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The Mineral Industry of Japan

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Note: In this chapter, information for 2020 is followed by information for 2021.

The metals and mineral-processing industries dominated Japan's mineral sector. In 2020, Japan was ranked second in the world in refined selenium production, accounting for 24% of world production (excluding United States production), as well as titanium sponge (21%, excluding United States production); tied for third, along with Canada, for refined indium (7%, excluding United States production); third for refined tellurium (an estimated 12%, excluding United States production), cadmium (8%, excluding United States production), refined copper (6%), silicon carbide (abrasives) (an estimated 6%), and pig iron and raw steel (5% each); and fourth for bromine (6%, excluding United States production). Japan had 4.9 million metric tons (Mt) of iodine reserves (the world's largest) and accounted for 30% of world iodine production, excluding United States production, ranking second in world production behind Chile (68%) (Anderson, 2022a–c; Callaghan, 2022; Flanagan, 2022; Gambogi, 2022; Schnebele, 2022a, b; Stewart, 2022; Tuck, 2022).

Owing to the depletion of domestic mineral resources and the lack of mine production, Japan imported metallic ores and concentrates of antimony, copper, iron, lead, nickel, silver, titanium, and zinc. In 2020, Japan remained the second ranked importer of ash, metallic ash, ores, and slag, accounting for 8% of global trade of these materials, by value, behind China (65%). Japan was the world's third-ranked importer of mineral fuels, accounting for 7% of global trade of mineral fuels, by value, behind China (17%) and the United States (8%) (table 3; United Nations Statistics Division, 2023).

Minerals in the National Economy

In 2020, Japan's nominal gross domestic product (GDP) was $5.05 trillion (JPY539 trillion);[1] real GDP decreased by 4.3%. The manufacturing, construction, and mining and quarrying industries accounted for 20.1%, 5.7%, and 0.1%, respectively, of Japan's GDP in 2020. In 2016 (the latest year for which data were available), 19,467 people were employed in the mining and quarrying industry (Japan Statistics Bureau, 2021, p. 270; Cabinet Office of Japan, 2022a, p. 9; 2022b; 2022c).

In 2020, Japan's total outward foreign direct investment (FDI) decreased to $99.7 billion, or by 57.1% compared with that in 2019. Outward FDI toward the mining and quarrying industry was $2.50 billion in 2020 compared with $9.73 billion in 2019. Outward FDI to industries related to the manufacturing of metals and the refining of petroleum were $1.92 billion and $240 million, respectively, compared with $4.07 billion and $188 million, respectively, in 2019. Total inward FDI to Japan decreased by 14.5% to $11.8 billion in 2020. Inward FDI to the mining and quarrying industry decreased to $14 million in 2020 from $39 million in 2019. Inward FDI to the manufacturing of metals was $27 million compared with $111 million in 2019, and that for the refining of petroleum was $61 million and had a net inflow (that is, a negative value of inward FDI) of $859 million (Japan External Trade Organization, 2023a, b).

Government Policies and Programs

The objective of the Government of Japan's mineral policy is to secure a stable supply of raw materials for the country's metal industry because of the lack of domestic resources. Japan's mining and quarrying industry is regulated by the 1950 Mining Act (No. 289 of 1950) as amended by the 2011 Mining Act (No. 84 of 2011). The amendment (1) includes an additional requirement that those applying for a mining permit must submit documents of their financial and (or) technical capabilities; (2) designates petroleum, natural gas, and deep-sea minerals as "specified minerals," meaning minerals that are particularly necessary for the country's economic stability; and (3) establishes a new procedure to grant mining permissions for specified minerals to applicants who match most with the permission criteria (Ministry of Economy, Trade and Industry, 2012, p. 1; Kikkawa, 2013, p. 33–35).

Production

In 2020, significant increases in mineral commodity production included that of alumina (by an estimated 100%), refined primary platinum (21%), mined gold (20%), and primary smelter copper (13%). Significant decreases in production included that of silicomanganese (by 52%); jet fuel and mined silver (50% each); tungsten metal (34%); ferronickel (Ni content) (28%); naphtha (26%); other unspecified ferroalloys (25%); ferrochromium and specialty steel (24% each); aluminum powder (23%); ferrovanadium and vanadium (22% each); zinc oxide (21%); quicklime and liquefied petroleum gas (20% each); gas oil petroleum (19%); coke from petroleum refining, pig iron, and titanium dioxide (18% each); raw steel, secondary refined palladium, and secondary smelter copper (16% each); asphalt petroleum, industrial silica, refined antimony, and titanium sponge (15% each); ordinary steel (14%); ferromanganese, secondary aluminum metal, and sulfur as a petroleum byproduct (13% each); and gasoline and lubricating oil (11% each). Data on mineral production are in table 1.

Structure of the Mineral Industry

The Agency for Natural Resources and Energy (ANRE), which was established under the Ministry of Economy, Trade and Industry (METI), is responsible for formulating Japan's

[1]Where necessary, values have been converted from Japanese yen (JPY) to U.S. dollars (US$) at the annual average exchange rates of JPY109.817=US$1.00 for 2021 and JPY106.725=US$1.00 for 2020.

mineral and energy policies. Japan Oil, Gas and Metals National Corp. (JOGMEC) is an independent administrative agency that was formed as a merger of the Japan National Oil Co. and the Metal Mining Agency of Japan in 2004. JOGMEC is charged with securing a stable supply of petroleum, natural gas, nonferrous metals, and other mineral commodities; and implementing mine pollution control measures (Agency for Natural Resources and Energy, 2018; Japan Oil, Gas and Metals National Corp., 2022a).

Japan's mineral industry was primarily owned and operated by private companies. The mining of coal and nonferrous metals was a small industry in Japan, but the industrial mineral production and the processing of ferrous and nonferrous metals were large industries. The Hishikari gold mine in Kagoshima Prefecture, which was operated by Sumitomo Metal Mining Co. Ltd. (SMM), was the only active metal mine in Japan (table 2; Sumitomo Metal Mining Co. Ltd., 2022a).

Mineral Trade

In 2020, Japan's total exports were valued at $641 billion. Exports of mineral products were valued at $8.43 billion. Of this amount, exports of ores and concentrates were valued at $158 million; and mineral fuels and products, $7.62 billion. Of the exports of mineral fuels and products, those of refined petroleum were valued at $5.55 billion; and those of petroleum gas and hydrocarbons, $100 million. In 2020, Japan's leading five export partners for refined petroleum were, in terms of export value, the Republic of Korea (which received 28% of Japan's refined petroleum, by value), Australia (16%), Singapore (13%), Malaysia (8.7%), and China (8.1%) (Japan Ministry of Finance, 2023).

Japan's exports of nonferrous metals and articles thereof were valued at $14.0 billion. Major exported nonferrous metals and articles thereof included copper, which had an export value of $9.35 billion (and total exported quantity of 1.37 Mt); aluminum, $2.24 billion [595,000 metric tons (t)]; and nickel, $922 million (51,500 t). In 2020, Japan's leading five export partners for nonferrous metals and articles thereof were China (which received 35% of Japan's exports of nonferrous metals and articles thereof, by value), Taiwan (12%), Thailand (8.9%), the Republic of Korea (8.3%), and India (8.0%). Exports of ferrous metals and articles thereof were valued at $31.7 billion, and the total imported quantity of these mineral commodities was 41.7 Mt. In 2020, Japan's leading five export partners for ferrous metals and articles thereof were the Republic of Korea (which received 19% of these exports, by value), China and Vietnam (14% each), Thailand (9.6%), and Taiwan (8.6%). Exports of precious and semiprecious stones and metals were valued at $13.3 billion. Major exported precious and semiprecious stones and metals included gold, which had an export value of $8.32 billion (indicating a total exported quantity of 148 t); silver, $1.60 billion (7,140 t); and platinum-group metals (PGMs), $1.59 billion (71.1 t). Japan's leading five export partners for gold were the Hong Kong Special Administrative Region of China (SAR) (which received 28% of Japan's gold exports), the United Kingdom (21%), Singapore (19%), Switzerland (15%), and Malaysia (3.9%) (Japan Ministry of Finance, 2023).

In 2020, Japan's total imports were valued at $637 billion. Imports of mineral products were valued at $129 billion. Of this amount, imports of ores and concentrates were valued at $21.8 billion. Major imported ores and concentrates included those of copper, which had an import value of $9.80 billion (indicating a total imported quantity of 5.23 Mt); iron, $9.66 billion (99.4 Mt); and zinc, $544 million (32,900 t). The leading five import partners for copper ores and concentrates were, in order of value, Chile (which provided 38% of Japan's imports of copper ores and concentrates), Australia (19%), Peru (12%), Canada (9.2%), and Indonesia (5.9%). The leading five import partners for iron ores and concentrates were Australia (which provided 52% of Japan's imports of iron ores and concentrates), Brazil (30%), Canada (7.2%), South Africa (3.6%), and India (2.0%) (Japan Ministry of Finance, 2023).

In 2020, Japan's imports of nonferrous metals and articles thereof were valued at $12.7 billion. Major imported nonferrous metals and articles thereof included aluminum, which had an import value of $6.55 billion (indicating a total imported quantity of 2.63 Mt); nickel, $2.41 billion (258,000 t); copper, $2.13 billion (307,000 t); and tin, $355 million (20,200 t). In 2020, Japan's leading five import partners for nonferrous metals and articles thereof were, in order of value, China (which provided 19% of Japan's imports of nonferrous metals and articles thereof, by value), Indonesia (7.9%), the United States (7.1%), Australia (7.0%), and Thailand (6.4%). Imports of ferrous metals and articles thereof were valued at $12.4 billion (indicating a total imported quantity of 8.67 Mt). In 2020, Japan's leading five import partners for ferrous metals and articles thereof were, in order of value, China (which provided 37% of Japan's imports of ferrous metals and articles thereof), the Republic of Korea (24%), Taiwan (8.4%), Vietnam (3.9%), and the United States (3.7%). Imports of precious and semiprecious stones and metals were valued at $16.1 billion. Major imported precious and semiprecious stones and metals included platinum, which had an import value of $6.97 billion (for a total imported quantity of 108 t); scraps of precious metal, $4.86 billion (165,000 t); and jewelry, $1.56 billion (209 t). Japan's leading five import partners for platinum were, in order of import value, South Africa (which provided 58% of Japan's imports of platinum, by value), Russia (22%), the United Kingdom (4.8%), Germany (4.2%), and the United States (3.9%) (Japan Ministry of Finance, 2023).

Imports of mineral fuels and petroleum refinery products (included in the imports of mineral products stated above) were valued at $106 billion. Of this amount, imports of crude petroleum were valued at $43.5 billion (indicating a total imported quantity of 123 Mt); petroleum gases and hydrocarbons, $34.1 billion (84.3 Mt); coal, $16.0 billion (174 Mt); and refined petroleum, $11.0 billion (25 Mt). In 2020, Japan's leading five import partners for mineral fuels and petroleum refinery products were Australia (which provided 21% of Japan's imports of mineral fuels and products, by value), Saudi Arabia (17%), the United Arab Emirates (15%), Qatar (8.6%), and the United States (7.3%) (Japan Ministry of Finance, 2023).

Commodity Review

Metals

Aluminum.—In fiscal year 2020 [(FY 2020), which ran from April 1, 2020, through March 31, 2021), aggregate domestic demand for aluminum in Japan was 3.67 Mt, which was an 11.1% decrease from that in FY 2019. Of this amount, demand for rolled products decreased by 7.7% to 1.74 Mt; die-cast materials, by 15.5% to 830,000 t; and cast materials, by 20% to 344,000 t. Imports of these materials decreased by 12.1% to 491,000 t (Japan Aluminium Association, 2020; Aluminum Survey Committee, 2021, 2022).

In 2020, Japan imported 1.2 Mt of nonalloyed unwrought aluminum (an 18% decrease compared with that imported in 2019), 883,000 t of alloyed unwrought aluminum (a 25% decrease), 227,000 t of wrought aluminum (a 9.6% decrease), and 52,800 t of aluminum waste and scrap (an 18% increase). Japan produced 690,200 t of secondary aluminum in 2020, which was a decrease of 13.2% from the amount produced in 2019. In 2020, Japan's leading five import partners were, by quantity for unwrought aluminum, Russia (which provided 406,000 t), Australia (329,000 t), the United Arab Emirates (268,000 t), New Zealand (180,000 t), and China (156,000 t). In 2020, 3.5 Mt of aluminum products were produced in Japan, of which 49% were rolled and extruded and 33% were casted and die-casted. The transportation sector accounted for 36% of the quantity of aluminum products consumed in Japan, followed by the fabricated metal sector, 13%; building and construction sector, 12%; and food sector, 11%. Japan exported 4.7% of the aluminum products that it produced in 2020 (Japan Aluminium Association, 2021, p. 1, 5, 6; Japan Ministry of Finance, 2023).

