USGS mineral review

by Staff, U.S. Geological Survey, National Minerals Information Center

An aerial view of the Santa Rita strip copper mine near Silver City, NM. Image from Shutterstock.

In 2022, the estimated total value of nonfuel mineral production in the United States increased by 4 percent, in nominal terms, to $98.2 billion, from the revised value of $94.6 billion in 2021. The estimated value of metals produced domestically decreased by 6 percent to $34.7 billion, and the estimated value of industrial minerals produced domestically increased by 10 percent to $63.5 billion (Table 1).

Increases in production of nonfuel mineral commodities and increases in prices of some industrial minerals and minerals used to make batteries contributed to the total value of nonfuel mineral production increasing in 2022. Gold, iron ore, magnesium metal, palladium, platinum, silver and titanium had some of the largest percentage decreases in production value. For the industrial minerals sector, increased construction and materials for energy and infrastructure projects as well as other manufacturing sectors led to increased production value. The largest percentage increases in production value were in barite, bromine, feldspar, helium, iodine, lithium, potash, pumice, and sand and gravel (industrial).

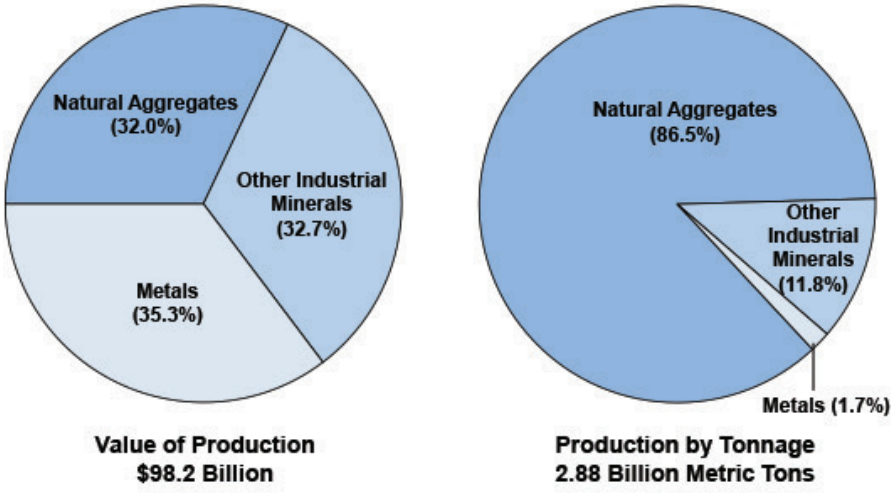
Mineral industry performance

Discussion of mine production is commonly segmented according to the type of materials produced within the broad categories of metals and industrial minerals (also known as nonmetallic minerals). Industrial minerals can be further subdivided as natural aggregates and other industrial minerals. Metals tend to have higher unit values, but low production quantities compared with those of industrial minerals, such as crushed stone or construction sand and gravel, which have higher production quantities but are lower-valued materials. Therefore, for discussion and analysis of the performance of the nonfuel minerals industry, the value of production is used rather than the tonnage produced. Tonnages of natural aggregates are orders of magnitude greater than those for most other mineral commodities, making direct comparisons based on weight less useful than value comparisons (Fig. 1).

As shown in Fig. 2, minerals are

Figure 1

Evaluation of the performance of the minerals industry by sector. In terms of the value of production, the three segments shown are relatively similar in their contribution to the U.S. economy. If measured by tonnage, natural aggregates dwarf the performance of the other sectors.



fundamental to the U.S. economy, contributing to the real gross domestic product at several levels, including mining, processing and manufacturing finished products. Net exports of mineral raw materials and old scrap were $4.9 billion and $15 billion, respectively. Domestic raw materials, along with domestically recycled materials, were used to produce mineral materials worth $815 billion. These mineral materials, including aluminum, brick, copper, fertilizers and steel, along with net imports of processed mineral materials (worth about $118 billion) were, in turn, consumed by downstream industries with a value added to the gross domestic product estimated to be $3,640 billion, a 9 percent increase from the revised value in 2021.

