THE MINERAL INDUSTRY OF

JAPAN

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Japan's reserves of limestone, pyrophyllite, and silica stone and sand are quite large and of world significance. Japan's reserves of nonferrous minerals, natural gas, and crude petroleum are, however, very small. Japan has considerable reserves of coal, but the production cost is too high and cannot compete with the major coal-producing countries in the world market. *(See table 3.)* Japan relied on imports to meet virtually all its raw material requirements for energy, ferrous, and nonferrous metals for its world-class mineral-processing and mineral-related manufacturing sectors. Japan also relied on imports to meet some of its requirements for refined base and rare metals, industrial mineral products, and refined petroleum products.

In 1996, Japan was the world's largest producer of iodine, pig iron, electrolytic manganese dioxide, selenium metal, and crude steel. It was the world's second largest producer of cadmium metal, cement, nickel metal, tellurium metal, and titanium sponge metal. Japan was the world's third largest producer of copper metal, indium metal, limestone, pyrophyllite, 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, fluorspar, gallium metal, iron ore, ilmenite and rutile, 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. The country was one of the world's major producers and exporters of cement, fertilizer materials, iodine, electrolytic manganese dioxide, high-purity rare metal products, steel products, and titanium sponge metal and mill products.

According to the Government of Japan (Economic Planning Agency, 1997), the value of output by the mining sector was $10.9 billion and accounted for 0.21% of Japan's gross domestic product (GDP) in 1995. Despite the small contribution by the mining sector, Japan's mineral-processing sector contributed about 5.2% to Japan's GDP and played a very important role in providing the primary materials for the export-oriented world-class manufacturing sector of the Japanese economy. The mineral-processing sector also played a significant role in providing ferrous and nonferrous metals, fabricated metal products, and industrial mineral products to the growing economies of China, Hong Kong, the Republic of Korea, Malaysia, Singapore, Taiwan, and Thailand.

Japan was an important market for U.S. exports of primary aluminum, beryllium metal, boron oxide and acid, cerium oxide and compounds, chromium trioxide and hydroxide, coal, copper (concentrate, refined metal, and chemicals), ferrous and nonferrous scrap metals, helium, lead ore and concentrate, lithium oxide and hydroxide, dust and powder of precious stones (abrasive), primary magnesium, molybdenum (concentrate, metal, and chemicals), phosphate rock, high-purity silicon and silicon oxide, silver metal, soda ash, tantalum metal and powder products, refined petroleum products (especially petroleum coke), uranium oxide and other compounds, and zinc ore and concentrate.

Japan was an important supplier of fabricated aluminum mill and copper mill products, cement, iodine, iron oxide, high-purity rare metals, high-quality steel products, titanium sponge, titanium scrap, and titanium powder to the United States.

Government Policies and Programs

The underlying mineral policy of Japan was to secure a stable supply of raw material requirements for its national security and growing economy. To achieve that overall policy goal for the next 9 years, the Ministry of International Trade and Industry (MITI) set three additional objectives for the nonferrous minerals sector—to improve competitiveness of domestic nonferrous metal smelters in the world market and to encourage and support Japanese trading and mining companies to participate in overseas nonferrous minerals exploration and development projects and to establish and invest in nonferrous metal smelting businesses overseas.

In July, the Metal Mining Agency of Japan (MMAJ) and the Japan International Cooperation Agency (JICA) signed an agreement with the Department of Mines and Petroleum of the Ministry of Natural Resources, Honduras, for a 2-year mineral-exploration project. MMAJ and JICA will conduct geologic and geophysical surveys, including drilling to identify and confirm reserves of lead, silver, and zinc in a 4-square-kilometer (km^2) area of San Antonio and a lead-silver-zinc deposit, about 40 kilometers (km) southeast of Tegucigalpa, the capital of Honduras, in the next 2 years (Nikkan Sangyo Shimbun, 1996b).

In August, the Government of Japan, through MMAJ and JICA, signed an agreement with the Corporacion Nacional del Cobre de Chile, one of Chile's State-owned copper producers, to explore jointly for copper in a 80-km^2 area of the Pastos Largo, near El Abra, the Chuquicamata, and the Collahuasi copper deposits, about 1,300 km north of Santiago. According to MMAJ, geologic, geochemical, geophysical, and other surveys, including drilling, will be conducted over a 3-year

period to investigate the geology and mineralization of the area. In 1996, MMAJ also signed a new cooperation agreement with another of Chile's State-owned copper producer, Empresa Nacional de Mieria, for joint exploration in a 30-km^2 area of Guanaca, about 800 km north of Santiago, and in the Cholqui area, about 93 km north of Santiago (Mining Journal, 1996b).

MITI, through MMAJ, reached a cooperative agreement with the Government of Vietnam to conduct a 3-year mineral exploration there. Beginning in 1997, MMAJ was to carry out a supraregional survey by using its satellite image analysis technology to identify the potential areas of mineralization beginning in 1997 (Nihon Kogyo Shimbun, 1996).

Environmental Issues

In recent years, Japan's biggest mine-related environmental issue has been the treatment of the outflowing acid drainage from closed and abandoned nonferrous metal mines. According to the Mine Safety Division of MITI (Kagawa, 1996), Japan has about 7,000 closed and abandoned mines, of those mines; about 230 require drainage treatment to prevent mine-related environmental and health hazards. In its continuing effort to deal with the issue, the Government instituted mine-related pollution-prevention programs at selected closed and abandoned nonferrous metals mines. In MITI's fiscal year 1996 budget, about $33 million was allocated for construction of drainage treatment plants and construction works for other water-pollution prevention, as well as other environmental protection measures, at selected closed and abandoned nonferrous metals mines. Of that $33 million, $26 million was for the pollution-prevention programs at the nonowners' closed and abandoned mines, and $7 million, for subsidizing the treatment costs of mine drainage at the owners' closed and abandoned mines. Additionally, the Government had included about $12 million in the budget for MMAJ to administer the mine-related pollution programs, including interest subsidies for the pollution-prevention loans.

As of 1996, drainage treatment plants operating at 73 closed and abandoned mines were using either lime or magnesium hydroxide as raw materials and either the ion-exchange method or the bacterial oxidation system to neutralize the outflowing acid drainage. About three-quarters of the treatment costs were paid by the central and local governments. In recent years, MMAJ has been conducting research to develop technology for labor- and energy-cost savings at the mine-drainage treatment plant. As a result of its ongoing research, MMAJ successfully developed a new technology to cut the energy cost for the drainage treatment plant in 1996. Instead of using slaked lime at the closed Tsuchihata copper mine in Iwate Prefecture, unslaked lime was used in the neutralization process and circulated part of the sludge back to the neutralization tank during the solid-liquid separation process. As a result of this new treatment process, the power cost was cut by 12%. To optimize the operational efficiency, MMAJ planned to conduct further testing at the Tsuchihata Mine in 1997 (Nikkei Sangyo Shimbun, 1996c).

Production

Mine production of all nonferrous minerals continued the downward trend, which began in 1993 because of depleting domestic ore reserves, the high Japanese yen value, and lower prices of metals. Mine production of industrial minerals and construction-related materials except dolomite and limestone was at a lower level than that of 1995 because of slow economic recovery.

In the mineral fuels sector, coal output increased slightly despite the closing of the Sorachi coal mine in Utashinai, Hokkaido Prefecture, in March 1995. Output of natural gas increased slightly, but the production of crude petroleum was at a lower level than that of 1995.

In the mineral-processing sector, production of most nonferrous metals except copper, gold, and titanium sponge decreased because of weaker domestic demand and lower market prices. Cement production increased owing mainly to a slight increase in domestic demand for cement by the construction industry. Production of most refined petroleum products continued the upward trend, which began in 1993 because of the continued strong demand for gasoline, naphtha, and distillate fuel oil. *(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. Japan was, however, a net importer of minerals with a mineral trade deficit of about $62.6 billion in 1996 because of its large import bill for mineral fuels.

According to the Government trade statistics (Ministry of Finance, 1996), imports of minerals totaled $69.5 billion. Of that total, $60.9 billion was for mineral fuels, including coal, LNG, crude and partially refined petroleum, refined petroleum products, and other mineral fuels; $6.9 billion, for nonfuel minerals, including ores and concentrates of ferrous and nonferrous minerals, slag, scrap, and ash of iron and steel, other metals, and metal compounds; and $1.7 billion, for salt, sulfur, earths and stone, plastering materials, lime, and cement. Imports of processed minerals and metals totaled $27.5 billion, of which $7.7 billion was for precious and semiprecious stones and precious metals; $2.9 billion, for products of stone, cement, asbestos, mica, ceramics, and glass; and $16.9 billion, for products of iron and steel, nonferrous metals, and rare metals. Japan's import bills for minerals and processed minerals products totaled $97 billion and accounted for 27.8% of Japan's total imports, which were valued at $349.2 billion.

Japan's export earnings from minerals and processed minerals products totaled $34.4 billion and accounted for 8.3% of Japan's total exports, which were valued at $411.1 billion. Exports of slat, sulfur, earths and stone, plastering materials, lime, cement, and mineral fuels were $2.7 billion. Exports of processed mineral products of stone, cement, asbestos, mica, ceramics, and glass amounted to $4.6 billion. Exports of precious and semprecious stones and precious metals were $1.3

billion. Exports of iron and steel products, nonferrous metals, and rare metals totaled $25.8 billion.

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 world-class ferrous, nonferrous, and industrial minerals processing sector. Mining and mineral-processing businesses were owned and operated by private companies incorporated in Japan. Because of the high value of the Japanese yen and the slow economic recovery of the past 2 years, the minerals industry continued to cut its workforce and output capacity.

In the mining sector, coal was produced from three major mines and several small-scale mines in Honshu (main island), Hokkaido, and Kyushu and had a total capacity of about 6.5 million metric tons per year (Mt/yr) and a workforce of 2,500. The number of operating nonferrous metal mines was reduced from 19 in 1995 to 17, and employment declined from 1,279 in 1995 to 1,202. The number of operating industrial-minerals mines declined from 557 in 1995 to 544, and employment declined from 12,518 in 1995 to 12,123. According to the Government statistics (Management and Coordination Agency, 1996), the number of persons employed by the mining industry was 60,000, accounting for 0.09% of the Japanese labor force of 67.1 million.