Cobalt.—Japan did not have any domestic production or imports of cobalt ore and concentrates, instead relying on imports of cobalt matte for refined cobalt production. In 2020, Japan produced an estimated 4,200 t of refined cobalt metal, which was exclusively from SMM's Niihama and Harima plants. Shipments of nickel and cobalt ores to Japan were disrupted because of suspensions of mining operations during the coronavirus disease 2019 (COVID-19) pandemic at Taganito HPAL Nickel Corp. of the Philippines, which affected approximately 200 t of cobalt production. In 2020, SMM was in the process of investing $320 million to increase monthly production of nickel-cobalt-aluminum cathode materials to 10,000 t from 4,550 t; the upgrade would be completed by March 2024. This expenditure follows previous expenditures of $338 million during the past few years to increase monthly production to 4,550 t from 850 t (tables 1, 2; Darton Commodities Ltd., 2021, p. 92).

In 2020, Japan imported 8,200 t of cobalt matte, unwrought cobalt, and cobalt powder. Japan's leading five import partners for cobalt matte, unwrought cobalt, and cobalt powder were Finland (which provided 61% of Japan's imports of cobalt matte, by quantity), Canada (8.9%), Morocco (6.5%), Norway (5.2%), and China (3.8%). Japan had no domestic producers of cobalt oxide and hydroxide on a large scale, and domestic demand for these mineral commodities was met entirely through imports. In 2020, imports of cobalt oxide and hydroxide totaled 487 t and 408 t, respectively. In 2020, the primary source of domestic demand for cobalt in Japan was cathode materials for lithium-ion batteries, the estimated consumption of which for the year was 6,100 t (Japan Oil, Gas and Metals National Corp., 2022e, p. 3, 6; Japan Ministry of Finance, 2023).

Copper.—Japan relied entirely on imports of copper ore and concentrate to supply its copper refining industry. In 2020, Japan imported 5.23 Mt of copper ore and concentrate. Chile was its leading import partner (46% by quantity), followed by Peru (14%), Australia and Canada (9.5% each), and Indonesia (5.6%). Refined copper production (primary and secondary) in 2020 was 1.59 Mt, of which approximately 775,000 t was exported. In 2020, domestic demand for copper was 891,000 t, of which 67% was for electric wire (table 1; Japan Oil, Gas and Metals National Corp., 2022b, p. 6; Japan Ministry of Finance, 2023).

In April 2020, JX Nippon Mining & Metals Co. Ltd. (JX Metals) and Mitsui Mining & Smelting Co. Ltd. (Mitsui Kinzoku) established their own subsidiaries with the Tamano smelter, Hitachi refinery, and Saganoseki smelter and refinery. These facilities were previously operated by or were subsidiaries of Pan Pacific Copper Co. Ltd. (PPC), which was established as a joint venture by JX Metals and Mitsui Kinzoku in 2000. From April onwards, Hibi Smelting Co. Ltd., which was a subsidiary of Mitsui Kinzoku, operated the Tamano smelter; and JX Metals Smelting Co. Ltd., which was a subsidiary of JX Metals, operated the Hitachi refinery and Saganoseki smelter and refinery; PPC no longer operated smelters or refineries and was responsible for such tasks as smelting and refining contracts, procurement of raw materials, and product marketing. These series of decisions were implemented because JX Metals intended to strengthen its downstream business processes and Mitsui Kinzoku planned to integrate its existing lead, zinc, and precious metals smelting and refining networks (Pan Pacific Copper Co. Ltd., 2019; Mitsui Mining & Smelting Co. Ltd., 2020).

Gold.—In 2020, Japan produced 7,590 kilograms (kg) of mined gold from the Hishikari Mine, which was operated by SMM. According to SMM, since 1985, the ore grade from the mine had been approximately 20 grams per metric ton (g/t) of gold, which was from four to seven times higher than the global average of 3 to 5 g/t gold (table 1; Sumitomo Metal Mining Co. Ltd., 2022a).

After amendments were made to the Mining Act in 2011—which allowed for foreign companies to hold prospecting and mining rights in Japan—Japan Gold Corp. of Canada established multiple projects for exploration of epithermal gold deposits on Hokkaido, Honshu, and Kyushu Islands. In 2020, 31 exploration projects were in operation, of which the Ikutahara and the Ohra-Takamine projects were the most advanced. The Ohra-Takamine project, located in the Hokusatsu-Kushikino Mining District in southern Kyushu, is 7.5 kilometers southwest of the historic Yamagano Mine, which was known for its production of 17.4 g/t of high-grade gold. The project was granted 11 prospecting blocks, whose area was 3,705 hectares in total, and completed two drill holes in November 2020; the first drill hole reached a depth of 602 meters (m) (Japan Gold Corp., 2020a, b; 2021a, p. 10; 2021b).

Iron and Steel.—In 2020, Japan ranked third in the world in raw steel production (83.1 Mt) after China [1.06 billion metric tons (Gt)] and India (100 Mt). The leading three producers of

raw steel in Japan in 2020 were Nippon Steel Corp. (which produced 41.6 Mt compared with 51.7 Mt in 2019), JFE Steel (24.4 Mt compared with 27.4 Mt in 2019), and Kobe Steel Ltd. (5.69 Mt compared with 6.89 Mt in 2019). Nippon Steel Corp. was the fifth-ranked producer of raw steel in the world in 2020 compared with ranking third in 2019 (World Steel Association, 2021a, p. 2; 2021b, p. 1, 2).

Japan's raw steel production in 2020 included 17.5 Mt of specialty steel. Total domestic consumption and exports of specialty steel products were 9.41 Mt and 4.00 Mt, respectively. In 2020, the domestic automobile sector was the leading consumer of specialty steel products (accounting for 40.0% of domestic consumption) and was followed by the industrial machinery and equipment sector (12.1%). Total domestic consumption and exports of ordinary steel products were 35.9 Mt and 20.7 Mt, respectively. The construction sector was the leading consumer of ordinary steel products (accounting for 17.6%), followed by the automobile sector (11.9%), shipbuilding sector (5.44%), and industrial machinery and equipment sector (2.11%); 19.7% was consumed by steel dealers (Japan Iron and Steel Federation, 2020a–c; 2021a, 2021e).

Nickel.—Japan relied entirely on imports of nickel ore and concentrate to supply its nickel refining industry. In 2020, Japan imported 2.52 Mt of nickel ore and concentrate. The import sources included New Caledonia (which supplied 74% of Japan's imports of nickel ores and concentrates, by quantity) and the Philippines (26%). In 2020, ferronickel production (Ni content) was estimated to be 45,200 t, and nickel metal production was 55,400 t. Apparent domestic consumption of ferronickel was 23,700 t in 2020. Consumption of nickel metal was 34,700 t, of which 82% was used in the production of specialty steels (table 1; Japan Oil, Gas and Metals National Corp., 2022d, p. 6, 7; Japan Ministry of Finance, 2023).

Rare Earths.—No mines produced rare earths in Japan. A deposit of rare earths was discovered in 2012 under the 5,700-m deep seabed within Japan's exclusive economic zone (an area of 2,500 square kilometers) located south of Minami-Torishima Island. Although the technology needed to produce rare earths on a commercial scale remained to be developed, the deposit was estimated to be large enough to supply all the needs of Japan's high-tech manufacturing industry. A 2018 analysis estimated the deposit's resources to be 16 Mt of rare earth minerals, including yttrium, dysprosium, europium, terbium, and yttrium, at levels that are hundreds of times that of current global consumption. Research on the Minami Torishima Island site and its development as a potential source of rare earths began in earnest in 2018 as part of a Cross-ministerial Strategic Innovation Promotion Program (SIP) administered primarily by the Japan Agency for Marine Earth Science and Technology (JAMSTEC) and conducted in coordination with academia and industry. The objectives of the SIP were to narrow down potential sites, estimate the quantity of rare earth reserves, and establish retrieval technologies using a coordinated fleet of autonomous underwater vehicles (AUVs) that are controlled from the sea surface. By the end of 2020, SIP successfully conducted a year-long marine acoustic survey at depths exceeding 5,000 m and verification tests of the new blade-based slurry removal process that was developed for removing rare-earth-rich clay from the seafloor (Asanuma, 2018; Sankei News, The, 2018; Japan Agency for Marine-Earth Science and Technology, 2021a, p. 2; 2021b, p. 7).

In 2020, domestic demand for rare earths was 17,400 t (in terms of rare earth oxide equivalent), of which cerium accounted for 37%. Japan imported 13,100 t of rare earth compounds and 6,800 t of rare earth metals in 2020. The leading five import partners for rare earth compounds were China (which supplied 62% of Japan's imports of rare earth compounds, by quantity), France (22%), India (7.9%), Estonia (5.1%), and Taiwan (1.0%). The leading five import partners for rare-earth metals were China (which supplied 49% of Japan's imports of rare-earth metals, by quantity), Vietnam (38%), Thailand (14%), and all other countries (less than 1%) (Japan Oil, Gas and Metals National Corp., 2022c, p. 5; Japan Ministry of Finance, 2023).

Titanium.—Japan depends entirely on imports of titanium ore and concentrate to satisfy the country's demand. Although approximately 90% of global titanium ore production consists of ilmenite, Japan has a higher consumption of non-ilmenite ores, such as rutile and rutile alloys (81% of domestic consumption in 2019, which was the latest year for which data were available), which can be used as the raw material for sponge titanium and titanium oxides. In 2020, Japan imported 343,000 t of titanium ores and concentrates. The leading five import partners for titanium ores and concentrates were India (which supplied 27% of Japan's imports of titanium ores and concentrates, by quantity), South Africa (24%), Canada (19%), Australia (13%), and Sierra Leone (6%). Japan also imported 11,800 t of titanium oxide. In 2020, production of titanium dioxide (TiO_2) was 156,000 t, and sponge titanium, 49,200 t (estimated). In 2019 (the latest year for which data were available), domestic consumption of titanium was 140,800 t, consisting of titanium oxide (81%) and sponge titanium (19%). Titanium dioxide was used mainly for pigment by the automotive industry (table 1; Japan Oil, Gas and Metals National Corp., 2021, p. 272, 273, 277, 279; Japan Ministry of Finance, 2023).

In 2020, Osaka Titanium Technologies Co. Ltd. (OTC) and Toho Titanium Co. Ltd.—Japan's only titanium sponge producers—had titanium sponge production capacities of 40,000 metric tons per year (t/yr) and 25,200 t/yr, respectively. In September, OCT announced the start of operations of a specialized plant to produce titanium low-oxygen powder as a byproduct of titanium sponge production. The company had started the construction of the 100-t/yr plant in November 2018 and planned to invest a total of $9.37 billion in its development. The production capacity of the plant was 100 t/yr (table 2; Osaka Titanium Technologies Co. Ltd., 2020).

Industrial Minerals

Iodine.—Iodine is used for X-ray contrast media, polarizing film, disinfectants, and catalysts. In Japan, raw iodine was extracted from brine produced in shallow natural gas fields. This process causes land subsidence, so local governments have regulated the pumping of natural gas brine, resulting in a stable level of iodine production over time. Raw iodine production areas in Japan were located in the Prefectures of Chiba, Miyazaki, and Niigata. The Southern Kanto gasfield was the largest water-soluble natural gas deposit in Japan and

had estimated reserves of 4.9 Mt of iodine at concentrations of 100–150 parts per million. The field is in Chiba Prefecture and accounted for approximately 80% of raw iodine production in the country. Japan produced 8,880 t of raw iodine in 2020 and exported 4,860 t. Leading export partners were Norway (which received 22% of Japan's exports of iodine, by quantity), China (18%), India (13%), Germany (9.7%), and Italy (9.6%) (table 1; Godo Shigen Co. Ltd., 2014; Kaneko and Kaiho, 2014, p. 231, 237; Ise Chemicals Corp., 2020; Kanto Natural Gas Development Co. Ltd., 2020; Japan Ministry of Finance, 2023).

