/yr (Nikkan Kogyo Shimbun, 1998c). Production of nickel oxide sinter was solely by Tokyo Nickel Co. Ltd. at its 43,000-t/yr plant in Matsusaka, Mie Prefecture. The company was also expected to increase the capacity of its Matsusaka plant to 60,000 t/yr in the next few years in line with the expected increase in raw material supply from P.T. Inco at Soroako, Indonesia.

According to Government minerals and nonferrous metals statistics, domestic demand for refined nickel dropped by 18.6% to 65,392 t, of which for production of specialty steel was 41,404 t; galvanized sheet, 5,624 t; batteries, 4,160 t; magnetic materials, 3,464 t; nonferrous alloys, 3,494 t; catalysts, 605 t; and other uses, 6,643 t (Ministry of International Trade and Industry, 1998d, p. 176). Exports of refined nickel were 218 t, of which 59.8% went to Taiwan; 18.8% to China, including Hong Kong; 12.5% to Indonesia; and 6.9% to the Philippines. Exports of nickel oxide sinter and other intermediate products of nickel metallurgy were 6,133 t, of which 59.5% went to Taiwan and 40.5% to the Republic of Korea. Exports of nickel powders and flakes were 745 t, of which 38.4% went to China, including Hong Kong; 31.1% to Taiwan; and 17.8% to France. Exports of nickel waste and scrap were 954 t, of which 33.0% went to the United States; 30.3% to the United Kingdom; 30.0% to Hong Kong (Ministry of Finance, 1998, export portion, p. 952).

Titanium.—Japan was the world's second largest producer of titanium sponge metal after Russia and one of the world's top producers of titanium dioxide pigment, but all of the raw material requirements for production of titanium metal and dioxide pigment were met by imports. Rutile was consumed by the producers of titanium sponge metal. Ilmenite was consumed mainly by the manufacturers of synthetic rutile and titanium dioxide pigment. Small amounts of rutile and ilmenite were consumed as blast furnace additives in the steel industry.

According to Government trade statistics, Japan imported 97,076 t of rutile principally from Australia, 64.6%; South Africa, 17.3%; and India, 10.9%. Japan also imported 371,3691 t of ilmenite mainly from Australia, 43.2%; Vietnam,

21.1%; Malaysia, 15.1%; India, 9.6%; and Canada, 8.1% (Ministry of Finance, 1998, import portion, p. 162, p. 173).

Production of titanium sponge declined mainly because of decreased exports to the United States in 1998. Titanium sponge was produced by Sumitomo Sitix Corp. in Amagasaki, near Osaka, Hyogo Prefecture, and Toho Titanium Co. Ltd. in Chigasaki, about 20 km south of Yokohama, Kanagawa Prefecture. Titanium sponge production at the Amagasaki plant was temporarily shut down in December because of a fire and explosions at the plant site. The fire, caused by spilling of molten magnesium from a container, badly damaged one of the two furnaces. As a result, the damaged larger furnace with a capacity of 700 to 800 metric tons per month was temporarily shut down for repairs. However, Sumitomo Sitix would be able to meet their customers immediate need with its inventories (Metal Bulletin, 1998b).

Total titanium sponge shipments declined slightly in 1998. Domestic shipments of titanium sponge increased to 15,188 t from 11,091 t in 1997. However, overseas shipments dropped sharply to 8,630 t from 13,486 t in 1997. Total shipments of titanium mill products decreased to 12,740 t from 13,286 t in 1997; domestic shipments of titanium mill products decreased to 6,146 t from 7,171 t in 1997, and overseas shipments increased to 6,594 t from 6,115 t in 1997. Domestic shipments of titanium mill products, by end-user, were 950 t for the chemical industry, 901 t for distributors, 745 t for power generation, 631 t for electrolysis, 572 t for consumer goods, 567 t for aerospace, 446 t for heat exchange, 280 t for sports leisure goods, 276 t for water-desalination plants, 176 t for architecture and civil engineering, 133 t for automotive, 98 t for shipping and marine, 25 t for medical, and 346 t for other users (Japan Titanium Society, 1999).

According to Government trade statistics, exports of titanium sponge decreased by 35.7% to 8,726 t, of which 51.4% went to the United Kingdom; 40.1% to the United States; 8.5% to other countries (Ministry of Finance, 1998, export portion, p. 603). Exports of titanium sponge to the United States decreased to 3,501 t from 7,153 t in 1997. Exports of titanium waste and scrap and titanium powder totaled 3,091 t, of which 71.2% went to the United States and 25.8% to the United Kingdom. To meet the domestic requirements, Japan imported 8,869 t of lower grade titanium sponge, waste, scrap, and powder principally from Kazakhstan, 59.3%; Russia, 34.9%; China, 2%; and Taiwan, 1.7%.

According to Government trade statistics, Japan imported 2,826 t of titanium mill products, principally from the United States, accounting for 93% of titanium mill imports in 1998 (Ministry of Finance, 1998, import portion, p. 634). Exports of titanium mill products increased to 7,578 t from 7,127 t in 1997. Export earnings from titanium mill products were valued at $194 million in 1998. The major buyers were Sweden, 17.9%; the United States, 14.4%; France, 11.4%; Italy and Taiwan, 8.4% each; the Netherlands, 8.1%; China, including Hong Kong, 8.0%; Germany, 7.2%; and the Republic of Korea, 4.3%.

Production of titanium dioxide pigment increased because of increased exports. Output was equivalent to about 73.5% of the industry's capacity of 341,400 t/yr in 1998. Ishihara Sangyo Co. Ltd., Japan's largest titanium dioxide pigment producer, operated a 155,000-t/yr plant in Yokkaichi, Mie Prefecture, and a 46,000-t/yr plant in Singapore. Despite the economic slowdown in southeast Asia, Ishihara Sangyo planned to construct a third plant to meet the future demand in the Asia region. Earlier in 1994, Ishihara Sangyo's plan to build a 75,000-t/yr plant in Singapore that did not materialize, owing to the withdrawal of Kemira Pigments Ltd., the joint-venture partner of Ishihara Sangyo (Industrial Minerals, 1998).

According to Government chemical industries statistics, total shipments of titanium dioxide pigment was 250,052 t in 1998 (Ministry of International Trade and Industry, 1998b, p. 55). According to Government trade statistics, exports of titanium oxides increased to 29,240 t from 27,513 t in 1997. Export earnings from titanium oxide were valued at $71.6 million (Ministry of Finance, 1998, export portion, p. 110). The major buyers were China, including Hong Kong, 23.8%; Taiwan, 22.3%; the Republic of Korea, 19.7%; Italy, 3.9%; the United States, 3.7%; Indonesia, 3.6%; the United Arab Emirates, 3.1%; and Thailand, 2.9%.

Industrial Minerals

Cement.—Japan was the world's third largest cement producer. Cement production decreased by 11.5%, owing a double-digit decline in domestic construction activities. According to Government statistics on principal economic indicators, orders for construction work decreased by 11.1%; and new dwelling construction started also decreased by 13.6% in 1998 (Ministry of International Trade and Industry, 1999b, p. 3). According to Government ceramics and building materials statistics, Japan's cement clinker capacity increased to 94.6 Mt/yr from 94.4 Mt/yr in 1997. Production of cement clinker, however, decreased to 85.6 Mt from 88.4 Mt in 1997. Production of cement also decreased to 81.3 Mt from 91.9 Mt in 1997, of which 64.2 Mt was portland cement and 17.1 Mt was blended cement. About 94.1% of blended cement contained blast furnace slag. In 1998, consumption of raw materials for production of cement included 85.1 Mt of limestone, 15.3 Mt of clay, 5.7 Mt of silica stone, 3.9 Mt of ore slag, and 3.0 Mt of gypsum. Energy consumed by the industry included 8.1 Mt of coal, 1.1 Mt of petroleum coke, 21,147 t of coke, 2.1 million barrels of heavy fuel oil, 46,450 barrels of kerosene and distillate fuel oil, 241,154 t of waste tire, 3,795 megawatts hours of electricity, and 14,134 t of steam in 1998. The number of cement plant employees declined to 4,921 from 4,960 in 1997 (Ministry of International Trade and Industry, 1998a, p. 100).