In the mineral-processing sector, the steel industry cut its employment from 255,875 in 1995 to 237,449. The industry's pig iron production capacity remained unchanged at 95.5 Mt/yr, but its steelmaking capacity decreased slightly from 149.8 Mt/yr in 1995 to 149.7 Mt/yr. Despite lower tariff on imports of nonferrous metals, Japan's refining capacity of copper remained unchanged at 1.3 Mt/yr and the industry had a workforce of 4,113. A zinc refinery was closed in Mikkaichi, Toyama Prefecture, in late 1995, and another was closed in Akita, Akita Prefecture, in 1996. As a result, refining capacity of slab zinc was reduced by 14%, to 649,200 metric tons per year (t/yr). Refining capacity of primary lead was reduced by 22.2%, to 193,800 t/yr, because of the conversion of two lead smelters to secondary lead smelter. The workforce in the primary lead and slab zinc smelting and refining industries was also reduced by 531 to 373 and by 394 to 1,331, respectively. The capacity of a nickel refinery in Niihama, Ehime Prefecture and a nickel oxide smelter in Matsuzaka, Mie Prefecture, were expanded by 7.5%, to 30,000 t/yr, and by 20%, to 43,000 t/yr, respectively. *(See table 2.)*

Commodity Review

Metals

Aluminum.—Production of primary aluminum by Nippon Light Metal Co. Ltd. at its Kanbara plant in Shizuoka Prefecture remained insignificant. Japan relied on imports to meet virtually all its annual requirement for primary aluminum. According to the Government trade statistics, Japan imported 2.76 million metric tons (Mt) of primary aluminum, of which 114,784 metric tons (t) was high-purity primary aluminum ingot, 1.95 Mt was regular-grade primary aluminum ingot, and 692,675 t was primary aluminum alloy ingots. Although Japan had widely diversified its overseas sources of primary aluminum into more than 50 countries, Australia, Brazil, Canada, Indonesia, New Zealand, Russia, the United States, and Venezuela had been the major supplying countries during the past 2 years. Imports of high-purity primary aluminum ingots were mainly from New Zealand, 30%; the United Arab Emirates, 23%; Indonesia, 22%; and the United States, 10%. Imports of regular-grade primary aluminum ingots were mainly from Brazil, 21%; Australia, 20%; Russia, 18%; the United States, 8%; South Africa, 7%; Indonesia and New Zealand, 6% each; and Bahrain and Venezuela, 5% each. Imports of primary aluminum alloyed were mainly from Canada, 18%; Russia, 17%; Taiwan, 14%; Australia, 10%; and the United States, 9%. Imports of primary aluminum were valued at $4.4 billion. Under the agreement with the World Trade Organization, the tariff on primary aluminum was 0.6% in 1996 and will be reduced to 0.4% in 1997 and 0.2% in 1998.

According to MITI, domestic demand for primary aluminum increased from almost 2.26 Mt in 1995 to more than 2.31 M t mainly because of increased consumption by the aluminum rolling sector. Consumption of primary aluminum by the aluminum casting, the aluminum wire and cable, and by the secondary smelting sectors decreased. Consumption of primary aluminum by sector was as follows: aluminum rolling, 1.95 Mt; aluminum casting, 103,674 t; secondary smelting, 88,488 t; wire and cable, 76,234 t; aluminum diecasting, 30,870 t; steel deoxidization, 25,102 t; and other, 41,431 t. According to the Government trade statisitcs, Japan's exports of primary aluminum, including aluminum alloyed ingot totaled 12,012 t and were valued at $26.9 million. The major buyers of primary aluminum were China, Hong Kong, Indonesia, Singapore, and Thailand. The yearend stocks of primary aluminum decreased from 405,216 t in 1995 to 370,977 t, of which 244,077 t was held by dealers; 113,516 t, by consumers; and 13,384 t, by the one primary aluminum producer.

Chromium.—Domestic mine production of refractory-grade chromite by Nippon Chrome Industries Co. Ltd. was from the Wakamatsu Mine in Tottori Prefecture with only 14 workers. The output of chromite concentrate from the Wakamatsu Mine was estimated to be between 6,000 and 7,000 t.

Japan relied on imports to meet most of its chromium requirements for the iron and steel industry.

Imports of chromite, including metallurgical- and refractory-grade, increased by 13%, to 686,451 t, and were valued at $92.2 million. The major supplying countries were South Africa, 351,106 t; India, 103,917 t; Iran, 61,603 t; Madagascar, 57,429 t; Kazakstan, 40,000 t; and Turkey, 27,558 t. Chromite consumption by the iron and steel industry dropped by 8%, to 402,963 t, and production of ferrochromium also declined by 8%, to 193,700 t, reflecting a weaker demand for ferrochromium by the specialty steel industry.

Imports of ferrochromium decreased from 825,718 t in 1995 to 718,567 t because of reduced demand for the production of chromium-base stainless steel. South Africa remained the dominant supplier of ferrochromium, providing 374,915 t, or 52%, of the total ferrochromium imports. Other major suppliers were India, 98,601 t; Kazakstan, 79,417 t; China, 57,255 t; Zimbabwe, 48,840 t; and the Philippines, 20,320 t. Imports of ferrochromium were valued at $503 million. Consumption of ferrochromium for steelmaking decreased from 936,407 t in 1995 to 877,701 t, of which 830,719 t was high-carbon ferrochromium and 46,982 t was low-carbon ferrochromium.

To secure a long-term supply source of ferrochromium from overseas, the Japan Metals & Chemicals Co. Ltd. (JMC) and Mitsui & Co. Ltd. reached an agreement with Zimbabwe Alloys Ltd. (Zimalloys) in January 1996 to establish a joint-venture firm for Mitsui to sell low-carbon ferrochromium in Japan and for JMC to provide the technology to increase production efficiency of the Zimalloys' low-carbon ferrochromium smelter at Gweru in Zimbabwe. By using JMC's technology, the Gweru smelter will be able to increase its output by up to 5,000 t/yr with the existing equipment. Under the agreement, JMC will buy 16,000 t/yr of low-carbon ferrochromium from Zimalloys (The Tex Report, 1996b).

Production of chromium metal was by Nippon Denko K.K., which operated a 1,000-t/yr plant using an aluminothermic process, at Oshima-cho, Imizu-gun in Toyama Prefecture, and by JMC, which operated a 200-t/yr plant using aluminothermic process, at Oguni-cho, Nishi Okitama-gun in Yamagata Prefecture. Tosoh Corp., the largest chromium metal producer in Japan, had suspended its chromium metal production in March 1995.

Copper, Lead, and Zinc.— Mine production of copper, lead, and zinc was by the Kamioka Mining and Smelting Co. Ltd. at its Tochibora deposit of the Kamioka Mine in Gifu Prefecture and by the Toyoha Mining Co. Ltd. at its Soya, Asemia, and Chignon deposits of the Toyota Mine in Hokkaido Prefecture. Copper concentrate has been produced as a byproduct of lead and zinc mining operations at the Kamioka and the Toyota Mines since the Akenobe (copper-tin-zinc) and the Syakanai (copper-lead-zinc) Mines in Akita Prefecture stopped their mining operations in 1987. Mine output of copper, lead, and zinc reached a record low in 1996. The quantity of domestic mine output of copper, lead, and zinc was equivalent to 0.1%, 2.9%, and 20.6%, respectively, of Japan's domestic consumption of the tree metals.

Because of the depleted domestic ore reserves of copper, lead, and zinc, most of Japan's ore and concentrate requirements for its nonferrous metals smelting and refining industry had been met by imports since 1992. To secure a steady supply of nonferrous ores and concentrates, Japan's major nonferrous metals mining and trading companies signed either short- and long-term contracts or financing agreements by loans with overseas suppliers. These companies had also been actively seeking a long-term supply of nonferrous minerals from overseas through direct investment as partners in the exploration and development of major mining projects.

Japan's major overseas investments in copper mining projects through equity participation were the Northparkes project in Australia, the La Escondida and the La Candelaria projects in Chile, the El Roble project in Colombia, and the Morenci and the Chino projects in the United States. Japan's major overseas investments in lead, silver, and zinc mining projects through equity participation were the McArthur River project in Australia, the Tizapa project in Mexico, and the Huanzala project in Peru.

The major nonferrous metals mining companies involved in overseas investment projects through equity participation in exploration and development of nonferrous metals mines were Dowa Mining Co. Ltd., Furukawa Co. Ltd., Mitsui Mining and Smelting Co. Ltd., Mitsubishi Materials Corp., Nippon Mining and Metals Co. Ltd., Nittetsu Mining Co. Ltd., and Sumitomo Metal Mining Co. Ltd. The major participating trading companies were Itochu Corp., Marubeni Corp. Mitsubishi Corp., Mitsui & Co. Ltd., Nissho Iwai Corp., and Sumitomo Corp.

To raise the percentage share of importing ore and concentrate through direct equity participation in overseas mineral exploration and development projects, Japan's major nonferrous metal mining and trading companies continued to increase their overseas investments in the exploration and development of copper. In Canada, two copper development projects were started in 1996, and in Chile, one copper development project was started in 1996 and another will start in 1997.

In May, Sumitomo Corp. acquired a 45% equity interest from Imperial Metals Corp. of Vancouver (55%) in the Mount Polley copper-gold project, 45 kilometers (km) northeast of Williams Lake in central British Columbia, Canada. Minable reserves at the Mount Polley deposit were estimated to be 82.3 Mt, grading 0.3% copper and 0.417 gram per metric ton (g/t) of gold. Development of an open-pit mine with a capacity of 6.5 Mt/yr of ore and a mill with a capacity of 48,000 t/yr of copper in concentrate was started in May. The $86 million development project was scheduled for completion in May 1997, and mine production will begin in July 1997. In addition to equity participation in the project, Sumitomo Corp. agreed to provide Imperial Metals with as much as $54 million in project debt financing and will act as a marketing agent for the copper concentrate for the joint venture (Imperial Metals Corp., 1996).

Also in May, a consortium of Mitsubishi Materials (25%), Dowa Mining (5%), Furukawa Co. Ltd. (5%), and Marubeni Corp. (5%) acquired 40% equity interest in the Huckleberry copper project, 54 km southwest of Houston in British Columbia, Canada, from Princeton Mining Corp. (60%). Minable reserves at the copper deposit were estimated to be 90 Mt, grading 0.5% copper. Development of an open-pit mine with a capacity of 6 Mt/yr and a mill with a capacity of 110,000 t/yr of copper concentrate was started; mine production will begin in August 1997 (Tekko Shinbum, 1996a).