Limestone.—The production of limestone in Japan in 2020 was 132 Mt. As of November 2020, there were 220 limestone quarries in operation in Japan, of which 20 quarries accounted for 82.1% of domestic limestone production. In FY 2020, of the limestone produced in Japan that was shipped for consumption, 45% was used for cement production; 22%, for concrete aggregate production; 12%, for steel production; 7%, for lime production; 2%, for road construction; 7%, for other applications (including soda and glass production); and 5%, for exports (Japan Business Federation, 2021, p. 1, 3; Limestone Association of Japan, 2022).

Mineral Fuels and Related Materials

In FY 2020, sources of power generation in Japan included natural gas (which generated 39% of Japan's total electric power), coal (31%), solar power (7.9%), hydropower (7.8%), petroleum (6.3%), nuclear power (3.9%), biomass (2.9%), wind power (0.9%), and geothermal power (0.3%) (Agency for Natural Resources and Energy, 2022a).

Coal.—In 2020, Japan was the world's third-ranked importer of coal (behind China and India) and imported 160 Mt of bituminous coal, 5.4 Mt of anthracite coal, and 8.2 Mt of other forms of coal (including briquets). In FY 2020, 54.8% of the total coal supply was used for power generation; 4.72%, for the manufacturing of iron and steel; and 2.67%, for the manufacturing of ceramic, stone, and clay products. From 2011 to yearend 2020, 29 new coal-fired powerplants with a total capacity of 6.5 gigawatts (GW) started operations. The 250-megawatt-capacity Nakoso Power Station, which was owned by Tohoku Electric Power and Japan's Energy for New Era Co. Inc., was retired in November 2020. A total of 13 new powerplants had been planned to come online between 2021 and 2026, for an additional capacity of 7.8 GW. Coal demand in Japan had increased following the suspension of all nuclear power from 2011 following the Fukushima Daiichi powerplant disaster (Agency for Natural Resources and Energy, 2022a, b; BP p.l.c., 2022, p. 40; Japan Beyond Coal, 2023; Japan Ministry of Finance, 2023).

Natural Gas.—In 2020, Japan's leading import partners of all forms of natural gas were, by the quantity supplied, Australia (which provided 36% of Japan's imports of natural gas), the United States and Malaysia (13% each), Qatar (11%), and Russia (7.3%). Japan was the world's leading importer of liquefied natural gas (LNG), accounting for 21% of global LNG imports. LNG imports declined by 3.2% in 2020 compared with those in 2019 owing to the lockdown measures put in place in response to the COVID-19 pandemic and subsequent decreased electricity consumption. In 2020, 62.6% of the total natural gas supply was used for power generation and 1.18% was used in the manufacturing industry (International Group of Liquefied Natural Gas Importers, 2021, p. 6, 30; Agency for Natural Resources and Energy, 2022b; Japan Ministry of Finance, 2023).

Petroleum and Petroleum Refinery Products.—In 2020, Japan was the world's fifth-ranked importer of crude petroleum, in terms of quantity, behind China, India, the United States, and the Republic of Korea. Japan produced 3.22 million barrels (Mbbl) of crude petroleum, which constituted approximately 0.3% of Japan's domestic consumption. Japan was the seventh-ranked producer of refined petroleum in 2020. Of the refined petroleum consumed domestically in FY 2020, 46% was for transportation; 45%, for industrial applications; and 9%, for residential applications. As of March, 22 petroleum refineries were active in the country and had a total (combined) daily capacity of 3.52 Mbbl. Approximately 19,100 people were employed in the petroleum refining and marketing industry (table 1; Petroleum Association of Japan, 2020a, p. 9; 2020b, p. 44; Agency for Natural Resources and Energy, 2022b; BP p.l.c., 2022, p. 20; Enerdata, 2023a, b).

In June, ENEOS Corp., which accounted for 54% of the country's petroleum refining capacity, finalized its name change from JXTG Nippon Oil & Energy Corp. This name change was initiated with the merger in 2017 of JX Holdings and TonenGeneral Sekiyu K.K., which were the top petroleum refiners in Japan at the time. In October, ENEOS Corp. permanently shut down its Osaka refining operations, which had an annual capacity of 42.0 Mbbl, owing to decreasing demand for petroleum products in Japan and increased competition in the Asian market. The refining capacity was shifted to the company's Chiba refinery in December. The Osaka site was to be converted to an asphalt-powered powerplant (table 2; Argus Media, 2020; ENEOS Corp., 2020).

MINERAL INDUSTRY HIGHLIGHTS IN 2021

Minerals in the National Economy

In 2021, Japan was ranked second in iodine production, excluding United States production , accounting for 27% of world production, as well as for refined selenium (23%, excluding United States production) and titanium sponge (an estimated 21%, excluding United States production); third for refined tellurium (an estimated 11%, excluding United States production), refined cadmium (an estimated 8%), indium (an estimated 7%), refined copper and silicon carbide (an estimated 6% each), and pig iron and raw steel (5% each); and fourth for bromine (5%, excluding United States production) (Callaghan, 2023; Flanagan, 2023a–c; Gambogi, 2023; Olson, 2023; Schnebele, 2023a, b; Tolcin, 2023; Tuck, 2023).

In 2021, Japan's nominal GDP was $5.00 trillion; real GDP increased by 2.1%. The manufacturing, construction, and mining industries accounted for 20.6%, 5.5%, and 0.1% of Japan's GDP, respectively. In 2021, 19,398 people were employed in the mining and quarrying industry (Cabinet Office of Japan, 2022a–c; Japan Ministry of Economy, Trade and Industry, 2022, p. 1).

Compared with that in 2020, Japan's total outward FDI in 2021 increased by 53.4% to $147 billion. Outward FDI toward

the mining and quarrying industry was $78 million, which was a decrease of 96.9% compared with that in 2020. Outward FDI to industries related to the manufacturing of metals and the refining of petroleum totaled $1.25 billion and $210 million, respectively, which were decreases of 32.4% and 10.3%, respectively, compared with those in 2020 (Japan External Trade Organization, 2023b).

Total inward FDI to Japan increased by 130% to $24.6 billion in 2021. Inward FDI to the mining and quarrying industry was $49 million in 2021, which was an increase of 250% compared with that in 2020. Inward FDI to the manufacturing of metals and the refining of petroleum was $93 million and $47 million, respectively, which was an increase of 244% and a decrease of 30.9%, respectively, compared with that in 2020 (Japan External Trade Organization, 2023a).

In 2021, Japan's total exports were valued at $757 billion. Exports of mineral products were valued at $11.2 billion. Of this amount, exports of ores and concentrates were valued at $178 million, and exports of mineral fuels and products were valued at $10.2 billion. Of the exports of mineral fuels and products, those of refined petroleum were valued at $7.22 billion, and those of petroleum gas and hydrocarbons were valued at $128 million (Japan Ministry of Finance, 2023).

Japan's exports of nonferrous metals and articles thereof were valued at $18.6 billion. Major exported nonferrous metals and articles thereof included copper, which had an export value of $12.9 billion (indicating a total exported quantity of 1.31 Mt); aluminum, $3.07 billion (758,000 t); and nickel, $876 million (41,000 t). Exports of ferrous metals and articles thereof were valued at $44.3 billion (indicating a total imported quantity of 41.9 Mt). Exports of precious and semiprecious stones and metals were valued at $14.3 billion. Major exported precious and semiprecious stones and metals included gold, which had an export value of $7.62 billion (indicating a total exported quantity of 167 t); silver, $2.10 billion (7,600 t); and platinum-group metals, $1.81 billion (55.3 t) (table 3; Japan Ministry of Finance, 2023).

In 2021, Japan's total imports were valued at $772 billion. Imports of mineral products were valued at $191 billion. Of this amount, imports of ores and concentrates were valued at $34.5 billion. Major imported ores and concentrates included those of copper, which had an import value of $13.0 billion (indicating a total imported quantity of 4.96 Mt); iron, $18.0 billion (113 Mt); and zinc, $1.04 billion (907,000 t) (Japan Ministry of Finance, 2023).

In 2021, Japan's imports of nonferrous metals and articles thereof were valued at $18.6 billion. Major imported nonferrous metals and articles thereof included aluminum, which had an import value of $9.62 billion (indicating a total imported quantity of 3.17 Mt); copper, $3.41 billion (351,000 t); nickel, $3.10 billion (251,000 t); and tin, $847 million (28,000 t). Imports of ferrous metals and articles thereof were valued at $16.4 billion (indicating a total imported quantity of 9.43 Mt). Imports of precious and semiprecious stones and metals were valued at $24.1 billion. Major imported precious and semiprecious stones and metals included platinum, which had an import value of $11.3 billion (indicating a total imported quantity of 81 t); scraps of precious metal, $7.05 billion (182,000 t); and jewelry, $1.94 billion (229 t) (Japan Ministry of Finance, 2023).

Production

In 2021, significant increases in mineral commodity production included that of tungsten metal (by 51%); secondary refined lead (42%); ferronickel (Ni content, an estimated 37%); aluminum powder (36%); ferrovanadium and specialty steel (28% each); vanadium (an estimated 25%); zinc oxide (21%); titanium dioxide (20%); refined antimony (an estimated 19%); raw steel (16%); secondary refined copper (15%); pig iron, quicklime, and secondary aluminum metal (14% each); ferrochromium and ordinary steel (11% each); and coke from petroleum refinery, ferromanganese, and other unspecified ferroalloys (10% each). Significant decreases in production included that of secondary refined gold (an estimated 31%), alumina (25%), refined cobalt (17%), bituminous coal (13%), kerosene and refined bismuth (an estimated 12% each), and bromine and primary refined copper (10% each). Data on mineral production are in table 1.

Commodity Review

Metals

Aluminum.—In FY 2021, aggregate domestic demand for aluminum in Japan was 3.96 Mt, which was a 7.9% increase compared with that in FY 2020. Of this amount, demand for rolled products increased by 9.3% to 1.90 Mt; die-cast materials, by 8.4% to 891,000 t; and cast materials, by 9.4% to 371,000 t; imports of these materials increased by 7.4% to 561,000 t. In 2021, Japan imported 1.4 Mt of nonalloyed unwrought aluminum (a 20% increase compared with that in 2020), 1.1 Mt of alloyed unwrought aluminum (a 29% increase compared with that in 2020), 251,000 t of wrought aluminum (a 10.7% increase), and 72,500 t of aluminum waste and scrap (a 37% increase). In 2021, Japan's leading five import partners were, by quantify of unwrought aluminum supplied, Russia (which provided 512,000 t), Australia (408,000 t), the United Arab Emirates (394,000 t), New Zealand (152,000 t), and Brazil (147,000 t). Japan produced 786,600 t of secondary aluminum in 2021, which was an increase of 14% compared with that in 2020. In 2021, 3.8 Mt of aluminum products was produced in Japan, of which 49% was rolled and extruded and 34% was casted and die-casted. The transportation sector accounted for 39% of the quantity of aluminum products consumed in Japan, followed by the fabricated metal sector, 14%; building and construction sector, 11%; and food sector, 10%. Japan exported 5.6% of the aluminum products that it produced in 2021 (Aluminum Survey Committee, 2022, p. 1; Japan Aluminium Association, 2022, p. 1, 5, 6; Japan Ministry of Finance, 2023).

Cobalt.—In 2021, production of refined cobalt metal in Japan was 3,500 t. Ongoing technical issues in the mining facilities of Taganito HPAL Nickel reduced the quantity of cobalt supplied to SMM's Niihama plant, decreasing SMM's production by 700 t compared with that in 2020. In 2021, Japan imported 8,516 t of cobalt matte, unwrought cobalt, and cobalt powder. Japan's leading five import partners for cobalt matte, unwrought

cobalt, and cobalt powder were Finland (which provided 59% of Japan's imports of cobalt matte, unwrought cobalt, and cobalt powder, by quantity), Canada (11%), Morocco (6.3%), Norway (5.0%), and Madagascar (4.7%). In 2021, imports of cobalt oxide and hydroxide totaled 512 t and 572 t, respectively (Darton Commodities Ltd., 2022, p. 16; Japan Ministry of Finance, 2023).

Copper.—In 2021, Japan imported 4.96 Mt of copper ore and concentrate. Chile was its leading import partner (supplying 38%, by quantity), followed by Australia and Indonesia (13%) each, Peru (12%), and Canada (7.9%). Refined copper production (primary and secondary) in 2021 was 1.55 Mt, of which approximately 627,000 t was exported (table 3; Japan Ministry of Finance, 2023).