In 2022, domestic production of 13 mineral commodities was valued at more than $1 billion each. These were, in decreasing order of value, crushed stone, cement, copper, construction sand and gravel, gold, industrial sand and gravel, iron ore, zinc, salt, lime, phosphate rock, molybdenum and soda ash.

In 2022, nine states had more than $3 billion worth of publishable nonfuel mineral commodities production value and another 12 states had more than $1.5 billion. The publishable mineral production of these 21 states, combined, accounted for about 80 percent of the total nonfuel mineral production value (Fig. 3).

Based on total nonfuel mineral production value, including withheld data, the top 10 states were, in descending order of production value, Arizona, Nevada, Texas, California, Minnesota, Alaska, Florida, Utah, Michigan and Missouri (Table 2).

In 2022, the United States continued to rely on foreign sources for many raw and processed mineral materials. Imports supplied more than 50 percent of apparent consumption for 51 nonfuel mineral commodities, and the United States was 100 percent net import reliant for 15 of those (Fig. 4). Figure 5 shows the countries from which the majority of nonfuel mineral commodities with greater than 50 percent net import reliance were imported and the ranges of the number of nonfuel mineral commodities for which each country was a leading supplier. China, followed by Canada, supplied the largest number of nonfuel mineral commodities for which the United States is more

Table 1

U.S. mineral industry trends (U.S. Geological Survey, 2022).

	2018	2019	2020	2021	2022[e]
Total mine production (million dollars):					
Metals	28,000	26,900	27,700	36,900	34,700
Industrial minerals	56,000	56,000	53,000	57,700	63,500
Coal	27,200	25,500	16,800	21,000	21,300
Employment (thousands of workers):					
Coal mining, all employees	52	51	40	37	38
Nonfuel mineral mining, all employees	140	140	136	138	140
Chemicals and allied products, production workers	546	558	537	540	570
Stone, clay and glass products, production workers	311	312	296	298	310
Primary metal industries, production workers	295	301	272	269	280
Average weekly earnings of workers (dollars):					
Coal mining, all employees	1,546	1,617	1,518	1,619	1,800
Chemicals and allied products, production workers	1,071	1,065	1,065	1,104	1,110
Stone, clay and glass products, production workers	945	968	981	1,017	1,100
Primary metal industries, production workers	1,038	1,026	1,008	1,074	1,200

[e]Estimated.
Sources: U.S. Geological Survey, U.S. Department of Energy and U.S. Department of Labor

than 50 percent net import reliant. Of the nearly 100 nonfuel mineral commodities evaluated, the United States was a net exporter of 17 mineral commodities.

The Defense Logistics Agency (DLA) Strategic Materials is responsible for providing safe, secure and environmentally sound stewardship for strategic and critical materials in the U.S. National Defense Stockpile (NDS) of strategic and critical materials. DLA Strategic Materials stores 47 commodities at nine locations in the United States. In fiscal year 2022, DLA Strategic Materials acquired one new material along with additional quantities of eight others and sold about $103 million of excess materials from the NDS.

Tariff issues

In 2018, as a result of U.S. Department of Commerce findings of harm to national security under Section 232 of the Trade Expansion Act of 1962, as amended (19 U.S.C. 1862), additional import duties for aluminum articles and steel articles were put into place. Several Presidential Proclamations were issued in 2019 and 2020 modifying or removing the tariff rates for certain countries. On Oct. 31, 2021, it was announced that the additional 10 percent and 25 percent ad valorem tariffs on aluminum and steel imports, respectively, from the European Union would be replaced with an import quota effective Jan. 1, 2022. The tariff would only be applied on imports from countries in the European Union that exceed specified quotas. In February 2022, the United States and Japan reached an agreement for the quota of steel that would not be subjected to the 25 percent ad valorem tariffs; however, the additional 10 percent ad valorem tariff for aluminum remained in place. Additionally, in March 2022, the United States and the United Kingdom reached an agreement regarding import quotas on steel and aluminum products. The agreement required the products could not contain primary material from Belarus, China or Russia.