In October, Chichibu Onoda Cement Corp., Japan's largest cement producer, and Nihon Cement Co. Ltd., the third largest, formally merged into one company, called Taiheiyo Cement Corp., and would have 39.3% of the domestic market share. Also in October, the marketing tieup between Mitsubishi Materials and Ube Industries Ltd. became effective. A new company called Ube Mitsubishi Cement Co. would market the production of cement by Mitsubishi Materials and Ube Industries. However, the cement manufacturing business was under separate control and management by Mistubishi

Materials and Ube Industries. According to an industry source, further restructuring of the Japanese cement industry is expected to continue because of the industry's excess capacity and price competition (International Cement Review, 1998, p171-172).

According to the Japan Cement Association (1999, p. 5), domestic demand for cement decreased to 71.0 Mt from 78.2 Mt in 1997, and exports of cement including clinker also decreased to 7.6 Mt from 12.1 Mt in 1997. Of the total domestic demand for cement in 1998, 70.6% was for ready-mixed concretes; 14.2% for cement products; 5.9% for civil engineering works; 1.8% for public and private buildings for construction of roads, bridges, ports, and powerplants; and 6.4% for other uses.

According to Government trade statistics, exports of cement clinker decreased to 1.79 Mt from 3.65 Mt in 1997 (Ministry of Finance, 1998, export portion, p. 97). Exports of portland cement also decreased to 5.81 Mt from 8.46 Mt in 1997. The major buyers of cement clinker were Singapore, 24.1%; Malaysia, 12.7%; China, including Hong Kong, 12.5%; the Philippines, 7.0%; Ivory Coast, 6.8%; Senegal, 6.0%; and Brazil, 5.7%. The major importers of portland cement were Singapore, 32.7%; Taiwan, 26.8%; China, including Hong Kong, 20.0%; Kuwait, 4.7%; Nigeria, 4.6%; and Egypt, 4.1%. Export earnings from cement clinker and portland cement were $39.9 million and $156.7 million, respectively, in 1998. The average export free-on-board (f.o.b.) price of portland cement was $26.97 per metric ton, compared with $39.69 per metric ton in 1997. Imports of cement, including portland, white, and aluminous, increased to 727,744 t from 544,686 t in 1997. The major suppliers were the Republic of Korea, 79.8% and 17.2%, by China. The average import c.i.f. price was $42.03 per metric ton, compared with $57.45 per metric ton in 1997 (Ministry of Finance, 1998, import portion, p. 160).

Iodine.—Japan was the world's second largest producer of iodine, accounting for 44% of the world production in 1998. Production of iodine from the Prefectures of Chiba, Niigata, and Miyazaki had declined to about 6,100 t/yr in late 1990's from 7,500 t/yr in early 1990's because of decreasing exports. However, the industry's capacity had been expanded to 10,800 t/yr from 9,220 t/yr in the early 1990's. Crude iodine was produced mainly by Ise Chemical Corp., Godo Shigen Sangyo Co. Ltd., Kanto Natural Gas Development Co. Ltd., Nihon Tennen Gas Co. Ltd., Nippon Chemicals Co. Ltd., and Toho Earthtech, Inc. (See table 2.) Additionally, two small producers were Tekikoku Oil Co. Ltd. operating a 600 t/yr-plant in Naruto, Chiba Prefecture and Japan Energy Development Co. Ltd. operating a 360 t/yr-plant in Nakajo, Niigata Prefecture.

Domestic consumption of iodine was estimated at about 750 t and about 81% of the 1998 iodine production was exported. In the domestic market, iodine was consumed mainly for pharmaceutical, synthetic chemicals and catalysts, food and feed additives, agricultural and sanitizer. Exports of iodine totaled 4,994 t and were valued at $83.2 million in 1998. The major buyers were the United States, 35.2%; the United Kingdom, 16.8%; France, 12.6%; Italy, 10.7%; Germany, 5.7%; and the Netherlands and Norway, 4.7% each (Ministry of Finance, 1998, export portion, p. 104).

Limestone.—Japan was the world's third largest producer of limestone. Production of limestone decreased by 8.7% in 1998, owing to a 13.7% decline in consumption of limestone by the cement industry. According to information provided the MITI's Mining Division, limestone was mined at 257 limestone quarries, mainly in the Prefectures of Aomori, Fukuoka, Iwate, Kochi, Oita, Saitama, Tochigi, and Yamaguchi. Most of the major limestone quarries were owned and operated by cement, construction, or steel companies.

According to Government minerals and nonferrous metals statistics, shipments of domestically produced limestone decreased to 186.5 Mt from 202.9 Mt in 1997, of which demand by the manufacturing sector declined to 126.3 Mt from 140.9 Mt in 1997. Demand by the construction sector declined to 54.7 Mt from 56.3 Mt in 1997. Demand by other users declined to 5.6 Mt from 5.8 Mt in 1997 (Ministry of International Trade and Industry, 1998d, p. 42-43). Of the 126.3 Mt consumed by the manufacturing sector, the cement industry used 85.1 Mt; the iron and steel industry, 22.4 Mt; the lime industry, 10.1 Mt; the filler and fertilizer industries, 5.3 Mt; the soda and glass industries, 1.6 Mt; and others, 1.8 Mt. Of the 54.7 Mt consumed by the construction sector, concrete making accounted for 33.5 Mt; road construction, 14.8 Mt; and other construction, 6.4 Mt. Japan was self-sufficient in limestone. According to Government trade statistics, Japan imported only 124,817 t of limestone flux, limestone, and other calcareous stone principally from the Philippines, 58.4% and Malaysia, 37.4% in 1997 (Ministry of Finance, 1998, import portion, p. 159). Japan, however, exported 3.5 Mt of limestone flux, limestone, and other calcareous stone mainly to Taiwan, 39.2%; Australia, 30.7%; and Hong Kong, 28.7% in 1998.

Mineral Fuels

Coal.—Japan's coal production decreased 14.3% to a historical low after the closure of the Miike coal mine in Omuta, Fukuoka Prefecture in March 1997. In 1998, the two remaining heavily subsidized major coal mining companies were Taiheiyo (Pacific) Coal Mining Co. Ltd. at Kushiro, Hokkaido Prefecture and Matsushima Coal Mining Co. Ltd. at Sotome, Nagasaki Prefecture. Under the current national coal policy, coal mining subsidies will expire in fiscal year 2001. According to the Coal Department of the Agency of Natural Resources and Energy under MITI, Japan's recoverable proven coal reserves, including brown coal were estimated at 821 Mt (Management and Coordination Agency, 1998). According to Government coal and petroleum statistics, of the total coal produced, 73.5% was from the Hokkaido area and 26.5% was from the Kyushu and the Honshu areas in 1998 (Ministry of International Trade and Industry, 1998e, p. 146-147). Japan's coal production was equivalent to 2.8% of domestic demand for coal. Japan relied on imports to meet 100% of its requirements for coking coal and anthracite and about 94.4% of its requirements for steam coal.

Despite the continued growth in demand for coal by the

electric power industries, demand for coking coal by the iron and steel industry decreased. As a result, overall coal imports decreased by 0.4%, to 128.9 Mt in 1998. According to Government coal and petroleum statistics, imports of coking coal decreased by 3.9% to 62.8 Mt. Imports of anthracite decreased by 7.4% to 3.7 Mt. Imports of steam coal increased by 3.9% to 62.4 Mt (Ministry of International Trade and Industry, 1998e, p. 162-165). The major suppliers of coking coal were Australia, 50.3%; Canada, 24.2%; the United States, 7.3%; Indonesia, 5.6%; China, 4.8%; Russia, 3.6%; and South Africa, 3.0%. The principal suppliers of anthracite were China, 54.2%; Vietnam, 35.8%; and North Korea, 10.0%. The major suppliers of steam coal were Australia, 61.3%; Indonesia, 14.0%; China, 11.5%; the United States, 4.1%; South Africa, 3.4%; Canada, 3.3%; and Russia, 2.3%.

According to Government coal and petroleum statistics, the overall total demand for coal in 1998 decreased by 1.5%, to 132.7 Mt, of which 3.8 Mt was supplied by domestic coal and 128.9 Mt was by imported coal (Ministry of International Trade and Industry, 1998e, p. 158-159, p. 166-169). Decreased demand for coal was largely attributed to a 2.3 % decline in demand for coking coal by the iron and steel industry. Demand for coal by end use in 1997 and 1998 is shown in table 8.