Gold.—In 2021, Japan produced an estimated 7,500 kg of mined gold from the Hishikari Mine. In 2021, to extend the life of the mine, SMM announced that the mine would transition to a more sustainable operation that would produce at a rate of 4.4 t/yr compared with a previous rate of 6.0 t/yr during the 3-year period from 2018 to 2021. The Government also planned to explore deep underground ore bodies to discover new reserves (table 1; Sumitomo Metal Mining Co. Ltd., 2022b, p. 44).

Iron and Steel.—In 2021, Japan ranked third in the world in raw steel production (96.3 Mt) after China (1.03 Gt) and India (118 Mt). The leading three producers of raw steel in Japan in 2021 were Nippon Steel Corp. (49.5 Mt), JFE Steel (26.9 Mt), and Kobe Steel Ltd. (6.75 Mt). Nippon Steel Corp. was the fourth-ranked producer of raw steel in the world (World Steel Association, 2022a, p. 1, 2; 2022b, p. 9).

Japan's raw steel production in 2021 included 22.4 Mt of specialty steel. Domestic consumption and export of specialty steel products totaled 12.1 Mt and 4.85 Mt, respectively. In 2021, the domestic automobile sector was the leading consumer of specialty steel products (accounting for 36.8% of consumption), followed by industrial machinery and equipment (13.4%), with further processing accounting for 33.1% of specialty steel product consumption, and miscellaneous consumption accounting for 16.6%. For ordinary steel products, the construction sector was the leading consumer, accounting for 27.1%, followed by the automobile sector (19.1%), the shipbuilding sector (6.9%), and industrial machinery and equipment sector (4.1%); 31.3% was consumed by steel dealers (Japan Iron and Steel Federation, 2021b–d; 2022a–b).

Nickel.—In 2021, Japan imported 3.09 Mt of nickel ore and concentrate. The import sources included New Caledonia (which supplied 54% of Japan's imports of nickel ores and concentrates, by quantity) and the Philippines (46%). In 2021, ferronickel production (Ni content) was estimated to be 62,000 t, and nickel metal production was 56,000 t. In July, SMM announced that it would build a new nickel-based cathode material plant at Niihama as well as expand the existing plant in Harima. The company planned to invest $360 million and $64 million, respectively, in the two projects, with scheduled completion in 2025 (table 3; Setsubitoushi Journal, 2021; Japan Ministry of Finance, 2023).

Industrial Minerals

Cement.—In April, Mitsubishi Materials Corp. (MMC) and Ube Industries Ltd. (UIL) definitively established their new joint venture—C Integration Arrangement Ltd.—under which the cement businesses of MMC and UIL would be integrated, with the effective date of the integration of the respective cement businesses also starting in this month. The new company was to be jointly owned by MMC and UIL, with each owning 50% of the shares (Mitsubishi Materials Corp., 2021).

Iodine.—Japan's production of raw iodine in 2021 was 9,221 t, which was a 4% increase from that in 2020. The country exported 5,070 t of raw iodine in 2021, and its leading export partners were Norway (which received 21% of Japan's exports of iodine, by quantity), China (18%), India (15%), Italy (9.4%), and Germany (9.0%). In December, K&O Energy Group, which was the parent company of Kanto Natural Gas Development Co. Ltd. (KNGD) and Nihon Tennen Gas Co. Ltd. (NTG, through KNGD), announced the reorganization of the iodine and natural gas businesses of its subsidiaries. In this reorganization, NTG was renamed to K&O Iodine Co. Ltd. and placed in charge of the iodine businesses of both NTG and KNGD. The reorganization was to take effect in January 2022 (tables 1, 3; Nihon Tennen Gas Co. Ltd., 2021, p. 1; Japan Ministry of Finance, 2023).

Limestone.—The production of limestone in Japan in 2021 was 132 Mt. In FY 2021, of the limestone produced in Japan that was shipped for consumption, 43% was used for cement production; 21%, for concrete aggregate production; 14%, for steel production; 7%, for lime production; 2%, for road construction; 7%, for other applications (including soda and glass production); and 4%, for export (table 1; Limestone Association of Japan, 2022).

Mineral Fuels and Related Materials

In FY 2021, sources of power generation in Japan included natural gas (which generated 34% of Japan's total electric power), coal (31%), solar power (8.3%), hydropower (7.5%), petroleum (7.4%), nuclear power (6.9%), biomass (3.2%), wind power (0.9%), and geothermal power (0.3%) (Agency for Natural Resources and Energy, 2022a).

Coal.—In 2021, Japan was the world's third-ranked importer of coal (behind China and India); it imported 168 Mt of bituminous coal, 6.2 Mt of anthracite coal, and 7.9 Mt of other forms of coal (including briquets). In FY 2021, 53.5% of the total coal supply was used for power generation; 5.5% was used for the manufacturing of iron and steel, and 2.4% was used for the manufacturing of ceramic, stone, and clay products. In 2021, a total of four coal-fired powerplants started operations for a total capacity of 1.83 GW. Two powerplants that were planned to be constructed were canceled in April—Akita Port Units 1 and 2, which was jointly operated by Kansai Electric Power and Marubeni and had a total capacity of 1.3 GW, and Nishiokinoyama Power Station Units 1 and 2, which were operated by Yamaguchi-Ube Power Generation Co. Ltd. and had a total capacity of 1.2 GW. As of yearend 2021, a total of 9 plants were planned to start up operations in the 2021 to 2023 timeframe, for an additional capacity of 5.4 GW

(Agency for Natural Resources and Energy, 2022c; BP p.l.c., 2022, p. 40; Japan Beyond Coal, 2023; Japan Ministry of Finance, 2023).

Natural Gas.—In 2021, Japan's leading import partners for all forms of natural gas were, by quantity supplied, Australia (which provided 33% of Japan's imports of natural gas), the United States (17%), Malaysia (12%), Qatar (11%), and Russia (7.8%). Japan was the world's second-ranked importer of LNG (behind China), accounting for 20% of global LNG imports. The quantity of LNG imports declined by 0.1% in 2021 compared with that in 2020 because of the continued restrictions on commercial activities during the COVID-19 pandemic as well as the decreased use of gas-fired power generation as nuclear power generation was gradually resumed. In 2021, 59.8% of the total natural gas supply was used for power generation and 1.3% of was used in the manufacturing industry (Nihon Tennen Gas Co. Ltd., 2021, p. 1; Agency for Natural Resources and Energy, 2022c; International Group of Liquefied Natural Gas Importers, 2022, p. 6, 36; Japan Ministry of Finance, 2023).

Petroleum and Petroleum Refinery Products.—In 2021, Japan was the world's fifth-ranked importer of crude petroleum in terms of quantity (importing 937 Mbbl), behind China, India, the United States, and the Republic of Korea. Japan produced 2.83 Mbbl of crude petroleum, which constituted approximately 0.2% of domestic consumption. The country was the seventh-ranked producer of refined petroleum. Of the refined petroleum consumed domestically in FY 2021, 46% was consumed for transportation; 46%, for industrial applications; and 8%, for residential applications. As of yearend 2021, 21 petroleum refineries were active in the country; these refineries had a total (combined) production capacity of 1,260 million barrels per year. As of March 2021, approximately 22,200 people were employed in the petroleum refining and marketing industry (Petroleum Association of Japan, 2021, p. 9; 2022, p. 29; Agency for Natural Resources and Energy, 2022c; BP p.l.c., 2022, p. 20; Enerdata, 2023a, b).

Outlook

As a result of the ongoing economic recovery following the lockdowns that took place during the COVID-19 pandemic, Japan's real GDP is expected to increase by 1% in 2024, followed by progressively smaller increases in subsequent years, with a projected annual real GDP increase of 0.4% in 2027. Ongoing projects to develop deep-sea rare earth deposits were undergoing feasibility tests, and if successful, could yield substantial and sustained domestic production in the long term. Gold production may increase in the future if the development of dozens of gold extraction projects by foreign companies is successful. In the near term, however, gold production is expected to decrease because of the mine life extension measures at the Hishikari Mine—the only active gold mine in the country (International Monetary Fund, 2022; United Nations Statistics Division, 2023).

The increasing use of renewable resources and nuclear energy, a trend since 2014, is likely to continue in the future as more nuclear facilities are restarted following the 2011 occurrence at the Fukushima Daiichi nuclear plant. The consumption of coal for energy likely will remain high in the near term, with the coming online of new coal powerplants through 2026 (Agency for Natural Resources and Energy, 2022c; Japan Beyond Coal, 2023).

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TABLE 1
JAPAN: PRODUCTION OF MINERAL COMMODITIES[1]

(Metric tons, gross weight, unless otherwise specified)

Commodity[2]		2017	2018	2019	2020	2021
METALS						
Aluminum:						
Alumina[e]		20,000	20,000	20,000	40,000	30,000
Metal, secondary		758,500	826,600	795,400	690,200	786,600
Products, powder		12,550	12,695	11,475	8,842	12,022
Antimony, refinery, metal		4,835 r	5,113 r	4,553 r	3,881	4,600 e
Bismuth, refinery[3]		525	571	570 r	570 e	500 e
Cadmium, refinery, primary		2,142	1,979	1,783	1,880 e	1,900 e
Cobalt, refinery, metal		4,159	3,669	4,000 r, e	4,200 e	3,500
Copper:						
Smelter, blister and anode:						
Primary		1,118,626	1,169,500	1,112,276	1,259,400	1,197,000
Secondary		369,525	421,736	394,401	332,100	357,800
Total		1,490,000	1,590,000	1,510,000	1,590,000	1,550,000
Refinery:						
Primary		1,166,194	1,241,100	1,152,847	1,242,743	1,119,400
Secondary		321,886	353,417	342,512	340,348	390,700
Total		1,490,000	1,590,000	1,500,000	1,580,000	1,510,000
Ferroalloys:						
Ferrochromium[e]		16,000	15,000	13,000	9,900	11,000
Ferromanganese		456,460	456,518	462,740	400,331	440,173
Ferromolybdenum		3,105 r	3,122 r	3,043 r	2,844	2,800 e
Ferronickel:						
Gross weight		312,324	339,844	337,790	234,505	243,275
Ni content		57,800	62,900	62,500 r	45,200	62,000 e
Ferrovanadium[e]		4,390	4,520 r	4,440 r	3,450	4,400
Silicomanganese		24,500	21,100	31,000 r	15,000	14,000
Other, unspecified		79,809	73,094	65,675	49,544	54,275
Gallium	kilograms	3,000	3,000	3,000	3,000	3,000 e
Gold:						
Mine, Au content	do.	6,372	6,453	6,322	7,590	7,500 e
Refinery:						
Primary	do.	80,285	104,736	80,463	80,000 e	80,000 e
Secondary	do.	29,965	30,255	29,993	29,000 e	20,000 e
Indium, refinery, primary[e]	do.	70,000	70,000	70,000	66,000	66,000
Iron and steel:						
Pig iron	thousand metric tons	78,330	77,328	74,907	61,600	70,344
Steel:						
Raw steel	do.	104,661	104,319	99,284	83,186	96,334
Products, semimanufactured, hot rolled:						
Ordinary steel	do.	72,097	71,645	68,526	59,258	65,873
Specialty steel	do.	20,344	20,794	19,189	14,506	18,551
Lead, refinery:						
Primary		87,366	78,223	82,098	80,304	80,600
Secondary		112,052	118,338	116,273	117,296	166,000
Molybdenum, metal		862	893	692	757	750 e
Nickel, Ni content:						
Chemicals		16,773	15,624	16,132	17,400 e	17,400 e
Metal		61,377	57,517	58,778 r	55,368	56,000 e
Oxide sinter		51,100	50,700	45,000 r	45,000 e	45,000 e
Platinum-group metals, refinery:						
Palladium:						
Primary	kilograms	7,715	8,264	8,305	8,600 e	8,500 e
Secondary	do.	16,100	11,800	13,200	11,100	11,000 e

See footnotes at end of table.