In August, a consortium of Mitsui Mining & Smelting, Mitsui & Co., and Nippon Mining and Metals had completed acquisition of a 12% equity interest in the Collahuasi copper project in Chile from Falconbridge Ltd. of Canada (44%) and

Minorco S.A. of Luxembourg (44%). Ore reserves at the Collahuasi deposit were estimated to be 3.1 billion metric tons, averaging 0.82% copper. The $1.72 billion development project was started in 1996 and will come on-stream in early 1999 with a capacity of 60 Mt/yr of ore. The project is to produce 330,000 t/yr of copper concentrate, including 50,000 t/yr of copper by the solvent extraction-electrowinning process (Tekko Shimbun, 1996a).

In December, a consortium of Nippon Mining and Metals (15%), Mitsubishi Materials (10%), Marubeni (8.75%), Mitsubishi Corp. (5%), and Mitsui & Co. (1.25%) reached an agreement to acquire 40% equity interest in the Los Pelambres copper project, about 200 km north of Santiago in Chile, from Antofagasta Holding (60%), a subsidiary of the Luksic group of the United Kingdom. The agreement was expected to be signed in January 1997. Minable reserves at the Los Pelambres deposit were estimated to be 928 Mt, grading 0.75% copper. The $1.3 billion development (major expansion) project was scheduled to start in July 1997 and to come on-stream in September 1999 with a mining capacity of 85 Mt/yr of ore and a milling capacity of 230,000 t/yr of copper concentrate. The Los Pelambres Mine, operated by Compania Minera Los Pelambres Ltda., a wholly owned subsidiary of Antofagasta, is producing 23,000 t/yr of copper concentrate (The Weekly Mining News, 1996).

Other Japanese overseas minerals-development projects, which are expected to start within the next 2 years, are the Los Bronces copper project in Chile and a major expansion project of the Tizapa lead-silver-zinc deposit in Mexico. A Japanese consortium of Nittetsu Mining and Itochu Corp. was to finalize its feasibility study in 1997 for the production of 25,200 t/yr of copper in concentrate from the Los Bronces Mine for 12 years at a total project cost of between $85 million and $90 million (Mining Journal, 1996a). A Japanese consortium of Dowa Mining (39%) and Sumitomo Corp. (10%) announced in May that it had discovered a promising lead and zinc deposit with high silver content west of its 49% owned Tizapa Mine. Ore reserves at the new deposit were estimated to be more than 1 Mt, grading 10.12% lead and zinc plus 915 g/t of silver. As a result of this new discovery, ore reserves at the Tizapa Mine totaled about 4.1 Mt, grading 1.64% lead, 7.9% zinc, 0.7% copper, 2 g/t of gold, and 314 g/t of silver. In early 1997, Dowa Mining will start development work to expand the mining capacity to 1,600 metric tons per day (t/d) from the current level of 1,000 t/d (Japan Metal Review, 1996).

To secure a steady supply of raw materials for its copper smelter and refinery in Saganoseki, Oita Prefecture, and its copper refinery in Hitachi, Ibaraki Prefecture, Nippon Mining and Metals signed a long-term purchase agreement with Minera Alumbrea Ltd. of Argentina in August. Under the agreement, Nippon Mining and Metals will purchase between 70,000 and 90,000 t/yr of copper concentrate from the Bajo de la Alumbrera Mine in Catamarca, Argentina, for 10 years beginning in 1998. Ore reserves at the mine were estimated to be 563 Mt, grading 0.52% copper. The mine, which is 50% owned by Mount Isa Mines Ltd. of Australia, was scheduled to begin production in the second half of 1997 (Nikkei Sangyo Shimbun, 1996a).

Japan remained the world's largest importer of copper ore and concentrate. The amount of Japan's copper concentrate imports accounted for more than 50% of the total copper concentrate traded in the world market in 1996. Japan's imports of copper concentrate totaled 3.84 Mt. The top eight overseas suppliers of copper concentrate to Japan were Chile, 36%; Indonesia, 16%; Canada, 12%; Australia, 10%; Papua New Guinea, 8%; the United States, 5%; the Philippines, 4%; and Peru, 3%.

Japan's imports of lead and zinc concentrates were 151,797 and 922,875 t, respectively. The top five overseas suppliers of lead concentrate were Australia, 36%; the United States, 18%; Peru, 17%; South Africa, 10%; and Canada, 7%. The top five overseas suppliers of zinc concentrate were Australia, 56%; Peru, 12%; the United States, 10%; Canada, 7%; and Mexico, 5%.

Production of refined copper increased by 5%, reflecting the continued strong domestic demand for refined copper by the manufacturers of wire and cable and the increased exports to Southeast Asia. Production of refined lead decreased by 1% because of the continued decline in demand for refined lead by the manufacturers of storage batteries and inorganic chemicals. Production of slab zinc decreased by 10% resulting from closure of the Akita zinc refinery by the Mitsubishi Materials in June and a weaker demand for slab zinc for the production of brass and bronze and zinc diecasting. Mitsubishi Materials, Japan's third largest slab zinc producer, closed down its 105,600-t/yr Akita zinc refinery in Akita, Akita Prefecture, in June because of the high value of the Japanese yen, lower tariffs for imports of slab zinc, and higher cost of production.

To meet the growing demand for refined copper in domestic and Asian markets, several major Japanese copper producers decided to expand the capacity of their domestic smelting and refining facilities in Japan, as well as to participate in construction of copper smelting and refining facilities overseas. Mitsubishi Materials, Nippon Mining and Metals, and Sumitomo Metal Mining decided to expand the capacity of their copper smelting and refining facilities in Naoshima, Kagawa Prefecture, Saganoseki, Oita Prefecture, and Besshi, Ehime Prefecture, respectively. A Japanese consortium led by Furukawa Co. Ltd. acquired a majority interest in an idle copper smelter at Port Kembla in Australia, and Mitsubishi Materials and Sumitomo Metal Mining began construction of overseas copper smelters and refineries in China, India, and Indonesia.

In December, Nippon Mining and Metals decided that it will expand the smelting capacity from 350,000 to 400,000 t/yr at its Saganoseki complex by 2000. Mitsubishi Materials will increase capacity of the 193,200-t/yr smelter at its Naoshima complex by 20% in the next 3 years, and Sumitomo Metal Mining will increase capacity of the 276,000-t/yr smelter at its Besshi complex from 20,000 to 40,000 t/yr in the next 3 years (Nikkei Shimbun, 1996).

In December, Furukawa, Itochu, Nittetsu Mining, and Nissho Iwai had jointly acquired 97.5% equity interest in the Port Kembla copper smelter in New South Wales, Australia, from Southern Copper Ltd. Before the acquisition, Southern Copper was owned by CRA Ltd. of Australia, 60%; Furukawa, 30%; and Nissho Iwai, 10%. After the acquisition, the copper smelter

is owned by Furukawa, 50%; Nittetsu Mining, 20%; Nissho Iwai, 17.5%; Itochu, 10%; and Denehurst Ltd. of Australia, 2.5%. In the next 2 years, the joint-venture Port Kembla copper smelter will be renovated with adequate antipollution facilities to collect and dispose the sulfur dioxide emissions, and its capacity will be expanded from 80,000 to 120,000 t/yr by the second half of 1998. The total project was estimated to cost $206 million. Most of the smelter's future output will be distributed in the Australian market, and the remainder, to markets in Southeast Asia and Japan (Nikkan Sangyo Shimbun, 1996c).

In July, Mitsubishi Materials (75%), in a joint venture with P.T. Freeport Indonesia (25%), started construction of the $600 million copper smelting and refining complex at Gresik in East Java, Indonesia. The 200,000-t/yr copper smelter was scheduled for completion by the second half of 1998 and to begin production by December 1998. The smelter will use Mitsubishi Materials' continuous copper smelting technology and will be fed by 600,000 t/yr of copper concentrate from the Grasberg Mine operated by P.T. Freeport Indonesia in Irian Jaya, Indonesia. The smelting and refining complex will be operated by Mitsubishi Materials (Nikkan Sangyo Shimbun, 1996a). Mitsubishi Materials also had acquired an 18% equity interest in a joint venture with Metdist Group (42%) of the United Kingdom and the Indian general public (40%) for construction of a 150,000-t/yr copper smelting and refining complex at Pipavav in Gujarat State, India. The Pipavav copper smelter will also use Mitsubishi Materials' continuous copper smelting technology and was scheduled to begin production in early 1998.

In joint venture with Tonling Nonferrous Metals Corp. and Hong Kong based-Sharpling International Ltd. of China, two subsidiaries of China National Nonferrous Metals Industry Corp., Sumitomo Metal Mining, Sumitomo Corp., and Itochu Corp. began construction of a 100,000-t/yr copper smelter in July at Tonling in Anhui Province, China. The copper smelter was scheduled to come on-stream in March 1998. The copper smelter, which will be the largest in China, is owned by Tonling Nonferrous Metals, 52%; Sumitomo Metal Mining, 20%; Sharpling International, 10%; and Itochu Corp. and Sumitomo Corp., 7.5% each.

To gain access to Mongolia's copper resources, Marubeni Corp. signed an agreement with Erdmin Co. Ltd., a Mongolia-Canada joint-venture company, for financing a $9 million solvent-extraction and electrowinning pilot plant with a capacity of 3,600 t/yr near the Erdenet copper mine in north-central Mongolia. Construction of the pilot plant was scheduled for completion in early 1997. Under the agreement, Marubeni will have the right to purchase as much as 60% of the plant's production of copper cathode for export to Japan. After a feasibility study for the second phase of construction is completed in 1997, Marubeni will consider making an additional investment in the plant-expansion project (Nikkan Kogyo Shimbun, 1996).

To reduce production cost and increase productivity, Mitsui Mining & Smelting, a major equity owner of the Hachinohe zinc refinery in Aomori Prefecture, introduced a technology developed by Ausmelt Ltd. of Australian to recover zinc from slag generated during zinc refining. The technology uses a device to blow air and reductant into slag to make zinc volatilize. By using this technology, the zinc recovery rate from slag was raised from 1% to 3.5%. As a result, the Hachinohe plant is expected to save about $1.2 million per year (Nikkei Sangyo Shimbun, 1996b).