Natural Gas and Petroleum.—Japan was the world's largest importer of natural gas and crude petroleum. Domestic production of natural gas and crude petroleum was very small. According to Government coal and petroleum statistics, domestic production of natural gas and crude petroleum totaled about 2.3 billion cubic meters and 5 million barrels (Mbbl), respectively, compared with 76.1 billion cubic meters and 1,541 Mbbl of domestic consumption of natural gas and crude petroleum in 1998 (Ministry of International Trade and Industry, 1998e, p. 20). According to an industry source, Japan's natural gas and crude petroleum reserves were estimated to be 39.1 billion cubic meters and 60.2 Mbbl, respectively (Oil & Gas Journal, 1998).

In 1998, Japan relied on imports to meet 97.0% of its domestic natural gas requirements and 99.7% of its crude petroleum requirements. According to Government coal and petroleum statistics, Japan imported 73.8 billion cubic meters of natural gas, in the form of LNG, and 1,603 Mbbl of crude petroleum (Ministry of International Trade and Industry, 1998e, p. 119). LNG imports were from Indonesia, 36.4%; Malaysia, 20.2%; Australia, 14.8%; Brunei, 11.0%; the United Arab Emirates, 9.3%; Qatar, 6.7%; and the United States, 2.6%. The import bills of LNG were valued at $7.8 billion in 1998. Crude petroleum imports were mainly from the Middle East, accounting for 85.6%; Asia including China, accounting for 11.9%; and other regions, 2.5%. The major suppliers of crude petroleum were the United Arab Emirates, 27.7%; Saudi Arabia, 21.0%; Iran, 10.8%; Qatar, 9.3%; Kuwait, 5.7%; Indonesia, 5.5%; Neutral Zone (the area equally shared by Kuwait and Saudi Arabia), 5.4%; Oman, 4.9%; and China, 3.3%. Production of refined petroleum products totaled 1,564.9 Mbbl in 1998. Refined petroleum products were produced by 23 oil companies operating 38 refineries mostly in the east coast of Honshu (main island) with a total capacity of 4.97 million barrels per day. Capacity utilization rate was about 78.6% in 1998 (Ministry of International Trade and Industry, 1998e, p. 67).

The 1998 domestic demand for refined petroleum, by product, was as follows: gasoline, 348.2 Mbbl; naphtha, 274.8 Mbbl; jet fuel, 31.0 Mbbl; diesel (distillate fuel oil), 276.4 Mbbl; kerosene, 177.9 Mbbl; heavy fuel oil, 394.3 Mbbl; lubricant, 14.7 Mbbl; asphalt, 32.4 Mbbl; and paraffin, 0.4 Mbbl. To meet the domestic demand, Japan imported 5.6 Mbbl of gasoline, 7.4 Mbbl of kerosene, 163.6 billion barrels of naphtha, 2.0 billion barrels of diesel, 13.0 billion barrels of heavy fuel oil, and small quantities of asphalt and paraffin. Imports of refined petroleum products decreased by about 14.3% in 1998 because of lower domestic demand for all refined petroleum products except gasoline, which increased by 2.1% in 1998. Consumption of domestically produced natural gas totaled 2.9 billion cubic meters—the gas industry consumed 46.4%; the electric power industry, 24.8%; the oil and gas industry, 14.7%; the chemical industry, 11.0%; and other manufacturing and service industries, 3.1%. Additionally, Japan consumed 49.3 Mt, or 73.8 billion cubic meters, of imported natural gas, in the form of LNG—the electric power industry consumed 70.1% for power generation, 28.6% for the city gas industry and household use; and 1.3% for the iron and steel industry.

Japan's stockpiling of crude petroleum, partially refined and refined petroleum products at the end of 1998 totaled 167 days supply, of which the national stockpile was 85 days and private stockpile, 82 days (Ministry of International Trade and Industry, 1998e, p. 196).

Reserves

Japan's ore reserves for limestone and other industrial minerals, such as iodine, pyrophyllite, and silica stone, are large and of world significance. With the exception of gold and zinc, its ore reserves for other minerals, especially oil and gas, and metallic minerals are very small. (*See table 3.*)

Infrastructure

Japan has one of the world's most modern and complete infrastructures for its mining and mineral processing industries. Despite its small land area, Japan has a highway system of 1.1 million kilometers, of which 68% is paved, and a railroad network of 27,327 km, of which 25,315 km is 1.067-meter narrow gauge. Highway and railroad networks link not only all major seaports and coastal cities on the four major islands, but also connect Honshu (the main island) to the islands of Shikoku and Kyushu in the south and Hokkaido in the north by mean of bridges and tunnels.

Japan's domestic and international telecommunication services are among the best in the world with five satellite earth stations, as well as submarine cables to China, the Philippines, Russia, and the United States. For electric power transmission, Japan has a route length of 87,500 km and a circuit length of 152,000 km. For power distribution, Japan's total length of line distances, including high- and low-voltage, was 1.13

million kilometers, concentrating in the major industrial areas of Fukuoka, Hiroshima, Nagoya, Osaka, Takamatsu, Tokyo, and Toyama. Japan also has an extensive pipeline system—natural gas, 1,800 km; crude petroleum, 84 km; and refined petroleum products, 322 km.

Japan has 25 major ports and more than 2,000 minor ports to receive raw materials from overseas and to export manufactured products. The major port facilities, including the terminals and warehouses, are among the most indispensable parts of the infrastructure for the mineral industry because of their role in receiving imported raw materials, such as coal, iron ore, nonferrous ore, phosphate rock, crude petroleum, and LNG for mineral processing plants and powerplants, as well as exporting value-added mineral and metal products. The important seaports of the major mineral-processing centers were Akita, Amagasaki, Chiba, Hachinohei, Higashi-Hamrima, Himeji, Hiroshima, Kawasaki, Kinuura, Kobe, Kushiro, Mizushima, Moji, Nagoya, Osaka, Sakai, Sakaide, Shimizu, Tokyo, and Yokohama on Honshu; Fukuoka, Kita Kyushu, and Oita on Kyushu; and Muroran and Tomakomai on Hokkaido.

Japan has 175 airports, of which 173 have permanent-surface runways. The major international airports were Fukuoka, Haneda (Tokyo), Kansai, Nagoya, Narita (New Tokyo), and Osaka. Japan's first round-the-clock airport, Kansai International, opened in September 1994 on reclaimed offshore land in Osaka Bay.

Outlook

The nonferrous metal mining and coal sectors are expected to increase slightly in 1999. Mining activities of industrial minerals, such as limestone and silica stone and sand, are expected to remain at a low level because of the slow economic recovery and the depressed housing market. Mine production of copper, lead, and zinc was expected to remain at the 1998 level in 1999.

Metal production of lead and zinc is expected to increase slightly, while production of refined copper is expected to increase in 1999, as exports to Asian markets increase, especially to China, the Republic of Korea, Malaysia, Taiwan, and Thailand. Production of crude steel is expected to increase slightly, as the Japanese economy gradually recovers in 1999.

As a result of decreasing domestic mine production of nonferrous metals and coal, imports of coal, nonferrous metals, and other minerals, are expected to remain at a high level. In line with its mineral policy to secure and diversify its long-term supply of raw materials, thus ensuring a steady economic growth, Japan is expected to continue its active search for direct investment in joint exploration and development of minerals in developed and developing countries, especially in Australia, Canada, Chile, China, Mexico, Peru, and the United States. The targeted minerals were antimony, chromium, coal, columbium (niobium), copper, gold, lead, lithium, manganese, molybdenum, natural gas, nickel, crude petroleum, rare earths, silver, strontium, tantalum, titanium, tungsten, vanadium, and zinc.