TABLE 1—Continued

JAPAN: PRODUCTION OF MINERAL COMMODITIES[1]

(Metric tons, gross weight, unless otherwise specified)

Commodity[2]		2017	2018	2019	2020	2021
METALS—Continued						
Platinum-group metals, refinery:—Continued						
Platinum:						
Primary	kilograms	1,747	1,827	1,575	1,900	2,000 e
Secondary	do.	25,800	24,000	22,700	23,800	24,000 e
Rhodium, secondary	do.	1,000	1,200	1,100	1,100	1,100 e
Selenium, Se content	do.	729,132	749,677	708,812	740,000 e	720,000 e
Silver:						
Mine, Ag content	do.	3,408	3,596	3,492	1,757	1,746
Refinery, metal:						
Primary	do.	1,186,463	1,101,845	1,032,843	1,070,403	1,070,000 e
Secondary	do.	774,247	759,050	750,245	686,642	687,000 e
Tellurium, refinery, Te content	do.	37,754	57,231	66,664	70,000 e	68,000 e
Tin, smelter, primary		1,624	1,650	1,547	1,558	1,500 e
Titanium:						
Dioxide		191,997	192,465	189,302	155,921	187,224
Sponge		50,300	49,300	58,200	49,200 e	49,200 e
Tungsten, metal		3,777	4,093	3,904	2,584	3,900 e
Vanadium, V content		2,852	2,935	2,886 r	2,245	2,800 e
Zinc:						
Oxide		61,901	62,855	60,648	48,100	58,062
Smelter, metal:						
Primary		436,656	441,651	437,609	416,600	428,000 e
Secondary		87,263	79,459	89,108	84,548	89,000 e
INDUSTRIAL MINERALS						
Arsenic trioxide[e]		45	45	40 r	40	40
Bromine[e]		20,000	20,000	20,000	20,000	18,000
Cement:						
Clinker	thousand metric tons	51,806	51,014	49,442	48,628	47,235
Hydraulic	do.	55,195	55,307	53,462	50,905	50,083
Clay, bentonite[e]		250,000	250,000	250,000	250,000	260,000
Diatomite[e]		40,000	40,000	40,000	40,000	40,000
Iodine		8,839	9,136	9,122	8,876	9,221
Lime:						
Quicklime	thousand metric tons	7,431	7,575	7,321	5,821	6,653
Slaked lime	do.	1,363	1,381	1,338	1,253	1,291
Nitrogen, ammonia, N content	do.	717	673	694	643	691
Salt	do.	926	929 r	903 r	874	855
Sand and gravel, industrial, silica	do.	2,695	2,524	2,273	1,924	2,045
Soda ash, synthetic		220,000 e	219,000 r	214,000 r, e	219,000 e	215,000 e
Stone, construction, crushed:						
Dolomite	thousand metric tons	3,359	3,440	3,259	3,217	2,926
Limestone	do.	141,634	142,212	138,534	131,533	131,830
Quartzite	do.	9,261	9,631	9,263	8,709	8,375
Sulfur, byproduct, S content:						
Metallurgy	do.	1,583	1,711	1,630 r	1,729	1,730 e
Petroleum	do.	1,789	1,697	1,629	1,412	1,420
Talc and related minerals, pyrophyllite[e]		160,000	160,000	160,000	160,000	160,000
MINERAL FUELS AND RELATED MATERIALS						
Coal, bituminous	thousand metric tons	1,389 r	1,041 r	758 r	772	675
Coke, metallurgical:						
All sources	do.	32,739	32,573	32,667	29,767	30,461
From petroleum refinery	do.	1,319	1,297	1,235	1,007	1,104
Natural gas, gross	million cubic meters	3,008	2,707	2,524	2,295	2,305

See footnotes at end of table.

TABLE 1—Continued

JAPAN: PRODUCTION OF MINERAL COMMODITIES[1]

(Metric tons, gross weight, unless otherwise specified)

Commodity[2]		2017	2018	2019	2020	2021
MINERAL FUELS AND RELATED MATERIALS—Continued						
Petroleum:						
Crude	thousand 42-gallon barrels	3,532	3,138	3,286	3,222	3,083
Refinery:						
Asphalt	do.	20,000 r	17,000 r	17,000 r	14,500	13,700
Distillate fuel oil	do.	186,969	184,739	168,926	162,312	164,371
Gas oil	do.	263,408	252,994	264,843	215,201	218,900
Gasoline	do.	338,002	322,852	313,242	277,600	281,865
Jet fuel	do.	95,256	93,249	101,440	50,535	50,844
Kerosene	do.	100,005	88,298	85,558	83,355	73,498
Liquefied petroleum gas	do.	52,400 r	47,000 r	44,400 r	35,300	36,500
Lubricating oil	do.	13,932	15,447	14,271	12,748	12,633
Naphtha	do.	118,190	103,436	113,762	84,144	81,232
Paraffin wax	do.	505	543	567	594	605
Total	do.	1,190,000	1,130,000	1,120,000	936,000	934,000

eEstimated. rRevised. do. Ditto.

[1]Table includes data available through December 21, 2022. All data are reported unless otherwise noted. Totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]In addition to the commodities listed, aluminum hydroxide, chromium, germanium, gypsum, manganese, rare-earth oxides, synthetic diamond, tantalum as a byproduct of metallurgy, and zeolites may have been produced, but available information was inadequate to make reliable estimates of output.

[3]Refined bismuth was produced as a byproduct of zinc production.

TABLE 2
JAPAN: STRUCTURE OF THE MINERAL INDUSTRY IN 2021

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Aluminum:				
Alumina		Denka Co. Ltd.	Omuta plant, Omuta, Fukuoka Prefecture	NA.
Metal, secondary		Almine Co. Ltd.	Plant in Kawakami, Kagoshima Prefecture	36.
Do.		do.	Plant in Misumi, Shimane Prefecture	45.
Do.		do.	Plant in Osaka, Osaka Prefecture	24.
Do.		Nihon Aluminum Rolling Co. Ltd.	Shiga plant, Higashioumi, Shiga Prefecture	6.
Do.		Nippon Light Metal Co. Ltd.	Complex in Kambara, Shizuoka Prefecture	127.
Do.		do.	Plant in Nagoya, Aichi Prefecture	100.
Do.		do.	Plant in Shimizu, Shizuoka Prefecture	420.
Do.		do.	Plants in Tomakomai, Hokkaido; and Funabashi, Chiba Prefecture	NA.
Do.		UACJ Corp.	Plant in Fukaya, Saitama Prefecture	60.
Do.		do.	Plant in Fukui, Fukui Prefecture	320.
Do.		do.	Plant in Nagoya, Aichi Prefecture	300.
Antimony	metric tons	Hosokura Metal Mining Co. Ltd. (Mitsubishi Materials Corp., 100%)	Refinery in Hosokura, Miyagi Prefecture	360.
Do.	do.	Kosaka Smelting and Refining Co. Ltd. (Dowa Metals & Mining Co. Ltd., 100%)	Refinery in Kosaka, Akita Prefecture	500.
Do.	do.	Toho Zinc Co. Ltd.	Chigirishima refinery, Toyoda, Hiroshima Prefecture	1,200.
Bismuth	do.	Hosokura Metal Mining Co. Ltd. (Mitsubishi Materials Corp., 100%)	Refinery in Hosokura, Miyagi Prefecture	84.
Do.	do.	Kosaka Smelting and Refining Co. Ltd. (Dowa Metals & Mining Co. Ltd., 100%)	Refinery in Kosaka, Akita Prefecture	180.
Do.	do.	Toho Zinc Co. Ltd.	Chigirishima refinery, Toyoda, Hiroshima Prefecture	180.
Bromine		Tosoh Corp.	Nanyo Complex, Shunan, Yamaguchi Prefecture	24.
Cadmium	metric tons	Akita Zinc Co. Ltd. [Dowa Metals & Mining Co. Ltd., 86%, and Sumitomo Metal Mining Co. Ltd. (SMM), 14%]	Plant in Iijima, Akita Prefecture	900.
Do.	do.	Hachinohe Smelting Co. Ltd. (Mitsui Mining & Smelting Co. Ltd., 85.51%; Toyo Zinc Co. Ltd., 10.48%; Nisso Metallochemical Co. Ltd., 4.01%)	Smelter in Hachinohe, Aomori Prefecture	400.
Do.		Kamioka Mining & Smelting Co. Ltd. (Mitsui Mining & Smelting Co. Ltd., 100%)	Plant in Hida, Gifu Prefecture	NA.
Do.		Toho Zinc Co. Ltd.	Annaka refinery, Annaka, Gunma Prefecture	NA.
Cement		Aso Cement Co. Ltd. (Aso Group, 95%, and LafargeHolcim Ltd., 5%)	Kanda plant, Miyako District, Fukuoka Prefecture	827, clinker; 1,700, cement.
Do.		do.	Tagawa plant, Tagawa, Fukuoka Prefecture	1,243, clinker; 1,900, cement.
Do.		Denka Co. Ltd.	Aomi plant, Itoigawa, Niigata Prefecture	1,996, clinker; 2,400, cement.
Do.		DC Co. Ltd. (Taiheiyo Cement Corp., 100%)	Kawasaki plant, Kawasaki, Kanagawa Prefecture	740, clinker; 1,300, cement.
Do.		Hachinohe Cement Co. Ltd. (Sumitomo Osaka Cement Co. Ltd., 100%)	Plant in Hachinohe, Aomori Prefecture	1,240, clinker; 1,500, cement.
Do.		Hitachi Cement Co. Ltd.	Plant in Hitachi, Ibaraki Prefecture	840.
Do.		Mitsubishi Materials Corp.	Plant in Higashidori, Aomori Prefecture	435, clinker; 1,600, cement.
Do.		do.	Plant in Ichinoseki, Iwate Prefecture	346, clinker; 480, cement.
Do.		do.	Plant in Kanda, Fukuoka Prefecture	6,512, clinker; 7,220, cement.
Do.		do.	Plant in Yokoze, Saitama Prefecture	722, clinker; 1,160, cement.
Do.		Myojo Cement Co. Ltd. (Taiheiyo Cement Corp., 100%)	Plant in Itoigawa, Niigata Prefecture	1,636, clinker; 1,620, cement.

See footnotes at end of table.

TABLE 2—Continued
JAPAN: STRUCTURE OF THE MINERAL INDUSTRY IN 2021

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Cement—Continued	Nippon Steel Blast Furnace Slag Cement Co. Ltd. (Nippon Steel Co. Ltd., 100%)	Plant in Kitakyushu, Fukuoka Prefecture	646, clinker; 1,750, cement.
Do.	Nippon Steel Cement Co. Ltd. (Nippon Steel Co. Ltd., and Sumitomo Osaka Cement Co. Ltd.)	Plant in Muroran, Hokkaido	736, clinker; 1,600, cement.
Do.	Sumitomo Osaka Cement Co. Ltd.	Plant in Ako, Hyogo Prefecture	2,765, clinker; 4,000, cement.
Do.	do.	Plant in Motosu, Gifu Prefecture	1,017, clinker; 1,650, cement.
Do.	do.	Plant in Sano, Tochigi Prefecture	773, clinker; 1,650, cement.
Do.	do.	Plant in Susaki, Kochi Prefecture	3,525, clinker; 4,350, cement.
Do.	Taiheiyo Cement Corp.	Fujiwara plant, Inabe, Mie Prefecture	1,720, clinker; 3,900, cement.
Do.	do.	Kamiiso plant, Hokuto, Hokkaido	3,705, clinker; 2,000, cement.
Do.	do.	Kumagaya plant, Kumagaya, Saitama Prefecture	1,396, clinker; 2,000, cement.
Do.	do.	Ofunato plant, Ofunato, Iwate Prefecture	1,966, clinker; 1,980, cement.
Do.	do.	Oita plant, Tsukumi, Oita Prefecture	4,129, clinker.
Do.	do.	Saitama plant, Hidaka, Saitama Prefecture	1,396, clinker.
Do.	Tokuyama Corp.	Nanyo plant, Shunan, Yamaguchi Prefecture	4,700, clinker.
Do.	Tosoh Corp.	Nanyo Complex, Shunan, Yamaguchi Prefecture	1,187, clinker; 1,240, cement.
Do.	Tsuruga Cement Co. Ltd. (Taiheiyo Cement Co. Ltd., 100%)	Plant in Tsuruga, Fukui Prefecture	628, clinker; 840, cement.
Do.	Ube Industries Ltd.	Plant in Isa, Yamaguchi Prefecture	3,761, clinker; 4,000, cement.
Do.	do.	Plant in Kanda, Fukuoka Prefecture	1,450, clinker.
Do.	do.	Plant in Ube, Yamaguchi Prefecture	1,536, clinker; 1,800, cement.
Do.	Ryukyu-Cement Co. Ltd.	Yabu plant, Nago, Okinawa Prefecture	640, clinker; 650, cement.
Do.	Wakayama Blast-Furnace Slag Cement Co. Ltd.	Plant in Wakayama, Wakayama Prefecture	1,000.
Coal, bituminous	Kushiro Coal Mine Co. Ltd.	Mine in Kushiro, Hokkaido Prefecture	700.
Cobalt, refined, metal	Sumitomo Metal Mining Co. Ltd. (SMM)	Harima plant, Kako District, Hyogo Prefecture	NA.
Do.	do.	Niihama plant, Niihama, Ehime Prefecture	4,500.
Copper, refined	Hibi Kyodo Smelting Co. Ltd. (Mitsui Mining & Smelting Co. Ltd., 63.51%; Nittetsu Mining Co Ltd., 20.28%; Furukawa Metals & Resources Co. Ltd., 16.21%)	Tamano smelter, Tamano, Okayama Prefecture	200.
Do.	JX Metals Smelting Co. Ltd. (JX Nippon Mining & Metals Co. Ltd., 100%)	Hitachi refinery, Ibaraki Prefecture	180.
Do.	do.	Saganoseki smelter and refinery, Oita Prefecture	270.
Do.	Kosaka Smelting and Refining Co. Ltd. (Dowa Metals & Mining Co. Ltd., 100%)	Refinery in Kosaka, Akita Prefecture	65.
Do.	Mitsubishi Materials Corp.	Plant in Naoshima, Kagawa Prefecture	234.
Do.	Onahama Smelting and Refining Co. Ltd. (Mitsubishi Materials Corp., 55.714%; Dowa Metals & Mining Co. Ltd., 31.621%; Furukawa Metals & Resources Co. Ltd., 12.665%)	Onahama smelter and refinery, Iwaki, Fukushima Prefecture	300.
Do.	Sumitomo Metal Mining Co. Ltd. (SMM)	Toyo plant, Saijo, Ehime Prefecture	460.