Imports of refined copper decreased by 7.5%, to 360,020 t. The top five overseas suppliers were Chile, 37%; the United States and Zambia, 15% each; Peru, 13%; and the Philippines, 10%. Imports of refined lead dropped by 55%, to 33,334 t, and imports of slab zinc rose by 15%, to 134,798 t. The top three overseas suppliers of refined lead were China, 44%; Peru, 31%; and Australia, 16%. The top five suppliers of zinc slab were China, 54%; Brazil, 8%; Peru, 7%; North Korea, 6% ; and Kazakstan, 5%.

Domestic consumption of refined copper remained unchanged at about 1.52 Mt. An increase in demand by the wire and cable industry was offset by a decrease in demand by the brass mill industry. Demand for copper by the wire and cable and the brass mill sectors accounted for 67% and 32% of copper consumption, respectively. Exports of refined copper increased by 3.7%, to 164,606 t. The major overseas buyers of refined copper were Taiwan, 56%; Thailand, 11%; China, 9%; and the Republic of Korea, 7%. Overall stocks of refined copper dropped by 23% to 113,480 t, at the end of December.

Domestic demand for refined lead decreased by 1%, to 271,396 t, of which 69% was for storage batteries; 15%, for inorganic chemicals; and the remaining 16%, for solders and other uses. Exports of primary lead decreased by 4%, to 1,148 t. The major buyers were the Philippines and Thailand accounting for 67% and 17%, respectively. Overall stocks of primary lead dropped by 31%, to 33,391 t, at the end of December. Domestic demand for zinc slab decreased by 3.3%, to 617,142 t—sheet galvanizing, 49%; other plating, 15%; brass mill products, 14%; zinc die-cast products, 10%; and inorganic chemicals and other uses, 12%. Exports of zinc slab increased by 1.9%, to 28,500 t. The major buyers were the Philippines and Taiwan accounting for 66% and 26%, respectively. Overall stocks of zinc slab dropped by 26%, to 87,146 t, at the end of December.

Gold and Silver.—Mine production of gold decreased slightly, and mine production of silver dropped by 15% because of reduced output as a coproduct from two major lead and zinc mines at Kamioka in Gifu Prefecture and at Toyota in Hokkaido Prefecture. Gold mine production was mainly by Sumitomo Metal Mining from the Hishikari Mine in Kagoshima Prefecture in southern Kyushu. The company was working on its Honko (main deposit), Sanjin, and Yamada deposits in the Hishikari mining area. Ore production averaged 150,000 t/yr, grading 55 g/t of gold. About 60% of ore was produced by bench stoping, and the remainder, from drifting. Ore was transported by trucks to a primary crusher, then the waste was removed at ore-sorting and hand-picking facilities at the mine site. For further processing, the processed ore was delivered to Sumitomo Metal Mining's Toyo smelter at the Besshi complex in Niihama. The

proven ore reserves at the Hishikari Mine were estimated to be 5.2 Mt containing 250 t of gold. The company undertook an expansion program to raise ore output to 160,000 t/yr in 1996. As of 1996, the workforce at the Hishikari Mine totaled 221; of those workers, 73 were contract workers (Sumitomo Metal Mining, 1996).

Refined gold and silver were produced by Kosaka Smelting and Refining Co. Ltd. at Kosaka in Akita Prefecture, Mitsubishi Materials at Naoshima in Kagawa Prefecture, Nippon Mining and Metals at Hitachi in Ibaraki Prefecture, and Sumitomo Metal Mining at Niihama. Mitsui Mining and Smelting operated a small gold and silver refinery using mainly gold- and silver-bearing scrap, such as semiconductor scrap, near the Kushikino gold mine in Kagoshima Prefecture. In September, Nippon Mining and Metals began construction of a $23 million hydrometallurgical plant to recover precious and rare metals from copper refinery slimes at its Saganoseki complex in Oita Prefecture. The plant with a designed capacity of 30 t/yr of gold and 300 t/yr of silver was scheduled to come on-stream in the first half of 1997. By using a hydrometallurgical process, the new plant will be more productive and will have a lower production cost than that of the Hitachi plant (Mining Journal, 1996c).

Japan's imports of gold ingots dropped by 50.6%, to 128.7 t, and imports of silver ingots rose by 9%, to 1,179 t. The sharp drop in the gold imports was due to excess supply and weaker demand for jewelry and private investment. The major suppliers of gold ingots were Australia, 35.6 t; South Africa, 20.4 t; the United Kingdom, 16.9 t; Switzerland, 12.8 t; the Republic of Korea, 10.7 t; the United States, 10.1 t; and Canada, 7.8 t in 1996. The principal suppliers of silver ingots were Mexico, 472.9 t; the United States, 333.7 t ; Australia, 127.7 t; and Singapore, 115.0 t.

The Japanese gold market in 1996 can be characterized by excessive gold supply and very weak gold demand. A higher secondary gold production in 1996 and a selloff of gold by private investors in 1995 had resulted in an excessive gold supply in the market. A cut back in private gold investment and a lower gold demand for jewelry had resulted in the weakest overall gold demand in 15 years. The overall demand for gold was estimated to be 283 t compared with 454 t in 1995. Domestic demand for gold, by end use, was 18 t for dentistry compared with 20 t in 1995; 64 t for electronics and telecommunications compared with 48 t in 1995; 22 t for plating compared with 24 t in 1995; 89 t for jewelry compared with 114 t in 1995; 55 t for private investment compared with 170 t in 1995; and 72 t for other uses, such as china and porcelain, fountain pens, clocks and watches, arts and crafts, and others, compared with 79 t in 1995 (Sumitomo Corp., 1997).

According to MITI, domestic demand for silver decreased by 3.3%, to 3,395 t, of which 1,708 t was for silver nitrate for photographic use; 284 t, for silver nitrate for other uses; 289 t, for electric contacts; 171 t, for rolled products; and 1,113 t, for brazing alloy, electroplating, jewelry, silverware, and other uses.

Iron and Steel.—Japan's iron sand and roasted pyrite production was small and insignificant. Japan's iron and steel industry relied on imports to meet virtually all its iron ore requirements. Imports of iron ore, including iron sand, pellet, and sinter, decreased from 120.4 Mt in 1995 to 119.2 Mt. The major suppliers of iron ore were Australia, 50%; Brazil, 22%; India, 13%; South Africa, 4%; and Chile, 3%. Imports of pig iron dropped sharply from 2.8 Mt in 1995 to about 1 Mt because of higher prices of pig iron in the world market. China provided 52% of total pig iron imports. On the basis of the Government trade statistics (Ministry of Finance, 1966), the average cost, insurance, and freight (c.i.f.) import price per metric ton of iron ore increased to $26.18 from $25.98 in 1995 and the average c.i.f. import price per metric ton of pig iron increased to $232.51 from $200.29 in 1995.

To secure a steady supply of iron ore from overseas, the Japanese steel mills had renewed a 7-year purchase contract with Hamersley Iron Pty. Ltd. of Australia in 1995 to supply 11 Mt/yr of iron ore beginning in 1996. In late 1996, the Japanese steel mills also reached an agreement with Hamersley to purchase an additional 28.5 Mt/yr of iron ore between April 1996 and March 1999. The total value of the two long-term purchased contracts was estimated to be about $2.1 billion.

Consumption of iron ore, including iron sand, pellet, and sinter by blast furnaces, decreased slightly from 123.35 Mt in 1995 to 122.96 Mt. Pig iron production decreased slightly to 74.6 Mt. Most of the pig iron production was for steelmaking, only 4,162 t was for foundry use. By yearend, the total capacity and number of furnaces, including blast, electric, and other furnaces for pig iron production, remained unchanged at 95.5 Mt/yr and 47, respectively.

Japan was the world's largest producer of pig iron and crude steel, accounting for 15% and 14%, respectively, of the world total in 1996. Nippon Steel Corp., which produced 25.32 Mt of crude steel in 1996, ranked as the largest steel maker in the world; NKK Corp., which produced 10.46 Mt, ranked 8th; Kawasaki Steel Corp., which produced 9.89 Mt, ranked 10th; Sumitomo Metal Industries, which produced 9.69 Mt, ranked 11th; and Kobe Steel Ltd., which produced 5.81 Mt, ranked 29th (Metal Bulletin, 1997).

Crude steel output decreased 2.8%. Of that amount, 66.7% was processed by basic oxygen furnaces, and 33.3%, by electric furnaces. In the steelmaking sector, the number of basic oxygen furnaces remained unchanged at 69, and the number of electric arc furnaces was reduced by 9 to 470 by yearend. As a result, the overall crude steel production capacity decreased slightly to 149.73 Mt/yr. The industry cut its labor force by 18,426 to 237,449 workers.

In new technology development, Kobe Steel and Midrex Direct Reduction Corp. of the United States had jointly developed a new process of making molten iron. In the new process, pellets made of iron ore fines and pulverized coal are heated to 1,300° C to 1,500° C. At these temperatures, the iron ore is reduced quickly within 6 to 10 minutes, yielding high-purity molten iron. The two companies planned to conduct three-stage research on this new technology. The first stage will be to study the reaction mechanism and the basic processing technology, the second stage will be to conduct bench-scale testing, and the third stage will be to invite potential process

users to invest in the construction and operation of a pilot plant. The two companies believed that if proven viable, the new process will become a revolutionary, next-generation ironmaking technology (Steel Today & Tomorrow, 1996).

In July, the Central Government, through its Science and Technology Agency, announced that it will join forces with private companies, led by Nippon Steel Corp. and Toyota Motor Corp., to launch a 10-year, $917 million project to develop stronger and more durable steel beginning in fiscal year 1997. The research project, which will be conducted at the Agency's National Research Institute for Metals in Tsukuba, Ibaraki Prefecture, will involve about 250 researchers from the Agency, academia, steelmakers, automakers, heavy industry, and the electric-power and construction industries. The project is to conduct experiment on special furnaces and special casting and rolling facilities for developing a material with high resistance to fatigue and wear. The specific target is to double the strength of steel sheet used in automobiles to 250 kilograms per square millimeter (kg/mm^2) and that of steel wire used in bridges to 500 kg/mm^2 by tinkering with the metal's crystal structure. The research project will also develop a stronger ferroconcrete for use in high-rise buildings (The Nikkei Weekly, 1996).