In September 2022, the Office of the United States Trade Representative (USTR) announced it was keeping the additional tariffs imposed under Section 301 (b) of the Trade Act of 1974, as amended, which determined that acts, policies and practices of China related to technology transfer, intellectual property and innovation were discriminatory or unreasonable, and those actions burdened or restricted United States commerce. In 2018, several lists of tariff lines (Lists 1, 2, 3, 4) were compiled, and imports for products from China for Lists 1, 2 and 3 had additional duty rates of 25 percent, and List 4, which included some nonfuel mineral commodities, had an additional duty rate of 7.5 percent. In October 2022, the USTR issued a Federal Register notice (87 FR 62914) seeking public comment regarding the effectiveness of the tariffs.

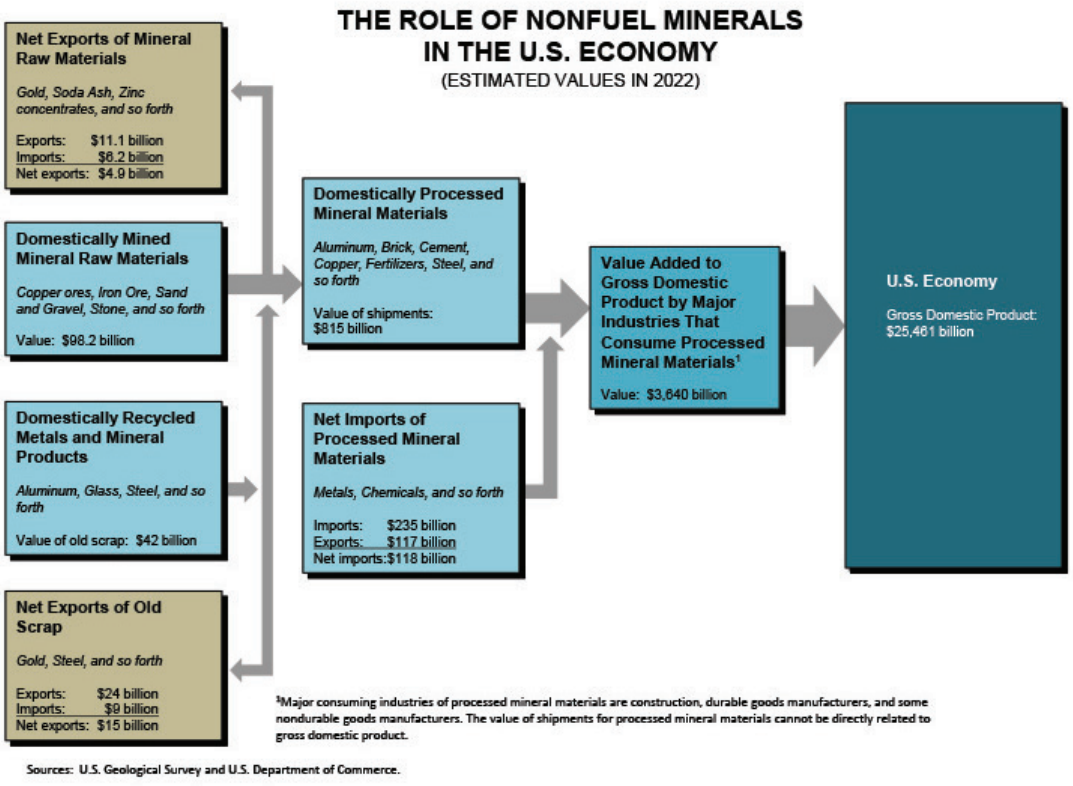
Executive Order 14065, "Blocking Property of Certain Persons and Prohibiting Certain Transactions With Respect to Continued Russian Efforts to Undermine the Sovereignty and Territorial Integrity of Ukraine" was issued in February 2022. The order outlined prohibitions on investments, exportation and importation of goods, services or technology to or from covered regions and financing.

Critical minerals

Executive Order 13817, "A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals (EO 13817)," was issued on Dec. 20, 2017. Several actions were required of federal agencies to address critical minerals. Pursuant to EO 13817, the Secretary of the Interior, in coordination with the Secretary of

Figure 2

The role of nonfuel minerals in the U.S. economy in 2022.