See footnotes at end of table.

TABLE 2—Continued
JAPAN: STRUCTURE OF THE MINERAL INDUSTRY IN 2021

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Gallium metric tons	Akita Zinc Co. Ltd. [Dowa Metals & Mining Co. Ltd., 86%, and Sumitomo Metal Mining Co. Ltd. (SMM), 14%]	Plant in Iijima, Akita Prefecture	10.
Do.	Nippon Rare Metal Inc.	Iwaki plant, Fukushima Prefecture	NA.
Gold:			
Mine, Au content kilograms	Sumitomo Metal Mining Co. Ltd. (SMM)	Hishikari Mine, Hishikari, Kagoshima Prefecture	7,500.
Refined do.	Ishifuku Metal Industry Co. Ltd.	Soka plant, Saitama Prefecture	10,000.
Do. do.	Japan Mint	Plant in Kita, Osaka Prefecture	15,000.
Do. do.	JX Metals Smelting Co. Ltd. (JX Nippon Mining & Metals Co. Ltd., 100%)	Plant in Saganoseki, Oita Prefecture	42,000.
Do. do.	Kosaka Smelting and Refining Co. Ltd. (Dowa Metals & Mining Co. Ltd., 100%)	Refinery in Kosaka, Akita Prefecture	24,000.
Do. do.	Mitsubishi Materials Corp.	Plant in Naoshima, Kagawa Prefecture	60,000.
Do. do.	Mitsui Mining & Smelting Co. Ltd.	Plant in Takehara, Hiroshima Prefecture	22,000.
Do. do.	Sumitomo Metal Mining Co. Ltd. (SMM)	Toyo plant, Saijo, Ehime Prefecture	60,000.
Do.	Tanaka Kikinzoku Kogyo K.K.	Shonan plant, Kanagawa Prefecture	NA.
Do. kilograms	Toho Zinc Co. Ltd.	Chigirishima refinery, Toyoda, Hiroshima Prefecture	1,800.
Do. do.	Tokuriki Honten Co. Ltd.	Kuki factory, Saitama Prefecture	120,000.
Gypsum, synthetic, industrial byproduct	Hachinohe Smelting Co. Ltd. (Mitsui Mining & Smelting Co. Ltd., 85.51%; Toyo Zinc Co. Ltd., 10.48%; Nisso Metallochemical Co. Ltd., 4.01%)	Smelter in Hachinohe, Aomori Prefecture	NA.
Do.	Hibi Kyodo Smelting Co. Ltd. (Mitsui Mining & Smelting Co. Ltd., 63.51%; Nittetsu Mining Co. Ltd., 20.28%; Furukawa Metals & Resources Co. Ltd., 16.21%)	Tamano smelter, Tamano, Okayama Prefecture	22.
Do.	JX Metals Smelting Co. Ltd. (JX Nippon Mining & Metals Co. Ltd., 100%)	Plant in Saganoseki, Oita Prefecture	10.
Do.	Mitsubishi Materials Corp.	Plant in Naoshima, Kagawa Prefecture	120.
Do.	Onahama Smelting and Refining Co. Ltd. (Mitsubishi Materials Corp., 55.714%; Dowa Metals & Mining Co. Ltd., 31.621%; Furukawa Metals & Resources Co. Ltd., 12.665%)	Onahama smelter and refinery, Iwaki, Fukushima Prefecture	336.
Do.	Toho Zinc Co. Ltd.	Annaka refinery, Annaka, Gunma Prefecture	NA.
Do.	do.	Chigirishima refinery, Toyoda, Hiroshima Prefecture	48.
Indium, metal metric tons	Akita Zinc Co. Ltd. [Dowa Metals & Mining Co. Ltd., 86%, and Sumitomo Metal Mining Co. Ltd. (SMM), 14%]	Plant in Iijima, Akita Prefecture	150.
Do. do.	Mitsui Mining & Smelting Co. Ltd.	Plant in Takehara, Hiroshima Prefecture	50.
Iodine, crude do.	Godo Shigen Sangyo Co. Ltd.	Plant in Chosei, Chiba Prefecture	2,400.
Do. do.	Ise Chemical Industries Corp. (AGC Inc., 52.80%; Mitsubishi Corp., 11.33%; Cornwall Master LP President Mai James, 3.14%)	Plants in Ichinomiya and Shirasato, Chiba Prefecture; and Sadowara, Miyazaki Prefecture	3,600.
Do. do.	Kanto Natural Gas Development Co. Ltd. (K&O Energy Group, 100%)	Plant in Mobara, Chiba Prefecture	1,200.
Do. do.	Nihon Tennen Gas Co. Ltd. (Kanto Natural Gas Development Co. Ltd., 50%, and Toyota Tsusho Corp., 41%)	Plants in Shirako and Yokoshiba, Chiba Prefecture	1,200.
Do. do.	Nippoh Chemicals Co. Ltd. (Nippon Shokubai Co. Ltd., 17%; Takeda Chemical Industries Ltd., 16.4%; Chugai Boyeki Co. Ltd., 13.6%)	Plant in Isumi, Chiba Prefecture	720.
Do. do.	Toho Earthtech Inc. (Itochu Corp., 34.1%; Mitsubishi Gas Chemical Co. Ltd., 32.2%; Nippon Light Metal Holdings Co. Ltd., 31.1%)	Plant in Kurosaki, Niigata Prefecture	720.

See footnotes at end of table.

TABLE 2—Continued
JAPAN: STRUCTURE OF THE MINERAL INDUSTRY IN 2021

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Lead, refined metric tons	Hachinohe Smelting Co. Ltd. (Mitsui Mining & Smelting Co. Ltd., 85.51%; Toyo Zinc Co. Ltd., 10.48%; Nisso Metallochemical Co. Ltd., 4.01%)	Smelter in Hachinohe, Aomori Prefecture	40,000.
Do. do.	Hosokura Metal Mining Co. Ltd. (Mitsubishi Materials Corp., 100%)	Refinery in Hosokura, Miyagi Prefecture	22,200.
Do. do.	Kamioka Mining & Smelting Co. Ltd. (Mitsui Mining & Smelting Co. Ltd., 100%)	Plant in Hida, Gifu Prefecture	33,600.
Do. do.	Kosaka Smelting and Refining Co. Ltd. (Dowa Metals & Mining Co. Ltd., 100%)	Refinery in Kosaka, Akita Prefecture	25,000.
Do. do.	Mitsui Mining & Smelting Co. Ltd.	Plant in Takehara, Hiroshima Prefecture	43,800.
Do. do.	Sumitomo Metal Mining Co. Ltd. (SMM)	Plant in Harima, Kako District, Hyogo Prefecture	30,000.
Do. do.	Toho Zinc Co. Ltd.	Chigirishima refinery, Toyoda, Hiroshima Prefecture	120,000.
Limestone	Asahi Kohmatsu Co. Ltd.	Hatayama Mine, Okayama Prefecture	80.
Do.	do.	Ishinokura Mine, Ibaraki Prefecture	125.
Do.	do.	Shin-takine Mine, Fukushima Prefecture	345.
Do.	Buko Mining Co. Ltd. (Taiheiyo Cement Co. Ltd., 100%)	Buko Mine, Yokoze, Saitama Prefecture	5,400.
Do.	Chichibu Taiheiyo Cement Co. Ltd. (Taiheiyo Cement Co. Ltd., 100%)	Kanouyama Mine, Kanna, Gunma Prefecture	2,000.
Do.	do.	Miwa Mine, Chichibu, Saitama Prefecture	950.
Do.	Denka Co. Ltd.	Aomi plant, Itoigawa, Niigata Prefecture	2,200.
Do.	Hachinohe Mining Co. Ltd. (Nittetsu Mining Co. Ltd., 70%, and Sumitomo Osaka Cement Co. Ltd., 30%)	Hachinohe Mine, Hachinohe, Aomori Prefecture	4,500.
Do.	INasas Co. Ltd. (Sumitomo Osaka Cement Co. Ltd., 100%)	Plant in Tochikubo, Hamamatsu, Shizuoka Prefecture	NA.
Do.	Ishizaki Co. Ltd. (Taiheiyo Cement Co. Ltd., 100%)	Fujiwara Mine, Inabe, Mie Prefecture	4,000.
Do.	JFE Mineral & Alloy Co. Ltd. (JFE Steel Corp., 100%)	Yoshii Mine, Ibara, Okayama Prefecture	NA.
Do.	Kawara Lime Chemical Industry Co. Ltd.	Kawara Mine, Kawara, Fukuoka Prefecture	480.
Do.	Komagata Inc. Co. Ltd.	Ohkama Mine, Sano, Tochigi Prefecture	132.
Do.	Mitsubishi Materials Corp.	Higashitani Mine, Kitakyushu, Fukuoka Prefecture	11,000.
Do.	do.	Nagasaka Mine, Ichinoseki, Iwate Prefecture	1,300.
Do.	Maruai Lime Industries Co. Ltd.	Hirui Mine, Hirui, Ogaki, Gifu Prefecture	120.
Do.	Myojo Cement Co. Ltd. (Taiheiyo Cement Co. Ltd., 100%)	Itoigawa plant, Itoigawa, Niigata Prefecture	2460.
Do.	Miyagi Lime Industry Co. Ltd.	Iwate plant, Ichinoseki, Iwate Prefecture	NA.
Do.	Nitchitsu Co. Ltd. (Nitchitsu Group, 100%)	Chichibu Mine, Chichibu, Saitama Prefecture	NA.
Do.	Nittetsu Mining Co. Ltd.	Higashishikagoe Mine, Minamifurano, Hokkaido	97.
Do.	do.	Ikura Mine, Okayama Prefecture	528.
Do.	do.	Oita Mine, Oita Prefecture	2,230.
Do.	do.	Shiriya Mine, Aomori Prefecture	2,950.
Do.	do.	Torigatayama Mine, Kochi Prefecture	10,900.
Do.	Oita Taiheiyo Cement Co. Ltd. (Taiheiyo Cement Co. Ltd., 100%)	Shin-Tsukumi Mine, Tsukumi, Oita Prefecture	11,000.
Do.	Ryokolime Industry Co. Ltd. (Mitsubishi Materials Corp., 100%)	Une Mine, Yokoze, Saitama Prefecture	4,000.
Do.	Ryushin Mining Co. Ltd. (Taiheiyo Cement Co. Ltd., 100%)	Plant in Ofunato, Iwate Prefecture	2,300.
Do.	Ryuyo Kosan Co. Ltd. (Taiheiyo Cement Co. Ltd., 100%)	Shigeyasu Mine, Mine, Yamaguchi Prefecture	2,500.
Do.	Showa Sekizai Kogyosho K.K.	Kori Mine, Okutama, Tokyo	1,500.
Do.	Shuho Mining Co. Ltd. (Sumitomo Osaka Cement Co. Ltd., 100%)	Shuho Mine, Shuho, Yamaguchi Prefecture	8,000.
Do.	Sumitomo Osaka Cement Co. Ltd.	Karazawa Mine, Sano, Tochigi Prefecture	3,000.
Do.	do.	Kokura Mine, Kitakyushu, Fukuoka Prefecture	900.