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TABLE 1
JAPAN: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity		1994	1995	1996	1997	1998 p/
METALS						
Aluminum:						
Alumina, gross weight	thousand tons	326	363	337	340 e/	330 e/
Metal:						
Primary:						
Regular grades	do.	17	18	17	17	16
High-purity	do.	24	28	29	36	35
Secondary 2/	do.	1,175	1,181	1,191	1,277	1,155
Antimony:						
Oxide		10,395	10,393	10,311	10,916	10,197
Metal		207	93	98	122	170
Arsenic, high-purity e/		60 r/	60 r/	56 r/	66 r/	110
Bismuth		505	591	562	550	479
Cadmium, refined		2,629	2,652	2,344	2,473	2,337
Chromium, metal e/		2,200	1,010	1,000 r/	800 r/	1,000
Cobalt metal		161	227	258	264	329
Columbium (niobium) and tantalum, tantalum metal e/		80	80	80	80	80
Copper:						
Mine output, Cu content		6,043	2,376	1,145	932	1,070
Metal:						
Blister and anode:						
Primary		1,029,742	1,043,275	1,122,571	1,214,172	1,171,657
Secondary		92,257	125,206	110,856	136,274	131,979
Total		1,121,999	1,168,481	1,233,427	1,350,446	1,303,636
Refined:						
Primary		1,025,510	1,081,235	1,140,502	1,157,299	1,149,266
Secondary		93,658	106,724	110,871	121,400	128,086
Total		1,119,168	1,187,959	1,251,373	1,278,699	1,277,352
Gallium metal: e/						
Primary		6	6	6	6	6
Secondary		40	40	41	41	40
Germanium:						
Oxide e/		10	10	11	11	10
Metal	kilograms	2,401 r/	2,222 r/	1,787 r/	1,039 r/	454
Gold:						
Mine output, Au content	do.	9,551	9,185	8,627	8,384	8,601
Metal:						
Primary	do.	102,778	113,148	127,506	136,079	129,859
Secondary 3/	do.	20,273	14,736	17,150	18,831 r/	20,000 e/
Total	do.	123,051	127,884	144,656	154,910 r/	149,859 e/
Indium metal	do.	58,564	61,222	33,184	24,407	29,413
Iron and steel:						
Iron ore and iron sand concentrate:						
Gross weight	thousand tons	3	3	4	4	4
Fe content	do.	2	2	2	2	2
Roasted pyrite concentrate (50% or more Fe):						
Gross weight	do.	160	--	--	--	--
Fe content	do.	101	--	--	--	--
Metal:						
Pig iron and blast furnace ferroalloys	do.	73,776	74,905	74,597	78,519	74,981
Electric-furnace ferroalloys:						
Ferrochrome		192,989	210,445	193,695	186,432	142,931
Ferromanganese		345,153	346,977	343,104	376,633	334,081
Ferronickel		242,447	351,337	328,699	352,840	345,772
Ferrosilicon		12,208	3,650	--	--	951
Silicomanganese		69,183	64,870	72,727	74,897	70,886
Other:						
Ferrocolumbium		868	37	--	--	--
Ferromolybdenum		3,930	4,109	4,420	4,328	3,443
Ferrotungsten		68	120	64	62	61
Ferrovanadium		3,418	3,618	3,902	4,232	4,073
Unspecified		6,363	4,669	4,820	5,021	1,101
Total		876,627	989,832	951,431	1,004,445	903,299

See footnotes at end of table.

TABLE 1--Continued
JAPAN: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity		1994	1995	1996	1997	1998 p/
METALS--Continued						
Iron and steel--Continued:						
Metal--Continued:						
Electric-furnace ferroalloys--Continued:						
Other--Continued:						
Steel, crude	thousand tons	98,295	101,640	98,801	104,545	93,548
Semimanufactures, hot-rolled:						
Of ordinary steels	do.	76,631	79,449	78,266	82,201	73,379
Of special steels	do.	15,014	16,171	15,332	16,517	14,774
Lead:						
Mine output, Pb content		9,946	9,659	7,753	5,227	6,198
Metal, refined:						
Primary		181,707	148,117	140,531	142,326	144,542
Secondary		110,512	139,461	146,842	154,438 r/	157,503
Total		292,219	287,578	287,373	296,764 r/	303,045
Magnesium metal:						
Primary		3,412	--	--	--	--
Secondary		19,009	11,767	8,175	10,934	7,807
Manganese metal:						
Oxide		54,560	60,366	58,523	57,920	52,341
Metal		2,555	865	--	--	--
Molybdenum metal		651	689	596	699	632
Nickel metal:						
Refined		25,311	26,824	26,564	26,889	29,397
Ni content of nickel oxide sinter		34,711	35,966	34,772 r/	26,899 r/	25,435
Ni content of ferronickel		50,186	69,876	66,796	72,079 r/	69,202
Ni content of chemical		2,400	2,297	2,323	2,536	2,511
Total		112,608	134,963	130,455 r/	128,403 r/	126,545
Platinum-group metals:						
Palladium metal	kilograms	1,277	2,174	2,182	1,899	4,151
Platinum metal	do.	691	730	816	693	533
Rare-earth oxide 4/		4,397	4,667	4,892	5,161	4,728
Selenium, elemental		614	548	588	546	550
Silicon, high-purity		3,031	3,328	4,112	5,486	5,340
Silver:						
Mine output, Ag content	kilograms	133,713	100,078	85,115	87,180	94,472
Metal:	do.					
Primary	do.	2,020,223	2,056,657	2,032,120	2,094,097	2,204,625
Secondary 3/	do.	162,076 r/	171,969	180,741 r/	218,999 r/	415,540
Total	do.	2,182,299 r/	2,228,626	2,212,861 r/	2,313,096 r/	2,620,165
Tellurium, elemental		47	43	37	25	39
Tin, metal, smelter		706	630	524	507	500
Titanium:						
Metal		14,847	16,702	21,062	24,462	24,182
Oxide		237,956	249,290	237,942	241,417	251,275
Tungsten metal		3,825	4,468	4,288	4,759	4,082
Vanadium metal e/ 5/		300	250	250	250	250
Zinc:						
Mine output, Zn content		100,653	95,274	79,709	71,569	67,670
Oxide		73,888	75,973	76,008	79,688	77,183
Metal:						
Primary		571,880	573,912	500,674	500,603	513,916
Secondary		141,154	137,139	141,593	149,605 r/	138,892
Total		713,034	711,051	642,267	650,208 r/	652,808
Zirconium oxide e/		6,000	6,000	6,000	6,000	6,000
INDUSTRIAL MINERALS						
Asbestos e/		21,000	20,000	18,000	18,000	18,000
Bromine, elemental e/		15,000	15,000	15,000	15,000	15,000
Cement, hydraulic	thousand tons	91,624	90,474	94,492	91,938	81,328
Clays:						
Bentonite		484,115	478,056	468,728	495,646	443,566
Fire clay, crude		685,390	566,569	526,143	560,759	573,143
Kaolin		138,412	182,122	141,230	110,915	83,257
Diatomite		183,779	174,510	194,115	194,000 e/	190,000 e/

See footnotes at end of table.

TABLE 1--Continued
JAPAN: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity		1994	1995	1996	1997	1998 p/
INDUSTRIAL MINERALS--Continued:						
Feldspar and related materials:						
Feldspar		56,003	65,086	55,122	55,000 e/	50,000 e/
Aplite		381,160	388,000	365,580	310,000 e/	310,000 e/
Gypsum	thousand tons	3,873	5,334	5,432	5,371	5,305
Iodine, elemental		5,592	5,492	6,178	6,036	6,142
Lime, quicklime	thousand tons	7,712	7,871	7,744	8,104	7,646
Nitrogen, N content of ammonia	do.	1,483	1,584	1,567	1,589	1,464
Perlite e/		200,000	200,000	200,000	200,000	200,000
Salt, all types	thousand tons	1,387	1,351	1,390 e/	1,400 e/	1,390 e/
Silica sand		3,942,368	3,734,425	3,556,998	3,305,595	3,049,263
Silica stone	thousand tons	18,479	18,349	19,026	18,074	16,235
Sodium compounds, n.e.s.:						
Soda ash		1,049,676	1,049,017	925,671	801,169	721,747
Sulfate		200,111	206,893	193,439	203,530	177,407
Stone, crushed and broken:						
Dolomite	thousand tons	3,831	3,773	3,905	4,013	3,873
Limestone	do.	202,481	201,097	202,894	201,399	183,955
Sulfur:						
S content of pyrite	do.	4	2 e/	2 e/	2 e/	2 e/
Byproduct:						
Of metallurgy	do.	1,299 r/	1,342 r/	1,314 r/	1,331 r/	1,310
Of petroleum	do.	1,626 r/	1,682 r/	1,791 r/	2,013 r/	2,083
Talc and related materials:						
Talc		56,120	57,269	56,153	53,000 e/	50,000 e/
Pyrophyllite		934,007	947,713	913,973	913,822	764,079
Vermiculite e/		15,000	15,000	15,000	15,000	15,000
MINERAL FUELS AND RELATED MATERIALS						
Carbon black	thousand tons	704	757	757	776	723
Coal:						
Anthracite	do.	1	--	4	2	2
Bituminous 6/	do.	6,931	6,263	6,476	4,272	3,661
Total	do.	6,932	6,263	6,480	4,274	3,663
Coke including breeze:						
Metallurgical	do.	41,287	42,010	40,728	41,089	39,554
Gashouse including breeze	do.	705	593	528	135	14
Gas, natural:						
Gross 7/	million cubic mete	2,274	2,209	2,230	2,279	2,301
Marketed	do.	2,334	2,315	2,325	2,367	2,375
Petroleum:						
Crude	thousand 42-gallor	5,472	5,415	5,265	5,296	4,982
Refinery products:						
Gasoline:						
Aviation	do.	70	64	63	59 r/	50
Other	do.	312,959	319,263	328,164	336,158 r/	347,422
Asphalt and bitumen	do.	37,222	36,459	37,230	36,020 r/	33,627
Distillate fuel oil	do.	276,392	287,498	296,381	302,870 r/	289,777
Jet fuel	do.	45,010	49,520	47,155	58,015 r/	66,205
Kerosene	do.	171,010	171,675	177,577	173,725 r/	174,116
Liquefied petroleum gas	do.	52,806	56,665	56,272	58,777 r/	55,135
Lubricants	do.	17,080	17,203	17,423	17,822 r/	16,541
Naphtha	do.	109,821	112,110	104,379	120,981 r/	113,234
Paraffin	do.	793	909	823	790	807
Petroleum coke e/	do.	950	950	900	950 r/	950
Refinery fuel and losses e/ 8/	do.	160,000	160,000	155,000	160,000	160,000
Residual fuel oil	thousand 42-gallor	508,505	489,605	463,087	467,311 r/	451,494
Unfinished oils e/	do.	60,000	60,000	55,000	60,000	60,000
Total e/	do.	1,752,618	1,761,921	1,739,454	1,793,478 r/	1,769,358