Japan's domestic demand for ordinary steel products increased by 2.9% in 1996, while domestic demand for specialty steel products increased by 0.1%. According to the statistics published by Japan Iron and Steel Federation (Japan Iron and Steel Federation, 1997), domestic demand for ordinary steel products and specialty steel products was 59.65 and 10.10 Mt, respectively, compared with 57.96 and 10.09 Mt, respectively, in 1995. Domestic demand for ordinary and specialty steel products by steel dealers was 22.10 and 1.38 Mt, respectively; by construction, 14.49 and 0.74 Mt, respectively; by automobile, 9.30 and 2.59 Mt, respectively; by conversion and processing, 3.42 and 3.42 Mt, respectively; by shipbuilding and marine equipment, 3.09 and 0.11 Mt, respectively; by electric machinery and equipment, 2.31 and 0.11 Mt, respectively; by tanks and containers, 2.05 and 0.03 Mt, respectively; by industrial machinery and equipment, 1.68 and 1.33 Mt, respectively; and by home and office appliance and other, 1.21 and 0.39 Mt, respectively.

According to the Government trade statistics, exports of iron and steel decreased from 22.99 Mt in 1995 to 20.61 Mt, of which pig iron was 978,614 t; ferroalloys, 88,167 t; steel ingots, 12,553 t; semifinished ordinary steel, 383,403 t; semifinished specialty steel, 32,151 t; ordinary steel products, 15.14 Mt; and specialty steel products, 3.42 Mt. Exports of iron and steel products to Asian markets totaled 16,067,236 t, accounting for 77.9% of total exports. The major buyers of Japan's iron and steel products in Asia were the Republic of Korea, 3,344,241 t; China, 2,537,673 t; Thailand, 2,235,888 t; Taiwan, 2,230,635 t; Malaysia, 1,509,106 t; Hong Kong, 1,381,687 t; and Singapore, 960,631 t. Exports of iron and steel products to the United States decreased from 2,334,209 t in 1995 to 2,049,283 t.

Imports of iron and steel products decreased from 11.72 Mt in 1995 to 8.62 Mt. Of the total imports, pig iron totaled 954,982 t; ferroalloys, 1.68 Mt; steel ingots, 3,855 t; semifinished steels, 295,543 t; ordinary steel products, 5.15 Mt; specialty steel products, 271,730 t; and process steels and other, 271,211 t. Hot-finished hoop, hot-rolled heavy and medium plates, cold-rolled coils and sheets, and galvanized sheets were the major import ordinary steel items in 1996. The major suppliers of ordinary steel products to Japan were the Republic of Korea, 2.81 Mt; Taiwan, 625,455 t; Brazil, 357,204 t; and China, 316,823 t. The Republic of Korea was the principal supplier of specialty steel providing 177,886 t or 65% of Japan's total imports of specialty steel, Taiwan with 40,280 t was second.

Manganese.—Japan produced a small amount of manganese ore from the Nodatamagawa Mine in Iwate Prefecture. Virtually all its manganese ore requirements were met by imports. Imports of manganese ore decreased slightly from 1.19 Mt in 1995 to 1.18 Mt—high-grade manganese dioxide ore, 10,836 t, and metallurgical-grade manganese ore, 1.17 Mt. The major suppliers of high-grade manganese dioxide ore were Gabon, Australia, and China, providing 47%, 33%, and 12%, respectively. The major suppliers of metallurgical-grade manganese ore were South Africa, Australia, India, and Brazil, providing 37%, 35%, 19%, and 5%, respectively. Japan also imported 82,270 t of ferruginous manganiferous ore principally from Ghana and India, accounting for 58% and 41%. Consumption of metallurgical-grade manganese ore by the ferroalloys industry for production of ferromanganese increased by 2.6%, to 617,444 t.

Production of ferromanganese was by four companies with a total capacity of about 407,000 t/yr—Chuo Denki Kogyo Co. Ltd. operated a 85,000-t/yr plant in Kashima, Ibaraki Prefecture; JMC, three plants with a combined capacity of 145,400 t/yr in Takaoka, Toyama Prefecture; Kobe Steel, Ltd., a 61,200-t/yr plant in Kakogawa, Hyogo Prefecture; and Nippon Denko Co. Ltd., a 95,200-t/yr plant in Tokushima, Tokushima Prefecture, and a 20,300-t/yr plant in Miyako, Iwate Prefecture. To operate more efficiently and to be closer to its major consumer (the Oita Works of the Nippon Steel in Kyushu), Nippon Denko announced in April that it will cease operation of the Miyako plant in March 1997 and will transfer some of the production facilities of medium- and low-carbon ferromanganese and staff members to its Tokushima plant on Shikoku Island in southern Japan (Metal Bulletin, 1996). For steelmaking, consumption of ferromanganese decreased from 385,676 t in 1995 to 380,078 t, of which 318,921 t was high-carbon ferromanganese and 61,157 t was low-carbon ferromanganese.

To gain access and secure overseas supply of medium- and low-carbon ferromanganese, a Japanese consortium led by the JMC established a joint-venture firm with Samanco Ltd. of South Africa, called ADVALLOY, to construct a ferroalloy plant at Meyerton in Gauteng Province, South Africa. The plant construction was started by ADVALLOY in July with Japanese technology and equipment, including a 30-t converter, a 6,000-kilovolt-ampere (KVA) electric furnace, and a 7,500-KVA electric furnace. The plant, which was scheduled for completion in early 1998, will have a total capacity of between 75,000 and 80,000 t/yr, including between 60,000 and 65,000 t/yr of

medium- and low-carbon ferromanganese, 8,000 t/yr of ultra-low-carbon (0.1%-0.2% carbon) ferromanganese, and 7,000 t/yr of ultra-low-carbon silicomanganese. Most of the plant output will be exported mainly to Nippon Steel in Japan. ADVALLOY is owned by Samanco, 50%; JMC, 35%; and Mitsui & Co. Ltd., a major Japanese trading company, 15% (The Tex Report, 1996a).

Nickel.—Japan was the world's largest importer and consumer of nickel and the second largest producer of nickel metal, including ferronickel, nickel oxide, and refined nickel. 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 stainless steel and battery industries and other end users. Nickel ore totaling 4.1 Mt was provided by New Caledonia, 46%; Indonesia, 28%; and the Philippines, 26%. Nickel matte totaling 81,755 t 66% was supplied by Indonesia, 66% and Australia, 34%. Ferronickel imports totaling 58,460 t were from New Caledonia, 60%; Indonesia, 20%; the Dominican Republic, 13%; Russia, 5%; and other countries, 2%. Imports of refined nickel were well diversified but came from mainly Russia, 21%; Norway, 18%; Zimbabwe, 14%; Brazil, 11%; Australia, Canada, and South Africa, 10% each; and the United Kingdom, 4%. Japan also imported 1,839 t of nickel oxide sinter from mainly Australia, 7,350 t of nickel powders and flakes from mainly the United Kingdom and Canada, and 7,711 t of nickel waste and scrap from mainly Hong Kong, Russia, and the United States.

Consumption of nickel ore by the ferroalloy industry for ferronickel production remained unchanged at about 2.9 Mt. Production of ferronickel was by Pacific Metals Industry Co. Ltd. in Hachinohe, Aomori Prefecture, with a capacity of 54,000 t/yr of nickel contained in ferronickel; Nippon Yakin Kogyo Co. Ltd. at Oeyama near Miyazu, Kyoto Prefecture, with a capacity of 14,400 t/yr of nickel contained in ferronickel; and Sumitomo Metal Mining, through Hyuga Smelting Co. Ltd., in Hyuga, Miyazaki Prefecture, with a capacity of 18,000 t/yr of nickel contained in ferronickel. Ferronickel produced by Pacific Metals and Hyuga Smelting contained 20% nickel and Nippon Yakin Kogyo, 22.5% nickel (Intenational Nickel Study Group, 1996). Japan's ferronickel production totaled 328,699 t with average nickel content of 20.32% nickel or containing 66,796 t of nickel. In June, Pacific Metals shut down one of the three operating 60,000-KVA furnaces to cut its ferronickel production because of reduced demand by the stainless steel industry.

Production of refined nickel was solely by Sumitomo Metal Mining at its 30,000-t/yr plant using Sumitomo's Matte Chorine Leaching Electrowinning process in Niihama. The company planned to increase the capacity of its Niihama nickel plant by 20% by 1998 (Japan Metal Review, 1997). To secure more raw materials for the plant, Sumitomo Metal Mining reportedly planned to participate in development of the Voisey's Bay nickel project in Canada. Pacific Metals was conducting a feasibility study to produce nickel and cobalt at the Rio Tuba Mine on Palawan Island in the Philippines. Pacific Metals also was testing the low-grade laterite ores (less than 1.2% nickel) from the Rio Tuba Mine by using the hydrometallurgical nickel refining process at its Hachinohe complex in Aomori Prefecture. If the testing of ore by the process is proven viable, then Pacific Metal planned to build a plant capable of treating from 400,000 to 500,000 t/yr of ore near the mine. Ore reserves of the low-grade ores, including stockpiled ore at the mine site, were estimated to be 19 Mt (Tekko Shimbun, 1996b).

Consumption of nickel, including nickel content of ferronickel and nickel oxide sinter, refined nickel, and nickel powder and flakes, totaled 178,960 t compared with 195,689 t in 1995. Because of reduced production of nickel-based stainless steel, domestic demand for nickel declined substantially. Demand for refined nickel for production of nickel alloys, galvanized sheet, and batteries also dropped considerably. According to the statistics published by the Government, domestic demand for refined nickel decreased by 15.3%, to 70,779 t—production of specialty steel, 49,827 t; galvanized sheet, 5,221 t ; batteries, 3,774 t; nonferrous alloys, 3,461 t; magnetic materials, 3,344 t; catalysts, 473 t; and other uses, 4,679 t. Japan exported 35,505 t of ferronickel and 5,182 t of nickel oxide sinter mainly to the Republic of Korea and Taiwan and 1,085 t of refined nickel, nickel powders and flakes mainly to China and the United States.

Titanium.—Japan was the world's second largest producer of titanium sponge metal and one of the world's top producers of titanium dioxide pigment, but all the raw material requirements for production of titanium metal and dioxide pigment were met by imports. For production of titanium sponge, 98,956 t of rutile was imported principally from Australia, 41,804 t, and South Africa, 35,059 t. For production of synthetic rutile and titanium dioxide pigment, 303,369 t of ilmenite was imported mainly from Australia, 160,063 t; Malaysia, 70,980 t; Vietnam, 25,365 t; India, 19,219 t; China, 15,132 t; and Sri Lanka, 12,308 t. For production of titanium dioxide, 123,004 t of titanium slag was imported principally from South Africa, 77,883 t, and Canada, 43,137 t.