See footnotes at end of table.

TABLE 2—Continued
JAPAN: STRUCTURE OF THE MINERAL INDUSTRY IN 2021

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Limestone—Continued	Taiheiyo Cement Co. Ltd.	Garo Mine, Hokuto, Hokkaido	9,500.
Do.	do.	Tosayama Mine, Tosa, Kochi Prefecture	3,200.
Do.	Todaka Mining Co. Ltd.	Todaka Mine, Tsukumi, Oita Prefecture	12,000.
Do.	Tohoku Tekkosha Co. Ltd. (Ube Material Industries Ltd., 100%)	Matsukawa Mine, Ichinoseki, Iwate Prefecture	NA.
Do.	Tsuruga Cement Co. Ltd. (Taiheiyo Cement Co. Ltd., 100%)	Ishiyama Mine, Ono, Gifu Prefecture	200.
Do.	do.	Tsuruga Mine, Tsuruga, Fukui Prefecture	NA.
Do.	Ube Industries Ltd.	Ube Isa Mine, Mine, Yamaguchi Prefecture	9,000.
Do.	Yoshizawa Lime Industry Co. Ltd.	Ohgano Mine, Sano, Tochigi Prefecture	2,300.
Manganese, electrolytic dioxide	Mitsui Mining & Smelting Co. Ltd.	Plant in Takehara, Hiroshima Prefecture	12.
Do.	Tosoh Hyuga Co. Ltd. (Tosoh Corp., 100%)	Plant in Hyuga, Miyazaki Prefecture	34.
Nickel:			
Ferronickel metric tons	Hyuga Smelting Co. Ltd. [Sumitomo Metal Mining Co. Ltd. (SMM), 60%; Nippon Steel Stainless Steel Corp., 25%; Mitsui & Co. Ltd., 15%]	do.	15,000.
Do. do.	Nippon Yakin Kogyo Co. Ltd.	Oheyama plant, Miyazu, Kyoto Prefecture	13,500.
Do. do.	Pacific Metals Co. Ltd.	Plant in Hachinohe, Aomori Prefecture	35,000.
Oxide do.	Vale Japan Ltd. [Vale Canada Ltd., 87.2%, and Sumitomo Metal Mining Co. Ltd. (SMM), 12.8%]	Matsusaka plant, Matsusaka, Mie Prefecture	66,000.
Powder do.	Toho Titanium Co. Ltd. (JX Nippon Mining & Metals Co. Ltd., 50.38%; Nippon Steel Corp., 4.92%; Master Trust Bank of Japan Ltd., 3.12%; State Street Bank and Trust Co., 2.06%)	Chigasaki plant, Chigasaki, Kanagawa Prefecture	720.
Do. do.	do.	Wakamatsu plant, Kitakyushu, Fukuoka Prefecture	320.
Refined do.	Sumitomo Metal Mining Co. Ltd. (SMM)	Harima plant, Kako District, Hyogo Prefecture	61,000.
Do. do.	do.	Nickel plant, Niihama, Ehime Prefecture	75,000.
Do. do.	Mitsubishi Materials Corp.	Plant in Naoshima, Kagawa Prefecture	2,400.
Petroleum, refined million 42-gallon barrels	Cosmo Oil Co. Ltd. (Cosmo Energy Holdings Co. Ltd., 100%)	Chiba refinery, Ichihara, Chiba Prefecture	65.
Do. do.	do.	Sakai refinery, Sakai, Osaka Prefecture	37.
Do. do.	do.	Yokkaichi refinery, Yokkaichi, Mie Prefecture	31.
Do. do.	ENEOS Corp. (ENEOS Holdings, 100%)	Kawazaki refinery, Kawazaki, Kanazawa Prefecture	90.
Do. do.	do.	Marifu refinery, Kuga District, Yamaguchi Prefecture	44.
Do. do.	do.	Mizushima refinery, Kurashiki, Okayama Prefecture	128.
Do. do.	do.	Negishi refinery, Yokohama, Kanazawa Prefecture	99.
Do. do.	do.	Oita refinery, Oita, Oita Prefecture	50.
Do. do.	do.	Sakai refinery, Sakai, Osaka Prefecture	51.
Do. do.	do.	Sendai refinery, Sendai, Miyagi Prefecture	53.
Do. do.	do.	Wakayama refinery, Arida, Wakayama Prefecture	47.
Do. do.	Fuji Oil Co. Ltd.	Sodegaura refinery, Sodegaura, Chiba Prefecture	52.
Do. do.	Idemitsu Kosan Co. Ltd.	Aichi refinery, Chita, Aichi Prefecture	58.
Do. do.	do.	Chiba refinery, Ichihara, Chiba Prefecture	69.
Do. do.	do.	Hokkaido refinery, Masago, Hokkaido	55.
Do. do.	Kashima Oil Co. Ltd. (ENEOS Corp., 72.2%, and Mitsubishi Materials Corp. and JERA Co. Inc., 27.8%)	Kashima refinery, Kamisu, Ibaraki Prefecture	74.
Do. do.	Osaka International Refining Co. Ltd. (ENEOS Corp., 51%, and PetroChina International Japan Co. Ltd., 49%)	Chiba refinery, Ichihara, Chiba Prefecture	47.
Do. do.	Seibu Oil Co. Ltd.	Yamaguchi refinery, Sanyo-Onoda, Yamaguchi Prefecture	44.

See footnotes at end of table.

TABLE 2—Continued
JAPAN: STRUCTURE OF THE MINERAL INDUSTRY IN 2021

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Petroleum, refined— million 42-gallon barrels	Showa Yokkaichi Sekiyu Co. Ltd. (Idemitsu Kosan Co. Ltd., 75%, and Mitsubishi Materials Corp., 25%)	Yokkaichi refinery, Yokkaichi, Mie Prefecture	93.
Continued			
Do. do.	Taiyo Oil Co. Ltd.	Shikoku refinery, Imabari, Ehime Prefecture	50.
Do. do.	Toa Oil Co. Ltd. (Idemitsu Kosan Co. Ltd., 50.1%, and others, 49.9%)	Keihin refinery, Kawasaki, Kanazawa Prefecture	26.
Platinum-group metals	Nippon PGM Co. Ltd. (Dowa Metals & Mining Co. Ltd., 40%; Tanaka Kikinzoku Kogyo K.K., 40%; Kosaka Smelting and Refining Co. Ltd., 20%)	Refinery in Kosaka, Akita Prefecture	NA.
Pyrophyllite	Ohira Co. Ltd.	Plant in Ohira, Okayama Prefecture	132.
Do.	Shokozan Mining Co. Ltd.	Plant in Yano-Shokozan, Hiroshima Prefecture	180.
Selenium	Kosaka Smelting and Refining Co. Ltd. (Dowa Metals & Mining Co. Ltd., 100%)	Refinery in Kosaka, Akita Prefecture	NA.
Do. metric tons	Mitsubishi Materials Corp.	Plant in Naoshima, Kagawa Prefecture	330.
Do.	Mitsui Mining & Smelting Co. Ltd.	Plant in Takehara, Hiroshima Prefecture	NA.
Do. metric tons	Nippon Rare Metal Inc.	Iwaki plant, Fukushima Prefecture	120.
Do.	Hibi Kyodo Smelting Co. Ltd. (Mitsui Mining & Smelting Co. Ltd., 63.51%; Nittetsu Mining Co Ltd., 20.28%; Furukawa Metals & Resources Co. Ltd., 16.21%)	Tamano smelter, Tamano, Okayama Prefecture	NA.
Do.	JX Metals Smelting Co. Ltd. (JX Nippon Mining & Metals Co. Ltd., 100%)	Plant in Hitachi, Ibaraki Prefecture	NA.
Do.	do.	Plant in Saganoseki, Oita Prefecture	NA.
Do. metric tons	Shinko Chemical Co. Ltd.	Amagasaki plant, Amagasaki, Hyogo Prefecture	80.
Do.	Sumitomo Metal Mining Co. Ltd. (SMM)	Toyo plant, Saijo, Ehime Prefecture	NA.
Silica	JFE Mineral & Alloy Co. Ltd. (JFE Steel Corp., 100%)	Takisawa Mine, Aomori, Aomori Prefecture	300.
Silver:			
Mine, Ag content kilograms	Sumitomo Metal Mining Co. Ltd. (SMM)	Hishikari Mine, Hishikari, Kagoshima Prefecture	1,100.
Refined metric tons	Hachinohe Smelting Co. Ltd. (Mitsui Mining & Smelting Co. Ltd., 85.51%; Toyo Zinc Co. Ltd., 10.48%; Nisso Metallochemical Co. Ltd., 4.01%)	Smelter in Hachinohe, Aomori Prefecture	15,000.
Do. do.	Kosaka Smelting and Refining Co. Ltd. (Dowa Metals & Mining Co. Ltd., 100%)	Refinery in Kosaka, Akita Prefecture	850.
Do. do.	Mitsubishi Materials Corp.	Plant in Naoshima, Kagawa Prefecture	480.
Do. do.	Toho Zinc Co. Ltd.	Chigirishima refinery, Toyoda, Hiroshima Prefecture	400.
Steel, raw	JFE Steel Corp. (JFE Holdings Inc., 100%)	Facilities: East Japan Works: Chiba, Chiba Prefecture; Nishinomiya, Hyogo Prefecture; Kawasaki, Kanagawa Prefecture	9,000.
Do.	do.	West Japan Works: Kurashiki, Okayama Prefecture, and Fukuyama, Hiroshima Prefecture	23,000.
Do.	Kobe Steel Ltd.	Kakogawa Steel Works, Kakogawa, Hyogo Prefecture	6,800.
Do.	do.	Kobe Steel Works, Kobe, Hyogo Prefecture	1,400.
Do.	Nippon Steel Corp.	Facilities: East Nippon Works: Kamaishi area, Kamaishi, Iwate Prefecture	NA.
Do.	do.	Kashima area, Kashima, Ibaraki Prefecture	7,150.
Do.	do.	Kimitsu area, Kimitsu, Chiba Prefecture	8,020.
Do.	do.	Naoetsu area, Joetsu, Niigata Prefecture	NA.
Do.	do.	Kansai Works: Amagasaki area, Amagasaki, Hyogo Prefecture	NA.
Do.	do.	Osaka area, Osaka, Osaka Prefecture	40.
Do.	do.	Wakayama area, Wakayama, Wakayama Prefecture	4,320.

See footnotes at end of table.