Defense, and in consultation with the heads of other relevant executive departments and agencies, was tasked with developing and submitting a list of minerals defined as critical minerals to the Federal Register. The final list of critical minerals was published in the Federal Register on May 18, 2018 (83 FR 23295), which included 35 mineral commodities or mineral material groups. The Energy Act of 2020 (Public Law 116–260, Dec. 27, 2020, 116th Cong.) defined critical minerals as those which are essential to the economic or national security of the United States; have a supply chain that is vulnerable to disruption; and serve an essential function in the manufacturing of a product, the absence of which would have significant consequences for the economic or national security of the United States. The act further specified that critical minerals do not include fuel minerals; water, ice, or snow; or common varieties of sand, gravel, stone, pumice, cinders, and clay. On May 7, 2021, the U.S. Geological Survey (USGS) published the Open-File Report 2021–1045, "Methodology and Technical Input for the 2021 Review and Revision of the U.S. Critical Minerals List," which included an updated evaluation methodology for identifying critical minerals and draft list of minerals recommended for inclusion in the U.S. critical minerals list. On Nov. 9, 2021, a proposed, revised critical minerals list was formally published in the Federal Register (86 FR 62199). This list contains 50 individual mineral commodities and differs from the prior 2018 list by individually listing the rare earth elements and platinum-group elements by specific element forms, adding nickel and zinc, and removing helium, potash, rhenium, strontium and uranium. Following adjudication of public comments, the final, revised critical minerals list was released on Feb. 22, 2022 (87 FR 10381) (Table 3).

Several initiatives were announced in 2022 to address the domestic availability and supply of critical minerals. On March 31, 2022, President Joe Biden authorized the use of Defense Production Act (DPA) Title III authorities to strengthen the U.S. industrial base for large-capacity batteries and specifically increasing domestic mining and processing of critical minerals used in batteries. DPA authorities allow the Secretary of Defense to support feasibility studies, production and processing of critical minerals used in batteries such as cobalt, graphite, lithium and nickel. The Inflation Reduction Act of 2022 (Public Law 117-169), signed into law on Aug. 16, authorized $391 billion in funding for climate change and domestic energy production. The act provided tax incentives for manufacturing domestically

Table 2

Value of nonfuel mineral production in the United States and principal nonfuel minerals produced in 2022[P,1,2] (U.S. Geological Survey, 2022).