See footnotes at end of table.

TABLE 1--Continued
JAPAN: PRODUCTION OF MINERAL COMMODITIES 1/

e/ Estimated. p/ Preliminary. r/ Revised.
1/ Table includes data available through September 15, 1999.
2/ Includes unalloyed ingot and alloyed ingot.
3/ Includes recovered from scrap and waste.
4/ Includes oxide of cerium, europium, gadolinium, lanthanum, neodymium, praseodymium, samarium, terbium, and yttrium.
5/ Represents metal content of vanadium pentoxide recovered from petroleum residues, ashes, and spent catalysts.
6/ All steam coal.
7/ Includes output from gas wells and coal mines.
8/ May include some additional unfinished oils.

Sources: Ministry of International Trade and Industry (Tokyo). Yearbook of Minerals and Nonferrous Metals Statistics, 1998; Yearbook of Iron and Steel Statistics, 1998; Yearbook of Chemical Industries Statisitics, 1998; Yearbook of Ceramics and Building Materials Statistics, 1998; and Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke, 1998.

TABLE 2
JAPAN: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Cement		Aso Cement Co. Ltd.	Tagawa, Fukuoka Prefecture	1,443
Do.		Chichibu Onoda Cement Corp. 1/	Ofunato, Iwate Prefecture; Chichibu and Kumagaya, Saitama Prefecture; Fujiwara, Mie Prefecture; and Tsukumi, Oita Prefecture	16,716
Do.		Daiichi Cement Co. Ltd.	Kawasaki, Kanagawa Prefecture	1,169
Do.		Denki Kagaku K.K.	Omi, Niigata Prefecture	2,762
Do.		Hachinohe Cement Co. Ltd.	Hachinohe, Aomori Prefecture	1,533
Do.		Hitachi Cement Co. Ltd.	Hitachi, Ibaraki Prefecture	941
Do.		Kanda Cement Co. Ltd.	Kanda, Fukuoka Prefecture	1,118
Do.		Mitsubishi Materials Corp.	Higashidori, Shimokita-gun, Apmori Prefecture; Higashiyama, Higashiiwai-gun, Iwate Prefecture; Yokoze, Saitama Prefecture; Kurosaki, Kyushu, and Higashitani, Fukuoka Prefecture	13,467
Do.		Mitsui Mining Co. Ltd.	Togawa, Fukuoka Prefecture	2,075
Do.		Myojo Cement Co. Ltd.	Itoigawa, Niigata Prefecture	2,482
Do.		Nihon Cement Co. Ltd. 1/	Kamiiso, Hokkaido Prefecture; Saitama, Saitama Prefecture; Tosa, Kochi Prefecture; Kawara, Fukuoka Peffecture; Saiki, Oita Perfecture	13,188
Do.		Nippon Steel Chemical Co. Ltd.	Tobata, Kitakyushu, Fukuoka Prefecture	855
Do.		Nittetsu Cement Co. Ltd.	Muroran, Hokkaido Prefecture	1,589
Do.		Ryukyu Cement Co. Ltd.	Yabu, Nago, Okinawa Prefecture	722
Do.		Sumitomo Osaka Cement Co. Ltd.	Tamura, Fukushima Prefecture; Aso, Tochigi Prefecture; Motosu, Gifu Prefecture; Sakata, Shiga Prefecture; Ako, Hyogo Prefecture; and Susaki, Kochi Prefecture	14,402
Do.		Tokuyama Cement Co. Ltd.	Nanyo, Yamaguchi Prefecture	5,936
Do.		Tosoh Corp.	Shin Nanyo, Yamaguchi Prefecture	2,869
Do.		Tsuruga Cement Co. Ltd.	Tsuruga, Fukui Prefecture	1,710
Do.		Ube Industries Ltd.	Ube, Isa, Yamaguchi Prefecture; and Kanda, Fukuoka Perfecture	10,736
Coal		Matsushima Coal Mining Co. Ltd.	Ikeshima in Sotome, Nagasaki Prefecture	1,400
Do.		Taiheiyo (Pacific) Coal Mining Co. Ltd.	Kushiro, Hokkaido Prefecture	2,200
Copper:				
Refined	metric tons	Hibi Kyodo Smelting Co. Ltd. (64% owned by Mitsui Mining and Smelting Co. Ltd., with minority ownership by Nittetsu Mining Co. Ltd. and Furukawa Co. Ltd.)	Tamano, Okayama Prefecture	190,800
Do.	do.	Mitsubishi Materials Crop.	Naoshima, Kagawa Prefecture	189,600
Do.	do.	Nippon Mining and Metals Co. Ltd. (wholly owned subsidiary of Nikko Kyodo Co. Ltd.)	Hitachi, Ibaraki Prefecture Saganoseki, Oita Prefecture	132,000 218,400
Do.	do.	Onahama Smelting and Refining Co. Ltd. (30% owned by Dowa Mining Co. Ltd., 12% by Furukawa Group Co., 49% by Mitsubishi Materials Corp., 4% by Mitsui Mining and Smelting Co. Ltd., and 5% by others)	Onahama, Fukushima Prefecture	258,000
Do.	do.	Sumitomo Metal Mining Co. Ltd.	Besshi, Ehime Prefecture	234,000
Do.	do.	Kosaka Smelting and Refining Co. Ltd. (wholly owned subsidiary of Dowa Mining Co. Ltd.)	Kosaka, Akita Prefecture	60,000
Do.	do.	Mitsui Mining and Smelting Co. Ltd.	Takehara, Hiroshima Prefecture	30,000
Gold:				
In concentrate	kilograms	Sumitomo Metal Mining Co. Ltd.	Hishikari, Kagoshima Prefecture	9,000
Refined	do.	Kosaka Smelting and Refining Co. Ltd. (wholly owned subsidiary of Dowa Mining Co. Ltd.)	Kosaka, Akita Prefecture	18,000
Do.	do.	Mitsui Mining and Smelting Co. Ltd.	Takehara, Hiroshima Prefecture	22,000
Do.	do.	Mitsubishi Materials Corp.	Naoshima, Kagawa Prefecture	60,000
Do.	do.	Nippon Mining and Metals Co. Ltd.	Hitachi, Ibaraki Prefecture	30,000

See footnotes at end of table.