All the 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. Production of titanium sponge was by Sumitomo Sitix Corp. at Amagasaki, near Osaka in Hyogo Prefecture, and Toho Titanium Co. Ltd. at Chigasaki, about 20 km south of Yokohama in Kanagawa Prefecture. For the first time in 5 years, titanium production exceeded the 21,000-t level because of increased exports to the United States. Total shipments of titanium sponge rose by 35.6%, to 21,310 t—domestic shipments increased by 5.9%, to 11,184 t, and overseas shipments, by 96.5%, to 10,126 t (Japan Titanium Society, 1997). On the basis of the Government trade statistics, exports of titanium sponge rose to 10,637 t from 5,370 t in 1995. Because of a strong recovery in the U.S. aircraft industry, exports of titanium sponge to the United States increased from 1,815 t in 1995 to 5,322 t.

Production of titanium dioxide pigment decreased because of

reduced output by Ishihara Sangyo Co. Ltd. and a weaker demand in the domestic and overseas markets. Output was equivalent to about 70% of the industry's capacity. According to the Japan Titanium Dioxide Industry Association, domestic demand for titanium dioxide pigment decreased from 174,742 t in 1995 to 172,765 t. Of the total domestic demand, the manufacturers of paints consumed 42.8%, inks and pigments, 21.7%; plastics, 12.3%; paper, 8.6%; chemical fibers, 2.4%; rubber, 1.7%; capacitors, 1.1%; and other end users, 9.4%. Exports of titanium dioxide pigment decreased by 8.6%, to 61,915 t (Roskill's Letter from Japan, 1997).

Industrial Minerals

Bromine.—Japan was the world's fifth largest bromine producer. Tosoh Corp., the sole bromine producer, operated three marine bromine plants at its Nanyo complex, near Shin-Nanyo in Yamaguchi Prefecture. Because of the increasing demand for hydrobromine acid as a catalyst for production of purified terephthalic acid, Tosoh planned to expand its bromine production capacity by 20%, to 24,000 t/yr, within the next 2 to 3 years. The worldwide demand for polyethelence terepthalate (PET) plastic has been rising at a double-digit rate in the past few years, especially in the industrialized countries of Asia, especially in Japan, the Republic of Korea, Singapore, and Taiwan. Purified terephthalic acid is an important intermediate in the production of PET (Industrial Minerals, 1996b).

Cement.—Japan was the world's second largest cement producer. Cement production increased owing to an 11.8% rise in new dwelling construction starts with a 13.6% increased in the amount of private dwelling investment and a 5.3% rise in the amount of public works investment resulting from stimulative spending by the Government. On the basis of statistics published by the Government, Japan's cement clinker capacity decreased from 94.8 Mt/yr (revised) in 1995 to 93.9 Mt/yr. Production of cement clinker totaled 91.5 Mt, compared with 89.0 Mt (revised) in 1995. Production of cement was 94.5 Mt, of which 76.0 Mt was portland cement, 18.5 Mt was blended cement, of which 96.2% was blast furnace slag type.

The cement industry comprised 20 companies operating 41 plants having a total of 80 operating kilns and employing about 5,300 employees. The 20 companies were Aso Cement Co. Ltd., Chichibu Onoda Cement Corp., Daiichi Cement Co. Ltd., Denki Kagaku Kogyo Co. Ltd., Hachinohe Cement Co. Ltd., Hitachi Cement Co. Ltd., Kanda Cement Co. Ltd., Mikawa Onoda Cement Co. Ltd., Mitsubishi Materials Corp., Mitsui Mining Co. Ltd., Myojo Cement Co. Ltd., Nihhon Cement Co. Ltd., Nippon Steel Chemical Co. Ltd., Nittetsu Cement Co. Ltd., Ryukyu Cement Co. Ltd., Sumitomo Osaka Cement Co. Ltd., Tokuyama Corp., Tosoh Corp., Tsuruga Cement Co. Ltd., and Ube Industries Ltd.

On the basis of statistics provided by Japan Cement Association (Japan Cement Association, 1997), domestic consumption of cement increased from 79 Mt in 1995 to 82 Mt—ready-mixed concrete, 70.9%; cement products, 14.4%; civil engineering works, 5.4%; public and private buildings, 2.1%; construction of roads, railroads, bridges, powerplants, and ports, 1.3% and other use, 5.9%. On the basis of the Government trade statistics, exports of cement clinker decreased from 5.8 Mt in 1995 to 4.8 Mt, valued at $191 million, and portland cement also decreased from 8.0 Mt in 1995 to 7.9 Mt, and valued at $342 million. The major buyers of cement clinker were Singapore, 1.7 Mt; Malaysia and the Philippines, 0.8 Mt each; Taiwan, 0.5 Mt; Hong Kong, 0.3 Mt; and Australia and Thailand, 0.2 Mt each. The major importers of portland cement were the Republic of Korea, 2.3 Mt; Taiwan, 1.9 Mt; Hong Kong, 1.7 Mt; Singapore, 0.8 Mt; Malaysia, 0.6 Mt; and Indonesia, 0.4 Mt. The average export free on board (f.o.b.) price was $43.22 per metric ton. Imports of cement totaled 617,115 t, of which about 83% was provided by the Republic of Korea and 15% by China. The average import c.i.f. price was $55.78 per metric ton.

Limestone.—Japan was world's third largest producer of limestone. Production of limestone increased by 9% in 1996 owing to increased demand by the cement and construction industries. According to information provided by the MITI's Mining Division, the limestone mining was at 257 limestone quarries, located mainly in the Prefectures of Aomori, Fukuoka, Iwate, Kochi, Oita, Tochigi, and Yamaguchi. Most of the major limestone quarries were owned and operated by cement, construction, or steel companies. The seven leading limestone producers were, in decreasing order, Nittetsu Mining Co. Ltd., Chichibu Onoda Cement Co. Ltd., Todaka Mining Co. Ltd., Mitsubishi Materials Corp., Ube Industries Ltd., Sumitomo Osaka Cement Co. Ltd., and Nippon Cement Co. Ltd.

According to statistics provided by the MITI, shipments of domestically produced limestone increased from 201.4 Mt in 1995 to 205.3 Mt—manufacturing sector, 143.8 Mt; construction sector, 55.4 Mt; and other, 6.0 Mt. Of the 143.8 Mt consumed by the manufacturing sector, the cement industry used 103.7 Mt; the iron and steel industry, 21.4 Mt; the lime industry, 9.4 Mt; and other manufacturing industries, 9.3 Mt. Of the 55.4 Mt consumed by the construction sector, concrete making accounted for 34.3 Mt; road construction, 15.3 Mt; and, other construction, 6.5 Mt.

Salt.—Domestic production of salt from evaporates was estimated to be between 1.3 and 1.4 Mt. To meet the salt requirements for general and industrial uses, Japan imported 7.7 Mt of table salt, denatured salt, and pure sodium chloride principally from Australia, 3.9 Mt and Mexico, 3.6 Mt. The average c.i.f. import price of salt from Australia and Mexico was $28.97 per metric ton and $27.67 per metric ton, respectively. Consumption of salt was estimated to be 9.1 Mt, of which 7.2 Mt was for industrial use mainly by the chlora-alkali industry for production of caustic soda. Consumption of salt for general use was estimated to be 1.9 Mt.

In Japan, salt has been marketed solely by Japan Tobacco Inc. (formerly Japan Tobacco and Salt Public Corp.) since 1905. To allow free competition among private companies engaged in production, importation, and distribution of salt, the Government decided in March 1995 to

liberalize the Japanese salt market. In early 1996, the Ministry of Finance announced that the Government was to end its 90-year monopoly of the salt market in March 1997, and a bill was introduced to the Diet (the Japanese parliament) later in the year (Industrial Minerals, 1996a).

Mineral Fuels

Coal.—Japan's coal production increased slightly, despite closure of the Sorachi coal mine in Utashinai, Hokkaido Prefecture, in 1995. The three remaining major coal mining companies were Mitsui Coal Mining Co. Ltd. at Miike in Omuta, Fukuoka Prefecture, Taiheiyo (Pacific) Coal Mining Co. Ltd. at Kushiro in eastern Hokkaido; and Matsushima Coal Mining Co. Ltd. at Ikeshima in Nagasaki Prefecture. Because of the mounting operating losses caused by high production costs and increasing pressure by the electric power industry to cut domestic coal prices, Mitsui Coal Mining Co. will permanently close its 2.5-Mt/yr coal mine at Miike in March 1997. According to Government statistics, of the total coal produced, 45% was from the Hokkaido area and 55% was from the Kyushu and the Honshu areas. Employment declined by 214 to 2,481 workers by yearend.

Japan was the world's largest coal importer. Because of increased consumption by the coke and the electric power industries, coal imports increased by 3%, to 126.3 Mt. Japan relied on imports to meet about 95% of its coal requirements. According to Government trade statistics, imports of coking coal increased to 65.5 Mt from 65.4 Mt in 1995. The major suppliers of coking coal were Australia, 31.7 Mt; Canada, 15.9 Mt; the United States, 5.8 Mt; Russia, 2.8 Mt, and South Africa, 2.7 Mt. Imports of anthracite rose to 3.7 Mt from 3.4 Mt in 1995. The major suppliers of anthracite were China, 1.8 Mt, and Vietnam, 1.3 Mt. Imports of steam coal increased from 53.8 Mt in 1995 to 57.1 Mt. The major suppliers of steam coal were Australia, 32.4 Mt; Indonesia, 7.5 Mt; China, 6.4 Mt; and the United States, 3.5 Mt.

Consumption of coal was 132.4 Mt, an increase of 2.6% over that of 1995. The growth was due to increased demands by the electric power industry, from 40.8 Mt in 1995 to 42.9 Mt, and the iron and steel industry, from 63.1 Mt in 1995 to 64.3 Mt. Demand for coal by other industries was as follows: manufacturers of coke, 4.2 Mt; manufacturers of cement and ceramics, 9.9 Mt; other manufacturers, 10.9 Mt; gas industry, 157,000 t; and other industries, 56,000 t. Of the total coal consumed, 126.1 Mt was import coal, and 6.3 Mt was domestic coal.