State	Value (millions)	Rank[3]	Percent of U.S. total[4]	Principal nonfuel mineral commodities[5]
Alabama	$1,920	17	1.96	Cement (portland), lime, sand and gravel (construction), sand and gravel (industrial), stone (crushed).
Alaska	4,510	6	4.59	Gold, lead, sand and gravel (construction), silver, zinc.
Arizona	10,100	1	10.31	Cement (portland), copper, molybdenum mineral concentrates, sand and gravel (construction), stone (crushed).
Arkansas	1,100	29	1.12	Bromine, cement (portland), sand and gravel (construction), sand and gravel (industrial), stone (crushed).
California[6]	5,610	4	5.71	Boron minerals, cement (portland), rare earths, sand and gravel (construction), stone (crushed).
Colorado	1,870	19	1.91	Cement (portland), gold, molybdenum mineral concentrates, sand and gravel (construction), stone (crushed).
Connecticut	194	43	0.20	Sand and gravel (construction), stone (crushed), stone (dimension).
Delaware[7]	25	50	0.03	Magnesium compounds, sand and gravel (construction), stone (crushed).
Florida[6, 7]	2,810	7	2.86	Cement (masonry and portland), phosphate rock, sand and gravel (construction), stone (crushed).
Georgia[6]	2,320	12	2.37	Cement (portland), clay (kaolin and montmorillonite), sand and gravel (construction), stone (crushed).
Hawaii	156	44	0.16	Sand and gravel (construction), stone (crushed).
Idaho	371	33	0.38	Lead, phosphate rock, sand and gravel (construction), silver, stone (crushed).
Illinois[6]	1,250	25	1.27	Cement (portland), magnesium compounds, sand and gravel (construction), sand and gravel (industrial), stone (crushed).
Indiana	1,380	26	1.40	Cement (portland), lime, sand and gravel (construction), stone (crushed), stone (dimension).
Iowa	846	34	0.86	Cement (portland), lime, sand and gravel (construction), sand and gravel (industrial), stone (crushed).
Kansas[7]	1,170	27	1.19	Cement (portland), helium (Grade-A), salt, sand and gravel (construction), stone (crushed).
Kentucky[7]	806	28	0.82	Cement (portland), lime, sand and gravel (construction), sand and gravel (industrial), stone (crushed).
Louisiana	1,030	31	1.05	Clay (common clay), salt, sand and gravel (construction), sand and gravel (industrial), stone (crushed).
Maine[7]	100	47	0.10	Cement (portland), peat, sand and gravel (construction), stone (crushed), stone (dimension).
Maryland[7]	414	35	0.42	Cement (masonry and portland), sand and gravel (construction), stone (crushed), stone (dimension).
Massachusetts[7]	206	41	0.21	Clay (common), lime, sand and gravel (construction), stone (crushed), stone (dimension).
Michigan	3,360	9	3.42	Cement (portland), iron ore, nickel sulfide concentrates, sand and gravel (construction), stone (crushed).
Minnesota[7]	4,780	5	4.86	Iron ore, sand and gravel (construction), sand and gravel (industrial), stone (crushed), stone (dimension).
Mississippi	225	42	0.23	Clay (bentonite and montmorillonite), sand and gravel (construction), sand and gravel (industrial), stone (crushed).
Missouri	3,150	10	3.21	Cement (portland), lead, lime, sand and gravel (industrial), stone (crushed).
Montana	1,600	21	1.63	Copper, molybdenum mineral concentrates, palladium, platinum, sand and gravel (construction).
Nebraska[7]	256	39	0.26	Cement (portland), lime, sand and gravel (construction), sand and gravel (industrial), stone (crushed).
Nevada	8,930	2	9.09	Copper, gold, lime, silver, stone (crushed).

State	Value (millions)	Rank[3]	Percent of U.S. total[4]	Principal minerals, in alphabetical order
New Hampshire[7]	$135	45	0.14	Sand and gravel (construction), stone (crushed), stone (dimension).
New Jersey	425	38	0.43	Sand and gravel (construction), sand and gravel (industrial), stone (crushed).
New Mexico	1,470	24	1.49	Cement (portland), copper, potash, sand and gravel (construction), stone (crushed).
New York	1,950	15	1.98	Cement (portland), salt, sand and gravel (construction), stone (crushed), zinc.
North Carolina	1,900	18	1.93	Clay (common), phosphate rock, sand and gravel (construction), sand and gravel (industrial), stone (crushed).
North Dakota[7]	105	48	0.11	Clay (common), lime, sand and gravel (construction), stone (crushed).
Ohio[7]	1,490	14	1.52	Cement (portland), lime, salt, sand and gravel (construction), stone (crushed).
Oklahoma	1,030	30	1.05	Cement (portland), iodine, sand and gravel (construction), sand and gravel (industrial), stone (crushed).
Oregon	693	36	0.70	Cement (portland), diatomite, perlite (crude), sand and gravel (construction), stone (crushed).
Pennsylvania[7]	2,060	13	2.09	Cement (masonry and portland), lime, sand and gravel (construction), stone (crushed).
Rhode Island[7]	88	49	0.09	Sand and gravel (construction), sand and gravel (industrial), stone (crushed).
South Carolina[7]	1,160	23	1.18	Cement (masonry and portland), gold, sand and gravel (construction), stone (crushed).
South Dakota	475	37	0.48	Cement (portland), gold, lime, sand and gravel (construction), stone (crushed).
Tennessee	1,940	16	1.97	Cement (portland), sand and gravel (construction), sand and gravel (industrial), stone (crushed), zinc.
Texas	8,030	3	8.17	Cement (portland), lime, sand and gravel (construction), sand and gravel (industrial), stone (crushed).
Utah	3,600	8	3.66	Copper, magnesium metal, molybdenum mineral concentrates, potash, sand and gravel (construction).
Vermont[7]	136	46	0.14	Sand and gravel (construction), stone (crushed), stone (dimension), talc (crude).
Virginia	1,530	22	1.56	Cement (portland), kyanite, lime, sand and gravel (construction), stone (crushed).
Washington	901	32	0.92	Cement (portland), diatomite, sand and gravel (construction), sand and gravel (industrial), stone (crushed).
West Virginia[7]	204	40	0.21	Cement (masonry and portland), lime, sand and gravel (construction), stone (crushed).
Wisconsin[7]	1,720	20	1.75	Lime, sand and gravel (construction), sand and gravel (industrial), stone (crushed), stone (dimension).
Wyoming	2,480	11	2.53	Cement (portland), clay (bentonite), helium (Grade-A), sand and gravel (construction), soda ash.
Undistributed	4,210	XX	4.29	
Total	**98,200**	**XX**	**100.00**	