TABLE 2--Continued
JAPAN: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Gold--Continued:				
Refined--Continued:	kilograms	Sumitomo Metal Mining Co. Ltd.	Niihama, Ehime Prefecture	30,000
Limestone		Chichibu Onoda Co. Ltd. 1/	Ohunato, Iwate Prefecture, and Ganji, Oita Perfecture	170,000
Do.		Mitsubishi Materials Corp.	Higashitani, Fukuoka Prefecture	10,000
Do.		Nippon Cement Co. Ltd. 1/	Garo and Tsukumi, Oita Prefecture	11,000
Do.		Nittetsu Mining Co. Ltd.	Torigatayama, Kochi Prefecture; Onoda-Tsukumi and Nittetsu-Tsukumi, Oita Prefecture; and Shiriya, Aomori Prefecture	29,000
Do.		Sumitomo-Osaka Cement Co. Ltd.	Shuho, Yamaguchi Prefecture, and Karazawa, Tochigi Prefecture	10,000
Do.		Todaka Mining Co. Ltd.	Todaka-Tsukumi, Otia Prefecture	13,500
Do.		Ube Industries Ltd.	Isa, Yamaguchi Prefecture	9,000
Iodine, crude	metric tons	Ise Chemical Corp. (52.4% owned by Asahi Glass Co. Ltd., 11.2% by Mitsubishi Corp.)	Oami-Shirasato, and Ichinomya, Chiba Prefecture; and Sadowara, Miyazaki Prefecture	3,600
Do.	do.	Godo Shigen Sangyo Co. Ltd. (11% owned by Kanto Natural Gas Development Co. Ltd., 10% by Mitsui & Co.)	Chosei, Chiba Prefecture	2,400
Do.	do.	Kanto Natural Gas Development Co. Ltd. (21.9% owned by Mitsui Chemicals, Inc.,14.3% by Godo Shigen Sangyo, Co.)	Mobara, Chiba Prefecture	1,200
Do.	do.	Nihon Tennen Gas Co. Ltd. (50% owned by Kanto Natural Gas Development Co., Ltd.; 41% by Tomen Corp.)	Shirako and Yokoshiba, Chiba Prefecture	1,200
Do.	do.	Toho Earthtech, Inc. (34.1% owned by Itochu Corp., 32.2% by Mitsubishi Gas Chemical Co., Ltd., 31.1% by Nippon Light Metal Co.)	Kurosaki, Niigata Prefecture	720
Iodine, crude	metric tons			
Do.	do.	Nippon Chemicals Co. Ltd. (17% by Nippon Shokubai Co., Ltd., 16.4% by Takeda Chemical Industries Ltd., 13.6% by Chugai Boyeki Co. Ltd.)	Isumi, Chiba Prefecture	720
Lead:				
In concentrate		Kamioka Mining and Smelting Co. Ltd. (wholly owned subsidiary of Mitsui Mining and Smelting Co. Ltd.)	Kamioka, Gifu Prefecture	4
Do.		Toyoha Mining Co. Ltd. (wholly owned subsidiary of Nippon Mining and Metals Co. Ltd.)	Toyoha, Hokkaido Prefecture	8
Refined	metric tons	Kamioka Mining and Smelting Co. Ltd. 2/	Kamioka, Gifu Prefecture	33,600
Do.	do.	Mitsui Mining and Smelting Co. Ltd.	Takehara, Hiroshima Prefecture	43,800
Do.	do.	Toho Zinc Co. Ltd.	Chigirishima, Hiroshima Prefecture	120,000
Do.	do.	Sumitomo Metal Mining Co. Ltd.	Harima, Hyogo Prefecture	30,000
Do.	do.	Kosaka Smelting and Refining Co. Ltd.	Kosaka, Akita Prefecture	25,200
Do.	do.	Hosokura Mining Co. Ltd. (wholly owned subsidiary of Mitsubishi Materials Corp.) 3/	Hosokura, Miyagi Prefecture	21,600
Manganese:				
In electrolytic dioxide		Mitsui Mining and Smelting Co. Ltd.	Takehara, Hiroshima Prefecture	25
Do.		Tosoh Corp.	Hyuga, Miyazaki Prefecture	32
Nickel:				
In ferronickel	metric tons	Hyuga Smelting Co. Ltd. (wholly owned subsidiary of Sumitomo Metal Mining Co. Ltd.)	Hyuga, Miyazaki Prefecture	18,000
Do.	do.	Nippon Yakin Kogyo Co. Ltd.	Oheyama, Kyoto Prefecture	14,400
Do.	do.	Pacific Metals Co. Ltd.	Hachinohe, Aomori Prefecture	54,000
In oxide	do.	Tokyo Nickel Co. Ltd.	Matsuzaka, Mie Prefecture	43,000
Refined	do.	Sumitomo Metal Mining Co. Ltd.	Niihama, Ehime Prefecture	30,000

See footnotes at end of table.

TABLE 2--Continued
JAPAN: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Pyrophyllite		Goto Kozan Co. Ltd.	Goto, Nagasaki Prefecture	204
Do.		Ohira Kozan Co. Ltd.	Ohira, Okayama Prefecture	132
Do.		Sankin Kogyo Co. Ltd.	Otsue, Hiroshima Prefecture	72
Do.		Shinagawa Shirenga Co. Ltd.	Mitsuishi, Okayama Prefecture	180
Do.		Shokozan Kogyosho Co. Ltd.	Yano-Shokozan, Hiroshima Prefecture	180
Do.		Showa Kogyo Co. Ltd.	Showa-Shokozan, Hiroshima Prefecture	60
Steel, crude		Kawasaki Steel Corp.	Mizushima, Okayama Prefecture, and Chiba, Chia Prefecture	16,880
Do.		Kobe Steel Ltd.	Kakogawa and Kobe, Hyogo Prefecture	8,300
Do.		NKK Corp.	Fukuyama, Hiroshima Prefecture, and Keihin, Tokyo Prefecture	22,130
Do.		Nippon Steel Corp.	Oita, Oita Prefecture; Kawata, Fukuoka Prefecture; Kimitsu, Chiba Prefecture; and Nagoya, Aichi Prefecture	48,800
Do.		Sumitomo Metal Industries, Ltd.	Kashima, Ibaraki Prefecture; Kokura, Fukuoka Prefecture; and Wakayama, Wakayama, Wakayama Prefecture	22,140
Titanium:				
In sponge metal		Sumitomo Sitix Corp. (92.4% owned by Sumitomo Metal Industries, Ltd. and 7.6% owned by Kobe Steel Ltd.)	Amagasaki, Hyogo Prefecture	15
Do.		Toho Titanium Co. Ltd. (47% owned by Nippon Mining and Metals Co. Ltd., 20% by Mitsui & Co. Ltd., and 33% by others)	Chigasaki, Kanagawa Prefecture	11
In oxide	metric tons	Fuji Titanium Industry Co. Ltd. (24.8% owned by Ishihara Sangyo Co. Ltd.)	Kobe, Hyogo Prefecture	16,200
Do.	do.	Furukawa Co. Ltd.	Osaka, Osaka Prefecture	23,400
Do.	do.	Ishihara Sangyo Co. Ltd.	Yokkaichi, Mie Prefecture	155,000
Do.	do.	Sakai Chemical Industries Co. Ltd.	Onahama, Fukushima Prefecture	43,200
Do.	do.	Tayca Corp.	Saidaiji, Okayama Prefecture	60,000
Do.	do.	Titan Kogyo Co. Ltd.	Ube, Yamaguchi Prefecture	17,000
Do.	do.	Tohken Products Corp.	Akita, Akita Prefecture	30,000
Zinc:				
In concentrate		Kamioka Mining and Smelting Co. Ltd.	Kamioka, Gifu Prefecture	50
Do.		Toyoha Mining Co. Ltd.	Toyoha, Hokkaido Prefecture	60
Refined	metric tons	Akita Smelting Co. Ltd. (57% owned by Dowa Mining Co. Ltd., 24% by Nippon Mining and Metals Co. Ltd., 14% by Sumitomo Metal Mining Co. Ltd., and 5% by Mitsubushi Materials Corp.	Iijima, Akita Prefecture	186,000
Do.	do.	Hachinohe Smelting Co. Ltd. (20% owned by Dowa Mining Co. Ltd., 50% by Mitsui Mining and Smeltinf Co. Ltd., 10% each by Nippon Mining and Metals Co. Ltd. and Mitsubishi Materials Corp., and 5% each by Toho Zinc Co. and Nisso Smelting Co.)	Hachinohie, Aomori Prefecture	108,000
Do.	do.	Hikoshima Smelting Co. Ltd.	Hikoshima, Yamaguchi Prefecture	84,000
Do.	do.	Kamioka Mining and Smelting Co. Ltd.	Kamioka, Gifu Prefecture	72,000
Do.	do.	Nikko Mikkaichi Recycle Co. Ltd. 4/	Mikkaichi, Toyama Prefecture	18,000
Do.	do.	Toho Zinc Co. Ltd.	Annaka, Gunma Prefecture	139,200
Do.	do.	Sumitomo Metal Mining Co. Ltd.	Harima, Hyogo Prefecture	90,000

1/ The companies merged and were named Taiheiyo Cement Corp. in October 1998.
2/ The plant was renovated to a secondary lead smelter recycling batteries in 1995.
3/ The plant became a secondary lead smelter recycling batteries in 1995.
4/ The plant closed in October 1995, was renovated to a secondary zinc refinery in 1997.