Petroleum and Natural Gas.—Japan was the world's largest importer of natural gas and crude petroleum. Domestic production of natural gas and crude petroleum was very small when compared with its huge requirements for crude petroleum, including refined petroleum products and LNG. Domestic production of crude petroleum decreased slightly, and production of natural gas remained unchanged. Consumption of crude petroleum and natural gas was 1,533 million barrels (Mbbl) and 71.8 billion cubic meters, respectively.

According to Government trade statistics, Japan imported 1,657 Mbbl of crude petroleum to meet the domestic demand. Imports of natural gas, in the form of LNG, reached a record high of 69.5 billion cubic meters. Imports of refined petroleum products, which included diesel, gasoline, heavy fuel oil, jet fuel, kerosene, and naphtha, increased by 13.9%, to 254.9 Mbbl, because of increased domestic demand for all refined petroleum products, except jet fuel and heavy fuel oil.

Crude petroleum imports were mainly from the Middle East, accounting for 80% compared with 78.6% in 1995; and Asia, accounting for 17% compared with 18% in 1995. The major suppliers of crude petroleum were the United Arab Emirates, 27%; Saudi Arabia, 20%; Iran, 10%; Indonesia, 7%; Qatar, 6%; and China, Kuwait, Neutral Zone, and Oman, 5% each. Imports of LNG rose from 42.8 Mt in 1995 to 46.4 Mt or 69.5 billion cubic meters, of which Indonesia supplied 40%; Malaysia, 20%; Australia, 16%; Brunei, 12%; the United Arab Emirates, 9%; and the United States, 3%.

Production of refined petroleum products decreased by 1%, to 1,417 Mbbl. Refined petroleum products were produced by 43 refineries with a total capacity of 5.27 million barrels per day.

Demand for refined petroleum products increased by 1.6%, to 1,603.6 Mbbl. Japan's net import reliance of refined petroleum products was 15.9%. Gasoline consumption increased by 3.7%, to 332.4 Mbbl; naphtha remained unchanged at 279.2 Mbbl; jet fuel decreased by 1.2%, to 30.3 Mbbl; kerosene increased by 4.5%, to 191.6 Mbbl; and diesel rose by 2.2%, to 288.9 Mbbl; heavy fuel oil, including types A, B, and C, dropped by 0.2%, to 430.1 Mbbl. Consumption of domestically produced natural gas totaled 2.7 billion cubic meters; the gas industry consumed 41%; the electric power industry, 25%; the chemical industry, 16%; the oil and gas industry, 15%; and other manufacturing and service industries, 3%. Additionally, Japan consumed 46.4 Mt, or 69.5 billion cubic meters, of imported natural gas, in the form of LNG—the electric power industry consumed 69% for power generation, the city gas industry, 29% for household use; and the iron and steel industry, 2% for steelmaking.

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 (Mkm), 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 Mkm, 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 part 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, Hachinohe, 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 and was operating smoothly in 1996.

Outlook

The nonferrous-metal-mining sector was expected to decline further in 1997. Coal mining is expected to decline drastically owing to the scheduled closure of the Miike coal mine in Fukuoka Prefecture of northern Kyushu in early 1997. Mining activities of industrial minerals, such as limestone and silica stone and sand, are expected remain steady in 1997. Mine production of copper, lead, and zinc was expected to decline in 1997 because of the continued high value of the Japanese yen and the depletion of ore reserves at the remaining two major nonferrous metal mines in the Prefectures of Gifu and Hokkaido.

The outlook of the mineral-processing sector is mixed. Metal production of lead and zinc is expected to remained steady, but production of refined copper is expected to increase in 1997 because of the growing domestic demand and increasing exports to Asian markets, especially to China, the Republic of Korea, and Taiwan. Production of crude steel is expected to remain at about 98 Mt in 1997 because of the slower-than-expected recovery of the Japanese economy.

As a result of decreasing domestic mine production of nonferrous minerals and coal, imports of coal, nonferrous minerals, and metals are expected to increase in 1997. 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, base metals, chromium, coal, columbium (niobium), gold, lithium, manganese, molybdenum, natural gas, nickel, crude petroleum, rare earths, silver, strontium, tantalum, titanium, tungsten, and vanadium.

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TABLE 1
JAPAN: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity		1992	1993	1994	1995	1996 p/
METALS						
Aluminum:						
Alumina, gross weight	thousand tons	316	327	326	363	330 e/
Metal:						
Primary:						
Regular grades	do.	19	18	17	18	17
High-purity	do.	20	20	24	28	29
Secondary 2/	do.	1,074	1,006	1,175	1,181	1,192
Antimony:						
Oxide		11,227	10,485	10,395	10,393	10,311
Metal		175	225	207	93	98
Arsenic (equivalent of arsenic acid) e/		50	40	40	40	40
Bismuth		530	497	505	591	562
Cadmium, refined		2,986	2,832	2,629	2,652	2,343
Chromium:						
Chromite, gross weight e/		8,000	7,000	7,000	7,000	7,000
Metal		3,730	3,297	2,200	1,010 r/	--
Cobalt metal		105	191	161	227	222
Columbium (niobium) and tantalum, tantalum metal e/		80	80	80	80	80
Copper:						
Mine output, Cu content		12,074	10,277	6,043	2,376	1,145
Metal:						
Blister and anode:						
Primary		1,046,200	1,099,100	1,025,500	1,081,200 r/	1,134,100
Secondary		128,700	85,700	96,500	87,300 r/	89,300
Total		1,174,900	1,184,800	1,122,000	1,168,500	1,223,400
Refined:						
Primary		1,046,155	1,099,083	1,025,510	1,081,235 r/	1,134,060
Secondary		114,704	89,693	93,658	106,724 r/	117,313
Total		1,160,859	1,188,776	1,119,168	1,187,959	1,251,373
Gallium metal: e/						
Primary		6	6	6	6	6
Secondary		38	39	40	40	41
Germanium:						
Oxide e/		11	11	10	10	11
Metal		3	3	2	2	2
Gold:						
Mine output, Au content	kilograms	8,893	9,352	9,551	9,185	8,627
Metal:						
Primary	do.	107,957	108,769	102,778	113,148	127,506
Secondary 3/	do.	93,700	105,000	100,000	110,000 e/	120,000 e/
Total	do.	201,657	213,769	202,778	223,148 e/	247,506 e/
Indium metal	do.	59,906	56,161	58,546	61,222	33,184
Iron and steel:						
Iron ore and iron sand concentrate:						
Gross weight	thousand tons	40	11	3	3	3
Fe content	do.	25	6	2	2	2
Roasted pyrite concentrate (50% or more Fe):						
Gross weight	do.	225 r/	200 r/	160 r/	--	--
Fe content	do.	142 r/	126 r/	101 r/	57	
Metal:						
Pig iron and blast furnace ferroalloys	thousand tons	73,144	73,738	73,776	74,905	74,597
Electric-furnace ferroalloys:						
Ferrochrome		267,857	204,719	192,989	210,445	193,695
Ferromanganese		361,941	382,912	345,153	346,977	343,104
Ferronickel		237,350	257,316	242,447	351,337	328,699
Ferrosilicon		37,656	29,084	12,208	3,650	--
Silicomanganese		96,360	64,758	69,183	64,870	72,727
Other:						
Ferrocolumbium		919	1,086	868	37	--
Ferromolybdenum		3,261	3,656	3,930	4,109	4,420
Ferrotungsten		71	80	68	120	64
Ferrovanadium		3,005	3,670	3,418	3,618 r/	3,902

See footnotes at end of table.

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

(Metric tons unless otherwise specified)

Commodity		1992	1993	1994	1995	1996 p/
METALS--Continued						
Iron and steel--Continued:						
Metal--Continued:						
Electric-furnace ferroalloys--Continued:						
Other--Continued:						
Unspecified		4,933	5,174	6,363	4,669	4,820
Total		1,013,353	952,455	876,627	989,832 r/	951,431
Steel, crude	thousand tons	98,132	99,623	98,295	101,640	98,801
Semimanufactures, hot-rolled:						
Of ordinary steels	do.	78,487	79,078	76,631	79,449	78,277
Of special steels	do.	14,842	14,767	15,014	16,171	15,332
Lead:						
Mine output, Pb content		18,839	16,470	9,946	9,659	7,753
Metal, refined:						
Primary		218,787	212,145	182,621	149,523	140,531
Secondary		111,374	97,307	109,641	137,011	146,842
Total		330,161	309,452	292,262	286,534	287,373
Magnesium metal:						
Primary		7,119	7,471	3,412	--	--
Secondary		12,978	13,215	19,009	11,767 r/	21,243
Manganese:						
Ore and concentrate: e/						
Gross weight		100	80	100	100	100
Mn content		21	16	20	20	20
Oxide		54,294	56,106	54,560	60,366	58,523
Metal		3,734	3,169	2,555	865 r/	-- e/
Molybdenum metal		564	619	651	689	596
Nickel metal:						
Refined		22,038	23,108	25,311	26,824	26,564
Ni content of nickel oxide sinter		27,520	28,812	34,711	35,966 r/	36,200
Ni content of ferronickel		57,447	51,120	50,186	69,876 r/	65,368
Ni content of chemical		2,427	2,258	2,400	2,297	2,344
Total		109,432 r/	105,298 r/	112,608 r/	134,963 r/	130,476 r/
Platinum-group metals:						
Palladium metal	kilograms	986	1,183	1,277	2,174	2,182
Platinum metal	do.	629	661	691	730	816
Rare-earth oxide 4/		3,948	3,830	4,397	4,615	4,892
Selenium, elemental		573	541	614	548	588
Silicon, high-purity		2,364	2,523	3,031	3,328	4,112
Silver:						
Mine output, Ag content	kilograms	178,330	136,886	133,713	100,078	85,115
Metal:	do.					
Primary	do.	2,181,130	2,159,517	2,020,223	2,056,657	2,032,120
Secondary 3/	do.	130,711	143,605	162,025	171,969 r/	173,000 e/
Total	do.	2,311,841	2,303,122	2,182,248	2,228,626	2,205,120 e/
Tellurium, elemental		57	47	47	43	37
Tin, metal, smelter		821	804	706	630	526
Titanium:						
Metal		14,554	14,426	14,847	16,702	21,063
Oxide		252,326 r/	245,992	237,956	249,290	237,942
Tungsten:						
Mine output, W content		347	66	--	--	--
Metal		3,307	3,477	3,825	4,468	4,287
Vanadium metal e/ 5/		245	252	300	250	250
Zinc:						
Mine output, Zn content		134,510	118,599	100,653	95,274	79,709
Oxide		82,334	75,203	73,888	75,973	76,008
Metal:						
Primary		645,079	609,272	571,880	573,912	500,674
Secondary		135,647	135,297	141,154 r/	137,139 r/	141,488
Total		780,726	744,569	713,034 r/	711,051 r/	642,162
Zirconium oxide e/		6,380	6,200	6,000	6,000	6,000

See footnotes at end of table.