[P] Preliminary. XX not applicable.
[1] Includes data available through Dec. 14, 2022.
[2] Data are rounded to no more than three significant digits; may not add to totals shown.
[3] Rank based on total, unadjusted state values.
[4] Percent of U.S. total calculated to two decimal places.
[5] Listed in alphabetical order.
[6] California also produces significant quantities of titanium mineral concentrates, and Florida and Georgia produce significant quantities of rare earths and titanium and zirconium mineral concentrates. Breakdown by state is not included in state total to avoid disclosure of company proprietary data.
[7] Partial total; excludes values that must be withheld to avoid disclosing company proprietary data, which are included with "undistributed."

sourced materials used in the production of batteries, electric vehicles, solar and wind power generation, and technologies such as carbon capture systems.

In 2022, the value of domestic primary mine production of critical minerals was $5.4 billion. A total of 14 individual mineral commodities and the rare earths group of minerals (without specification of the specific lanthanides) were produced in the United States. The United States was 100 percent net import reliant for 12 of the 50 critical minerals and more than 50 percent net import reliant for an additional 31 critical minerals (including 14 lanthanides that are listed under rare earths). The United States had secondary production for 14 critical minerals that resulted in net import reliance being less than 100 percent.

Metals

The estimated value of domestic metal mine production in 2022 was $34.7 billion, 6 percent less than that in 2021. There was reduced production for several metals owing to weather-related issues and lower ore grades. Gold, iron ore, magnesium metal, palladium, platinum, silver and titanium had some of the largest percentage decreases in production value. Principal contributors to the total value of metal mine production in 2022 were copper (33

Table 3

The 2022 U.S. critical minerals list (U.S. Geological Survey, 2022).

Critical mineral	Applications
Aluminum	Metallurgy and many sectors of the economy.
Antimony	Flame retardants and lead-acid batteries.
Arsenic	Semiconductors.
Barite	Hydrocarbon production.
Beryllium	Aerospace and defense.
Bismuth	Medical, metallurgy, and atomic research.
Cerium[2]	Catalytic converters, ceramics, glass, metallurgy, and polishing compounds.
Cesium	Research and development.
Chromium	Metallurgy.
Cobalt	Batteries and metallurgy.
Dysprosium[2]	Data storage devices, lasers, and permanent magnets.
Erbium[2]	Fiber optics, glass colorant, lasers, and optical amplifiers.
Europium[2]	Nuclear control rods and phosphors.
Fluorspar	Cement, industrial chemical, and metallurgy.
Gadolinium[2]	Medical imaging, metallurgy, and permanent magnets.
Gallium	Integrated circuits and optical devices.
Germanium	Defense and fiber optics.
Graphite	Batteries, fuel cells, and lubricants.
Hafnium	Ceramics, nuclear control rods, and metallurgy.
Holmium[2]	Lasers, nuclear control rods, and permanent magnets.
Indium	Liquid crystal displays.
Iridium[3]	Anode coatings for electrochemical processes and chemical catalyts.
Lanthanum[2]	Batteries, catalysts, ceramics, glass, and metallurgy.
Lithium	Batteries.
Lutetium[2]	Cancer therapies, electronics, and medical imaging.

percent), gold (28 percent), iron ore (15 percent) and zinc (9 percent), all with production values of more than $3 billion. The remaining 15 percent of metal mine production value was from 15 other metals and (or) metal ore concentrates.