TABLE 3
JAPAN: RESERVES OF MAJOR MINERAL COMMODITIES IN 1997

(Thousand metric tons unless otherwise specified)

Commodity		Reserves	
Coal 1/		821,000	
Copper ore, Cu content		36	
Dolomite 2/		1,188,000	
Gold ore, Au content	kilograms	180,207	
Iodine		18,000	e/
Lead ore, Pb content		623	
Kaolin		36,025	
Limestone 3/		57,915,000	
Pyrophyllite		151,100	
Silica sand 4/		275,200	
Silica stone, white 5/		1,738,900	
Zinc ore, Zn content		3,245	

e/ Estimated.
1/ Recoverable reserves, including 17 million metric tons of lignite.
2/ Average ore grade is 17.9% MgO.
3/ Average ore grade is 54.2% CaO.
4/ Average ore grade is 73.1% SiO.
5/ Average ore grade is 87.9% SiO.

Sources: Ministry of International Trade and Industry (Tokyo). Agency of Natural Resources and Energy.

TABLE 4
JAPAN: MINERALS TRADE

(Million of U.S. dollars)

Commodity		Imports 1/		Exports 1/	
Code	Description	1997	1998	1997	1998
25	Salt, sulfur, earths and stone, lime, plastering materials, cement	1,661	1,409	659	334
26	Ferrous and nonferrous metal ores, slag, ash	7,201	6,114	22	21
27	Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes	62,851	43,172	1,912	1,232
28	Inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth metals of radioactive elements or of isotopes	3,257	2,980	1,725	1,570
31	Fertilizers	540	491	111	85
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	1,114	906	894	813
69	Ceramic products	614	512	1,340	1,236
70	Glass and glassware	1,273	996	2,043	1,813
71	Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal, and articles thereof; imitation jewelery; coin	6,447	5,335	1,509	1,638
72	Iron and steel	4,207	2,930	12,842	11,870
73	Articles of iron and steel	2,189	1,821	6,560	6,093
74	Copper and articles thereof	1,590	1,038	2,175	2,087
75	Nickel and articles thereof	1,023	717	213	182
76	Aluminum and articles thereof	6,039	4,753	1,517	1,491
78	Lead and articles thereof	44	30	17	14
79	Zinc and articles thereof	265	159	58	85
80	Tin and articles thereof	176	146	19	18
81	Other base metals; cermets; articles thereof	866	831	497	454
	Total, minerals trade	101,357	74,340	34,113	31,046
	Total, Japan merchandise trade	338,705	279,756	421,354	386,603

1/ Values have been converted from Japanese yen (Y) to U.S. dollars at the rate of Y120.92=US$1.00 for 1997 and Y131.02=US$1.00 for 1998.

Source: Ministry of Finance, Japan Exports & Imports, Commodity by Country, December 1997-98.

TABLE 5
JAPAN: MAJOR OVERSEAS DEVELOPMENT PROJECTS OF NONFERROUS METALS MINES AND SMELTERS IN THE 1990's

Item	Location and name of the project					
	Northern Territory, Australia	New South Wales, Australia	British Columbia, Canada	British Columbia, Canada	Region III, Chile	Region I, Chile
	McArthur River	Northparkes	Mount Polley	Huckleberry	La Candelaria	Collahuasi
Nature of project involvement	Investment in exploration and development	Investment in exploration and development	Equity participation	Equity participation and provided loan	Investment in exploration and development	Equity participation and provided loan.
Participated Japanese companies and their equity share	Nippon Mining and Metals Co. Ltd., 15%; Mitsui & Co. Ltd., 5%; Mitsubishi Materials Corp., 5%; Marubeni Corp., 5%	Sumitomo Metal Mining Co. Ltd. and Sumitomo Corp., 20%	Sumitomo Corp., 45%	Mitsubishi Materials Corp., 25%; Dowa Mining Co. Ltd., 5%; Furukawa Co. Ltd., 5%; Marubeni Corp., 5%	Sumitomo Metal Mining Co. Ltd., 15%; and Sumitomo Corp., 5%	Mitsui & Co. Ltd., 6.9%; Mitsui Mining & Smelting Co. Ltd., 1.5%: Nippon Mining and Metals Co. Ltd., 3.6%.
Majority equity holder and/or other equity holder	Mount Isa Mines Ltd. of Australia, 70%	North Broken Hill Peko Ltd. of Australia, 80%	Imperial Metals Corp. of Canada, 55%	Princeton Mining Corp. of Canada, 60%	Phelps Dodge Corp. of the United States, 80%	Falconbridge Ltd. of Canada, 44%; and Mantos Minorco S.A. of Luxembourg, 44%.
Mineral commodity involved	Lead, silver, zinc	Copper and gold	Copper and gold	Copper	Copper and gold	Copper.
Estimated reserves and ore grade	227 million metric tons, 4.1% lead, 9.2% zinc plus 41 grams per ton of silver	80 million metric tons, 1.12% copper plus 0.56 gram per ton of gold	81.5 million metric tons, 0.3% copper plus 0.42 gram per ton of gold	162 million metric tons, 0.47% copper	399 million metric tons, 1.06% copper plus 0.25 gram per ton of gold	3,100 million metric tons, 0.82% copper.
Type of mine	Underground	Open pit and underground	Open pit	Open pit	Open pit	Open pit.
Total cost of the project and Japanese share	246 million Australian $ 22 million Australian $	303 million Australian $ 75.6 million Australian $	123 million Canadian $ 109 millon Canadian $	136 million Canadian $ 78 million Canadian $	592 million US$ 296 million US$	1,800 million US$ 174 million US$.
Annual production capacity	1,350,000 metric tons of crude ore containing 6.2% lead, 13.9% zinc plus 63 grams per ton of sliver	5,230,000 metric tons of crude ore containing 1.3% copper plus 0.6 gram per ton of gold	6,500,000 metric tons of crude ore	6,000,000 metric tons of crude ore	11,000,000 metric tons of crude ore containing 1.1% copper	22,000,000 metric tons of crude ore containing 1.5% copper.
Annual shipment to Japan	25,000 metric tons of lead and 56,000 metric tons of zinc in mixed concentrate	11,000 metric tons of copper in concentrate plus gold value	15,000 metric tons of copper in concentrate plus gold value	28,500 metric tons of copper in concentrate	60,000 metric tons of copper in concentrate plus gold value	83,000 metric tons of copper in concentrate.
Construction started	August 1993	May 1993	September 1996	1996	April 1993	1996.
Production started or planned	September 1995	October 1995	July 1997	October 1997	March 1995	October 1998.