TABLE 2—Continued
JAPAN: STRUCTURE OF THE MINERAL INDUSTRY IN 2021

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Steel, raw—Continued	Nippon Steel Corp.	Facilities:	
		Kyushu Works:	
		Oita area, Oita, Oita Prefecture	8,750.
Do.	do.	Yawata area, Kitakyushu, Fukuoka Prefecture	4,790.
Do.	do.	Muroran Works, Muroran, Hokkaido	1,430.
Do.	do.	Nagoya Works, Tokai, Aichi Prefecture	6,460.
Do.	do.	Setouchi Works:	
		Hirohata area, Himeji, Hyogo Prefecture	650.
Do.	do.	Kure area, Hiroshima Prefecture	2,730.
Do.	do.	Sakai area, Osaka Prefecture; Toyo area, Ehime Prefecture; and Osaka area, Osaka Prefecture	NA.
Soda ash, synthetic	Tosoh Corp.	Nanyo Complex, Shunan, Yamaguchi Prefecture	1,125.
Do.	do.	Yokkaichi Complex, Yokkaichi, Mie Prefecture	126.
Sulfuric acid	JX Metals Smelting Co. Ltd. (JX Nippon Mining & Metals Co. Ltd., 100%)	Plant in Hitachi, Ibaraki Prefecture	280.
Do.	do.	Plant in Saganoseki, Oita Prefecture	700.
Do.	Kosaka Smelting and Refining Co. Ltd. (Dowa Metals & Mining Co. Ltd., 100%)	Refinery in Kosaka, Akita Prefecture	265.
Do.	Mitsubishi Materials Corp.	Plant in Naoshima, Kagawa Prefecture	600.
Do.	Onahama Smelting and Refining Co. Ltd. (Mitsubishi Materials Corp., 55.714%; Dowa Metals & Mining Co. Ltd., 31.621%; Furukawa Metals & Resources Co. Ltd., 12.665%)	Onahama smelter and refinery, Iwaki, Fukushima Prefecture	660.
Do.	Toho Zinc Co. Ltd.	Annaka refinery, Annaka, Gunma Prefecture	NA.
Do.	do.	Chigirishima refinery, Toyoda, Hiroshima Prefecture	55.
Do.	do.	Onahama refinery, Iwaki, Fukushima Prefecture	NA.
Tantalum	Global Advanced Metals Japan K.K.	Aizu plant, Aizu-Wakamatsu, Fukushima Prefecture	NA.
Do. metric tons	Japan New Metals Co. Ltd. (Mitsubishi Materials Corp., 100%)	Plant in Akita, Akita Prefecture	95.
Do.	Mitsui Mining & Smelting Co. Ltd.	Plant in Omuta, Fukuoka Prefecture	NA.
Do.	Taki Chemical Co. Ltd.	Plants in Kako, Hyogo Prefecture; Ichihara, Chiba Prefecture; and Kitakyushu, Fukuoka Prefecture	NA.
Do.	Taniobis Japan Co. Ltd. (JX Nippon Mining & Metals Co. Ltd., 100%)	Mito plant, Hitachi-Omiya, Ibaraki Prefecture	NA.
Tin, metal metric tons	Kosaka Smelting and Refining Co. Ltd. (Dowa Metals & Mining Co. Ltd., 100%)	Refinery in Kosaka, Akita Prefecture	600.
Do. do.	Mitsubishi Materials Corp.	Plant in Ikuno, Hyogo Prefecture	900.
Titanium:			
Sponge metal do.	Osaka Titanium Technologies Co. Ltd. (Kobe Steel Ltd., 20.92%, and Nippon Steel Co., 19.43%)	Amagasaki plant, Amagasaki, Hyogo Prefecture	40,000.
Do. do.	Toho Titanium Co. Ltd. (JX Nippon Mining & Metals Co. Ltd., 50.38%; Master Trust Bank of Japan Ltd., 3.12%; State Street Bank and Trust Co., 2.06%)	Wakamatsu plant, Kitakyushu, Fukuoka Prefecture; and Chigasaki plant, Chigasaki, Kanazawa Prefecture	25,200.
Dioxide do.	Fuji Titanium Industry Co. Ltd. (Ishihara Sangyo Kaisha Ltd., 100%)	Kobe plant, Kobe, Hyogo Prefecture	17,400.
Do. do.	Ishihara Sangyo Kaisha Ltd.	Yokkaichi plant, Yokkaichi, Mie Prefecture	155,000.
Do. do.	Sakai Chemical Industries Co. Ltd.	Onahama plant, Iwaki, Fukushima Prefecture	60,000.
Do. do.	Tayca Corp.	Okayama plant, Higashi Ward, Okayama Prefecture	60,000.
Do. do.	Titan Kogyo Ltd.	Ube plant, Ube, Yamaguchi Prefecture	16,800.
Tungsten	A.L.M.T. Corp.	Plants in Sakata, Yamagata Prefecture; and Toyama, Toyama Prefecture	NA.
Do.	Japan New Metals Co. Ltd. (Mitsubishi Materials Corp., 100%)	Plant in Akita, Akita Prefecture	NA.

See footnotes at end of table.

TABLE 2—Continued
JAPAN: STRUCTURE OF THE MINERAL INDUSTRY IN 2021

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Zeolites	Nitto Funka Kogyo K.K.	Mines and factories in Iizaka, Fukushima Prefecture, and Shiroishi, Miyagi Prefecture; and factory in Adachi, Fukushima Prefecture	NA.
Zinc, refined metric tons	Akita Zinc Co. Ltd. [Dowa Metals & Mining Co. Ltd., 86%, and Sumitomo Metal Mining Co. Ltd. (SMM), 14%]	Plant in Iijima, Akita Prefecture	200,400.
Do. do.	Hachinohe Smelting Co. Ltd. (Mitsui Mining & Smelting Co. Ltd., 85.51%; Toyo Zinc Co. Ltd., 10.48%; Nisso Metallochemical Co. Ltd., 4.01%)	Smelter in Hachinohe, Aomori Prefecture	112,000.
Do. do.	Hikoshima Smelting Co. Ltd. (Mitsui Mining & Smelting Co. Ltd., 100%)	Hikoshima smelter, Shimonoseki, Yamaguchi Prefecture	84,000.
Do. do.	Kamioka Mining & Smelting Co. Ltd. (Mitsui Mining & Smelting Co. Ltd., 100%)	Plant in Hida, Gifu Prefecture	72,000.
Do. do.	Sumitomo Metal Mining Co. Ltd. (SMM)	Harima plant, Kako District, Hyogo Prefecture	90,000.
Do. do.	Toho Zinc Co. Ltd.	Annaka refinery, Annaka, Gunma Prefecture	140,000.
Do. do.	do.	Onahama refinery, Iwaki, Fukushima Prefecture	88,000.

Do., do. Ditto. NA Not available.

TABLE 3
JAPAN: IMPORTS AND EXPORTS OF SELECTED MINERAL COMMODITIES IN 2021

Commodity		Import		Export	
		Quantity (metric tons)	Value[1] (thousand dollars)	Quantity (metric tons)	Value[1] (thousand dollars)
METALS					
Aluminum:					
Alumina		288,867	254,592	101,191	246,943
Bars and rods		18,416	107,118	18,822	116,284
Foil		73,354	462,966	93,857	889,005
Metal and alloys, unwrought		2,537,178	6,226,192	28,629	95,580
Plates, sheets and strip		143,542	551,373	185,463	772,658
Powder		3,729	22,167	1,101	5,577
Scrap		72,543	147,882	389,599	580,293
Tube and pipe		4,344	45,985	5,598	82,599
Wire		12,471	44,201	8,469	43,669
Antimony:					
Antimony oxides		4,185	35,546	1,317	14,985
Ore and concentrates		422	678	270	412
Unwrought		5,465	58,103	262	2,942
Bismuth, refined		414	3,147	237	5,692
Cobalt:					
Hydroxides		572	19,880	--	--
Mattes, lump, powder		8,516	415,616	3,141	121,735
Oxides		512	21,129	--	--
Copper:					
Metal and alloys, unwrought		9,856	89,502	627,372	5,673,374
Ores and concentrates		4,959,308	13,032,520	--	--
Plates, sheets and strip		32,954	349,247	123,454	1,635,330
Powder		1,393	19,220	5,234	92,664
Scrap		200,189	1,574,092	402,887	2,338,923
Tube and pipe		27,663	400,694	8,288	164,198
Ferroalloys:					
Ferrocerium		771	3,753	190	540
Ferrochromium		678,018	1,113,927	2,221	8,394
Ferromanganese		64,128	84,882	14,641	26,954
Ferromolybdenum		1,791	43,216	19	461
Ferronickel		20,845	94,914	127,943	327,933
Ferroniobium		8,037	198,839	5	188
Ferrosilicon		443,399	812,687	11,139	24,862
Ferrotungsten and ferrosilicotungsten		1,230	35,071	2	80
Ferrovanadium		2,938	74,887	300	5,642
Silicochromium		6,843	12,275	--	--
Silicomanganese		266,940	349,914	87	247
Gold:					
Semimanufactures	kilograms	1,507	75,825	64,230	1,617,533
Unwrought	do.	2,870	166,206	102,161	6,005,020
Iron ore		113,070,693	17,835,552	229	190
Iron and steel:					
Bars and rods, hot rolled		343,552	275,547	1,767,970	1,512,999
Pig iron		117,987	72,937	39,483	22,730
Scrap		87,858	181,938	7,298,678	3,613,454
Shapes and sections		56,321	44,006	532,863	439,728
Tube and pipe		171,452	359,795	939,110	2,769,358
Wire		177,313	226,964	74,460	181,851
Lead:					
Ores and concentrates		120,458	345,094	--	--
Unwrought		33,161	80,461	47,131	100,532
Lithium:					
Carbonates		20,623	206,816	178	1,777
Oxides and hydroxides		33,876	388,296	4	90

See footnotes at end of table.

TABLE 3—Continued
JAPAN: IMPORTS AND EXPORTS OF SELECTED MINERAL COMMODITIES IN 2021

Commodity		Import		Export	
		Quantity (metric tons)	Value[1] (thousand dollars)	Quantity (metric tons)	Value[1] (thousand dollars)
METALS—Continued					
Nickel:					
Ores and concentrates		3,100,793	287,269	--	--
Powder		4,968	115,276	2,151	146,315
Plates, sheets, strip and foil		1,807	57,869	8,269	191,034
Scrap		10,468	121,100	8,743	45,928
Unwrought		41,971	787,066	18,106	300,951
Platinum-group metals, refined:					
Palladium	kilograms	50,399	3,964,579	11,508	414,256
Platinum	do.	279	10,217	8,133	100,314
Rare earth compounds, gross weight:					
Cerium oxide		2,426	29,364	--	--
Cerium compounds		8,472	32,207	2,009	69,540
Lanthanum oxide		2,058	14,537	--	--
Other compounds		2,334	204,841	2,122	127,874
Yttrium oxide		1,482	4,223	--	--
Rare-earth metals (scandium and yttrium)		8,475	312,979	137	16,346
Selenium		5	87	685	12,673
Silver:					
Ores and concentrates		12,893	148,647	--	--
Powder		96	78,417	4,967	1,629,441
Semimanufactures		283	50,918	2,597	445,745
Unwrought		2,343	1,774,565	40	21,479
Tin:					
Scrap		55	809	5	21
Semimanufactures		298	9,583	712	31,217
Unwrought		27,038	816,700	983	29,079
Titanium:					
Ores and concentrates		294,149	199,453	20 [2]	25
Oxides		13,494	36,620	19,190	85,047
Scrap		736	3,839	4,224	18,302
Unwrought		360	8,287	30,374	273,497
Zinc:					
Ores and concentrates		906,760	1,043,065	--	--
Oxide and peroxide		9,091	26,422	2,408	17,718
Plates, sheets, strip and foil		1,144	6,605	23,960	66,707
Powder		372	1,577	3,846	15,407
Scrap		1,423	3,030	3,988	8,381
Unwrought		20,310	62,113	139,131	409,954
INDUSTRIAL MINERALS					
Arsenic		24	480	25	4,185
Cement and clinker		87,912	35,510	11,453,447	382,018
Clay, bentonite		142,004	41,588	6,886	6,608
Diamond	kilograms	618	625,734	76	39,709
Dolomite		2,514,428	105,445	3,040	568
Granite		3,939	1,786	19,022	7,762
Graphite, natural		58,796	91,995	1,037	10,178
Gypsum		2,344,517	98,383	1,768	2,399
Iodine		121	4,071	5,066	151,097
Limestone		503,451	39,704	5,934,779	62,470
Nitrogen, ammonia		217,415	121,123	2,901	5,474
Quartzite		102,173	14,871	863	1,708
Salt, unspecified		7,467,198	331,979	1,801	4,137
Sulfur		941	631	851,047	106,447

See footnotes at end of table.

TABLE 3—Continued
JAPAN: IMPORTS AND EXPORTS OF SELECTED MINERAL COMMODITIES IN 2021

Commodity	Import		Export	
	Quantity (metric tons)	Value[1] (thousand dollars)	Quantity (metric tons)	Value[1] (thousand dollars)
MINERAL FUELS AND RELATED MATERIALS				
Coal:				
Anthracite	6,207,910	948,809	5	17
Bituminous	168,495,594	23,744,978	5,678	2,031
Other, including briquettes, ovoids, and similar solid fuels	7,911,381	815,182	3,311 [3]	1,278
Coke, semicoke	2,248,987	1,087,944	2,775,475	964,554
Liquefied natural gas	84,460,140	45,634,881	189,328	127,799
Petroleum:				
Crude	122,050,328	63,067,397	200	110
Refinery products	28,721,809	18,449,712	11,589,134	7,222,441

do. Ditto. NA Not available. -- Zero.

[1]Values have been converted from Japanese yen (JPY) to U.S. dollars (US$) at an annual average exchange rate of JPY109.817=$1.00 for 2021.

[2]Source: United Nations Comtrade, 2022.

[3]Source: Global Trade Tracker, August 2023. Based on reported imported quantities from countries worldwide.

Source: Ministry of Finance of Japan, Trade Statistics of Japan: Commodity by Country, 2021, unless otherwise specified.