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

(Metric tons unless otherwise specified)

Commodity		1992	1993	1994	1995	1996 p/
INDUSTRIAL MINERALS						
Asbestos e/		29,500	24,900	21,000	20,000	18,000
Bromine, elemental e/		15,000	15,000	15,000	15,000	15,000
Cement, hydraulic	thousand tons	88,253	88,046	91,624	90,474	94,492
Clays:						
Bentonite		534,472	517,389	484,115	478,056 r/	468,728
Fire clay		751,661	736,503	685,390	566,569 r/	526,638
Kaolin		122,948	110,318	138,412	182,122 r/	141,230
Feldspar and related materials:						
Feldspar		72,285	71,568	56,003	65,086 r/	55,122
Aplite		416,304	403,724	381,160	388,000	365,580
Gypsum	thousand tons	4,322	3,953	3,873	5,334 r/	5,300 e/
Iodine, elemental		6,764	6,489	5,592	5,492 r/	5,500 e/
Lime, quicklime	thousand tons	8,049	7,958	7,712	7,871	7,744
Nitrogen, N content of ammonia	do.	1,545 r/	1,471 r/	1,483 r/	1,584 r/	1,564
Perlite e/		203,000	200,000	200,000	200,000	200,000
Salt, all types	thousand tons	1,405	1,378	1,387	1,400 e/	1,390 e/
Silica sand		3,842,984	3,882,719	3,942,368	3,734,425 r/	3,632,260
Silica stone	thousand tons	19,275	18,849	18,479	18,349 r/	19,026
Sodium compounds, n.e.s.:						
Soda ash		1,056,803	1,055,959	1,049,676	1,049,017	925,671
Sulfate		242,771	229,346	200,111 r/	206,893 r/	204,000 e/
Stone, crushed and broken:						
Dolomite	thousand tons	4,854	4,755	3,831	3,773	3,905
Limestone	do.	203,854	200,455	202,481	201,097 r/	202,894
Sulfur:						
S content of pyrite	do.	31	29	4	2 e/	2 e/
Byproduct:						
Of metallurgy	do.	1,374	1,383	1,269	1,312 r/	1,350 e/
Of petroleum	do.	1,340	1,510	1,550 e/	1,500 e/	1,550 e/
Talc and related materials:						
Talc		61,120	57,229	56,120	57,269	56,153
Pyrophyllite		1,055,897	1,028,399	934,007	947,713 r/	918,680
Vermiculite e/		15,000	15,000	15,000	15,000	15,000
MINERAL FUELS AND RELATED MATERIALS						
Carbon black	thousand tons	771	702	704	757	757
Coal:						
Anthracite	do.	--	--	1	--	4
Bituminous 6/	do.	7,598	7,217	6,931	6,263	6,476
Total	do.	7,598	7,217	6,932	6,263	6,480
Coke including breeze:						
Metallurgical	do.	42,308	41,767	41,287	42,010	40,728
Gashouse including breeze	do.	1,096	1,024	705	593	527
Gas, natural:						
Gross 7/	million cubic meters	2,159	2,204	2,274	2,209	2,230
Marketed	do.	2,295	2,308	2,334	2,315	2,323
Petroleum:						
Crude	thousand 42-gallon barrels	6,302	5,730	5,472	5,415	5,265
Refinery products:						
Gasoline:						
Aviation	do.	78	72	70	64 r/	63
Other	do.	290,913	301,782	312,959 r/	319,263 r/	328,894
Asphalt and bitumen	do.	37,719 r/	37,296 r/	37,222 r/	36,459 r/	37,216
Distillate fuel oil	do.	250,724	259,442	276,392	287,498 r/	296,413
Jet fuel	do.	37,795	40,569	45,010	49,520 r/	47,079
Kerosene	do.	163,560	169,573	171,010	171,675 r/	177,649
Liquefied petroleum gas	do.	54,494 r/	52,975 r/	52,806 r/	56,665 r/	56,208
Lubricants	do.	15,583	15,951	17,080	17,203 r/	17,423
Naphtha	do.	100,649	109,178	109,821	112,110 r/	104,379
Paraffin	do.	918	804	793	909 r/	850 e/
Petroleum coke e/	do.	900	900	950	950	900
Refinery fuel and losses e/ 8/	do.	155,000	150,000	160,000	160,000	155,000

See footnotes at end of table.

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

(Metric tons unless otherwise specidied)

Commodity		1992	1993	1994	1995	1996 p/
MINERAL FUELS AND RELATED MATERIALS--Continued						
Petroleum--Continued:						
Refinery products--Continued:						
Residual fuel oil	thousand 42-gallon barrels	476,875	479,799	508,505	489,605 r/	463,099
Unfinished oils e/	do.	58,000	58,000	60,000	60,000	55,000
Total e/	do.	1,643,208 r/	1,676,341 r/	1,752,618 r/	1,761,921 r/	1,740,173

e/ Estimated. p/ Preliminary. Revised.

1/ Table includes data available through Aug. 15, 1997.

2/ Includes unalloyed ingot and alloyed ingot.

3/ Recovered from scrap and waste and returned by end users.

4/ Includes oxides of cerium, eruopium, gadolinium, lanthanum, neodymim, praseodymim, 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, 1996; Yearbook of Iron and Steel Statistics, 1996; Yearbook of Chemical Industries Statisitics, 1996; Yearbook of Ceramics and Building Materials Statistics, 1996; and Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke, 1996.

TABLE 2
JAPAN: STRUCTURE OF THE MINERAL INDUSTRY FOR 1996

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Coal		Mitsui Coal Mining Co. Ltd. 1/	Miike in Omuta, Fukuoka Prefecture	2,500
Do.		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 Corp.	Naoshima, Kagawa Prefecture	187,200
Do.	do.	Nippon Mining and Metals Co. Ltd. (wholly owned subsidiary of Nikko Kyodo Co. Ltd.)	Hitachi, Ibaraki Prefecture Saganoseki, Oita Prefecture	132,000 198,000
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	247,200
Do.	do.	Sumitomo Metal Mining Co. Ltd.	Besshi, Ehime Prefecture	210,000
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	38,400
Gold:	kilograms			
In concentrate		Sumitomo Metal Mining Co. Ltd.	Hishikari, Kagoshima Prefecture	9,000
Refined		Mitsubishi Materials Corp.	Naoshima, Kagawa Prefecture	60,000
Do.		Nippon Mining and Metals Co. Ltd.	Hitachi, Ibaraki Prefecture	15,000
Do.		Sumitomo Metal Mining Co. Ltd.	Niihama, Ehime Prefecture	30,000
Limestone		Chichibu Onoda Co. Ltd.	Ohunato, Iwate Prefecture, and Ganji, Oita Prefecture	170,000
Do.		Mitsubishi Materials Corp.	Higashitani, Fukuoka Prefecture	10,000
Do.		Nippon Cement Co. Ltd.	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, Tochogi 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 Industries Co. Ltd. (wholly owned subsidiary of Asahi Glass Co. Ltd.)	Oami-Shirasato, Ichinomya, Misaki, and Hikari, Chiba Prefecture; Kurosaki, Niigata Prefecture; and Sadowara, Miyazaki Prefecture	4,300
Do.	do.	Nippon Natural Gas Industry Co. Ltd.	Minamihinato-Shirako, Koji-Shirake, Yokoshiba, and Narashino, Chiba Prefecture	1,300
Do.	do.	United Resources Industry Co. Ltd.	Chosei and Otaki, Chiba Prefecture	1,800
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	94,800
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, Toyama Prefecture	25
Do.		Tosoh Corp.	Hyuga, Miyazaki Prefecture	24
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
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, Chiba 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 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

See footnotes at end of table.

TABLE 2--Continued
JAPAN: STRUCTURE OF THE MINERAL INDUSTRY FOR 1996

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Titanium--Continued:				
In sponge metal--Continued:		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	154,000
Do.	do.	Sakai Chemical Industries Co. Ltd.	Onahama, Fukushima Prefecture	43,200
Do.	do.	Teika Co. Ltd.	Saidaiji, Okayama Prefecture	48,600
Do.	do.	Titan Kogyo Co. Ltd.	Ube, Yamaguchi Prefecture	16,800
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. (52% owned by Dowa Mining Co. Ltd., 24% by Nippon Mining and Metals Co. Ltd., 14% by Sumitomo Metal Mining Co. Ltd., and 5% each by Mitsubushi Materials Corp. and Toho Zinc Co. Ltd.)	Iijima, Akita Prefecture	156,000
Do.	do.	Hachinohe Smelting Co. Ltd. (20% owned by Dowa Mining Co. Ltd., 50% by Mitsui Mining and Smelting 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.)	Hachonohe, Aomori Prefecture	108,000
Do.	do.	Hikoshima Smelting Co. Ltd.	Hikoshima, Yamaguchi Prefecture	84,000
Do.	do.	Kamioka Mining ans Smelting Co. Ltd.	Kamioka, Gifu Prefecture	72,000
Do.	do.	Mitsubishi Materials Corp. 4/	Akita, Akita Prefecture	105,600
Do.	do.	Toho Zinc Co. Ltd.	Annaka, Gunma Prefecture	139,200
Do.	do.	Sumitomo Metal Mining Co. Ltd.	Harima, Hyogo Prefecture	90,000

1/ To be closed in Mar. 1997.
2/ The plant was renovated to a secondary lead smelter recycling batteries in 1995.
3/ The plant became a secondary smelter recycling batteries in 1995.
4/ Closed in June 1996.

TABLE 3
JAPAN: RESERVES OF MAJOR MINERAL COMMODITIES FOR 1996

(Thousand metric tons unless otherwise specified)

Commodity		Reserves
Coal 1/		821,000
Copper ore, Cu content		36
Dolomite 2/		1,210,000
Gold ore, Au content	kilograms	550,000 e/
Iodine		1,800 e/
Lead ore, Pb content		623
Kaolin		61,600
Limestone 3/		57,430,000
Pyrophyllite		151,000
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.