TABLE 5--Continued
JAPAN: MAJOR OVERSEAS DEVELOPMENT PROJECT OF NONFERROUS METALS MINES AND SMELTERS IN THE 1990's

Item	Location and name of the project					
	Region IV, Chile	Region III, Chile	Sumbawa Island, Indonesia	East Java, Indonesia	Anhui Province, China	New South Wales, Australia
	Los Pelambres	El Bronce	Batu Hijau	Gresik Copper Smelter	Jinlong Copper Smelter	Port Kembla Copper Smelter
Nature of project involvement	Equity participation	Investment in exploration and development	Equity participation	Equity participation and technology transfer	Equity participation and technology transfer	Equity participation and technology transfer.
Participated Japanese companies and their equity share	Nippon Mining and Metals Co. Ltd., 15%; Mitsubishi Materials Corp., 10%; Marubeni Corp., 8.75%; Mitsubishi Corp., 5%; Mitsui & Co. Ltd., 1.25%	Nittetsu Mining Co. Ltd., 32%; and Itochu Corp., 8%	Sumitomo Corp., 27.5%; Sumitomo Metal Mining Co. Ltd., 5.0%; Mitsubishi Materials Corp., 2.5%	Mitsubishi Materials Corp., 60.5%; Mitsubishi Corp., 9.5%; Nippon Mining and Metals Co. Ltd., 5.0%	Sumitomo Metal Mining Co. Ltd., 20%; Sumotomo Corp., 7.5%; Itochu Corp., 7.5^	Furukawa Co. Ltd., 52.5%; Nittetsu Mining Co. Ltd., 20.0%; Nissho Iwai Corp., 17.5%; Itochu Corp., 10%.
Major equity holder and/or other equity holder	Antofagasta Holding, a subsidiary of Luksic Group of the United Kingdom, 60%	El Bronce SA of Chile, 60%	Newmont Gold Co. of the United States, 45%; and P.T. Pukuafu Indah of Indonesia, 20%	P.T. Freeport Indonesia of Indonesia, 25.0%	Tongling Nonferrous Metals Corp. of China, 52.0%; and Hong-Kong based Jinguang International Ltd., 13.0%	None.
Mineral commodity involved	Copper and molybdenum	Copper	Copper and gold	Copper and gold	Copper	Copper.
Estimated reserves and ore grade	2,400 million metric tons, 0.63% copper	20 million metric tons, 1.5% copper	1,022 million metric tons, 0.52% copper plus 0.41 gram per ton of gold	Not applicable	Not applicable	Not applicable.
Type of mine	Open pit	Underground	Open pit	do.	do.	Do.
Total cost of the project Japanese share	1,360 million US$ 164 million US$	132 million US$ 116 million US$	1,925 million US$ 513 million US$	738 million US$	153 million US$	191 million US$.
Annual production capacity	31,000,000 metric tons of crude ore containing 0.75% copper and 0.02% molybdenum	1,820,000 metric tons of crude ore containing 1.5% copper	43,800,000 metric tons of crude ore	200,000 metric tons of copper	100,000 metric tons of copper	120,000 metric tons of copper.
Annual shipment to Japan	138,000 metric tons of copper in concentrate	10,000 metric tons of copper in concentrate	101,400 metric tons of copper in concentrate	Unspecified	Unspecified	Unspecified.
Construction started	November 1997	December 1998	September 1996	July 1996	1996	September 1997.
Production started or planned	March 2000	December 2000	October 1999	December 1998	April 1997	June 1999.

Sources: The Ministry of International Trade and Industry, Agency of Natural Resources and Energy, Mining Division, Mining Handbook, 1999, p. 208-218. Keiichi Goto, 1999, The current situation of the Japanese nonferrous mining industry: Journal of the Mining and Material Processing Institute of Japan, v. 115, no. 1, January, p. 6-7.

TABLE 6
JAPAN: DOMESTIC ORDERS FOR ORDINARY AND SPECIALTY STEEL PRODUCTS, BY END USE

(Thousand metric tons)

End use	Ordinary steel products				Specialty steel products			
	1995	1996	1997	1998	1995	1996	1997	1998
Automobiles	9,513	9,304	9,722	8,314	2,649	2,591	2,709	2,279
Construction	14,280	14,491	14,283	12,945	676	743	773	689
Conversion and processing	3,109	3,420	3,423	2,848	3,558	3,422	3,630	2,980
Electric machinery and equipment	2,413	2,308	2,417	2,003	105	108	125	104
Home and office appliances	673	656	623	523	243	226	228	186
Industrial machinery and equipment	1,676	1,679	1,741	1,284	1,250	1,332	1,364	983
Rolling stock	31	33	32	27	15	14	14	16
Shipbuilding and marine equipment	2,804	3,087	3,261	3,166	101	113	79	76
Steel dealers	20,846	22,099	21,656	17,994	1,325	1,377	1,412	1,120
Tanks and containers	2,099	2,050	1,985	1,769	27	29	21	20
Other:	515	519	592	504	138	143	158	89
Domestic demand total	57,959	59,646	59,735	51,377	10,087	10,098	10,513	8,542
Exports	14,632	13,538	15,619	15,778	3,563	3,326	4,065	4,197
Total	72,591	73,184	75,354	67,155	13,650	13,424	14,578	12,739

Source: The Japan Iron and Steel Federation.

TABLE 7
JAPAN: IRON AND STEEL PRODUCTS TRADE, BY DESTINATION

(Thousand metric tons)

Destinations	Exports				Imports			
	1995	1996	1997	1998	1995	1996	1997	1998
Asia:	17,894	16,067	17,647	15,556	8,313	5,755	6,871	5,147
China	3,843	2,538	2,659	2,477	3,250	1,284	1,815	906
Hong Kong	1,254	1,382	1,644	1,568	(1/)	(1/)	(1/)	(1/)
Korea, the Republic of	3,128	3,344	3,566	2,756	3,718	3,306	3,434	3,024
Malaysia	1,358	1,509	1,661	1,138	58	96	116	15
Taiwan	2,585	2,231	2,428	2,959	710	736	1,139	998
Thailand	2,629	2,236	2,194	1,749	36	33	32	31
Singapore	1,111	961	1,183	918	(1/)	(1/)	(1/)	(1/)
Other countries	1,986	1,866	2,312	1,991	541	300	335	173
Middle East	583	628	848	1,146	37	8	1	5
Europe	615	710	734	1,192	1,255	885	926	385
North America:	2,702	2,409	3,170	8,350	358	192	34	30
United States	2,334	2,049	2,703	7,020	256	104	20	17
Other countries	368	360	467	1,330	102	88	14	13
South America:	387	223	382	563	753	626	637	249
Brazil	31	21	66	94	704	606	592	189
Other countries	356	202	316	469	49	20	45	60
Africa:	372	269	408	409	647	695	818	606
South Africa	38	32	39	59	563	631	736	551
Other countries	334	237	369	350	84	64	82	55
Oceania:	434	309	345	434	360	465	282	209
Australia	61	58	275	381	225	302	166	117
Other countries	373	251	70	53	135	163	116	92
Total	22,987	20,615	23,534	27,650	11,723	8,626	9,569	6,631

1/ Includes in other countries.

Source: Ministry of International Trade and Industry, Yearbook of Iron and Steel Industry, 1995-98.

TABLE 8
JAPAN: COAL DEMAND, BY END USE

(Metric tons)

End use	Anthracite		Bituminous				Total	
			Coking		Steam			
	1997	1998	1997	1998	1997	1998	1997	1998
Briquets:								
Domestic	--	--	--	--	1,508	1,658	1,508	1,658
Imported	80,672	53,413	--	--	2,997	3,279	83,669	56,692
Cement and ceramics:								
Domestic	--	--	--	--	350	320	350	320
Imported	1,476,007	1,187,790	--	--	8,601,288	7,419,559	10,077,295	8,607,349
Chemicals, imported	282,093	188,124	--	--	4,304,710	3,989,525	4,586,803	4,177,649
City gas, imported	10,905	--	22,666	12,250	--	--	33,571	12,250
Coke, imported	--	--	5,786,302	5,337,936	--	--	5,786,302	5,337,936
Electric power:								
Domestic	--	--	--	--	5,222,585	3,781,568	5,222,585	3,781,568
Imported	--	--	--	--	39,378,461	42,241,925	39,378,461	42,241,925
Iron and steel, imported	2,135,072	2,332,897	59,579,783	57,467,472	1,993,511	2,475,887	63,708,366	62,276,256
Paper and pulp:								
Domestic	--	--	--	--	2,074	--	2,074	--
Imported	--	--	--	--	4,043,584	4,364,853	4,043,584	4,364,853
Other:								
Domestic	--	--	--	--	19,438	21,170	19,438	21,170
Imported	26,335	37,450	--	1,500	1,731,503	1,762,428	1,757,838	1,808,378
Total	4,011,084	3,799,674	65,388,751	62,819,158	65,302,009	66,062,172	134,701,844	132,681,004
Of which								
Domestic	--	--	--	--	5,245,955	3,804,716	5,245,955	3,804,716
Imported	4,011,084	3,799,674	65,388,751	62,819, 158	60,056,054	62,257,456	129,455,889	128,876,288

Source: Ministry of International Trade and Industry, Yearbook of Production, Supply, and Demand of Petroleum, Coal, and Coke, 1997-98.