Ferrous metals. The estimated value of U.S. iron ore production in 2022 was $5.2 billion, a 22 percent decrease from the value in 2021. Production decreased slightly due to rising global inflation, which resulted in decreased steel demand and consumption.

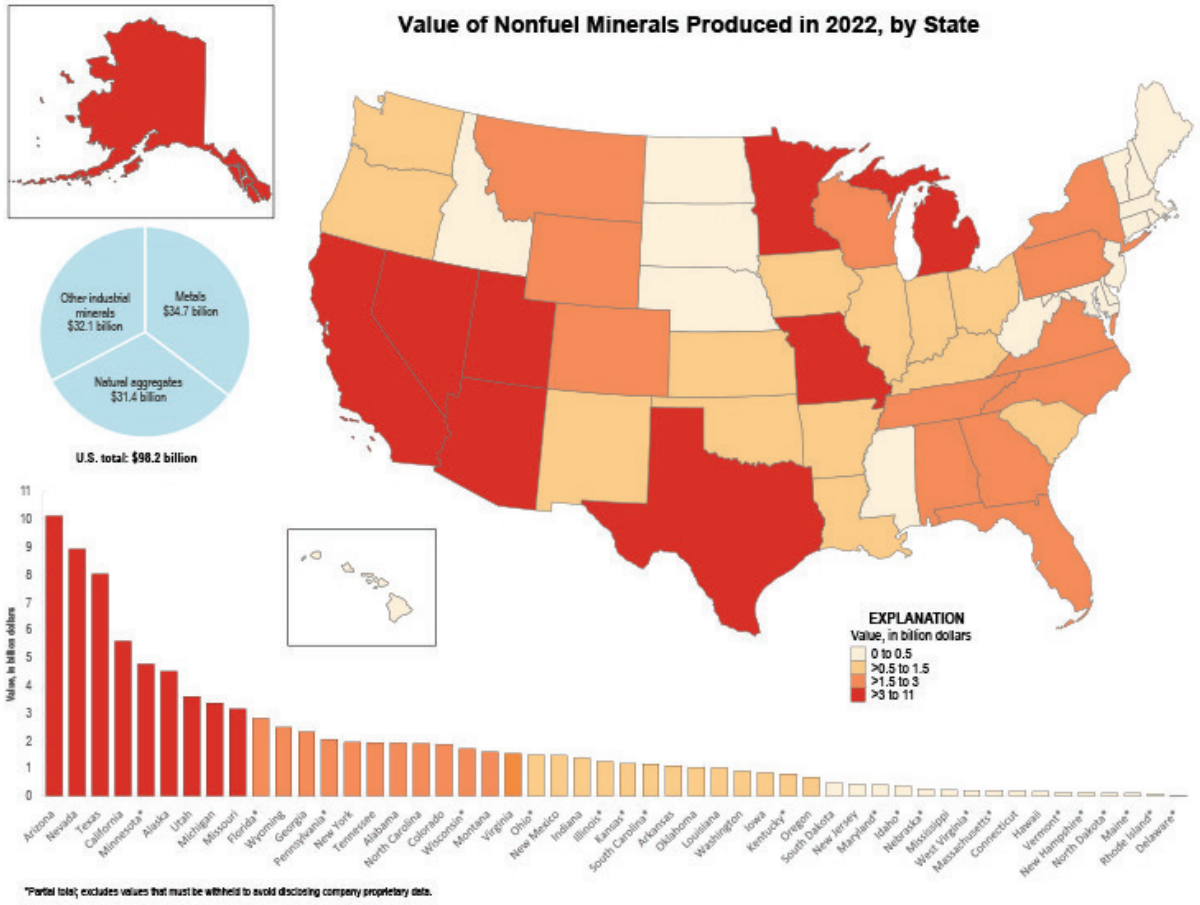
Mines in Michigan and Minnesota shipped 98 percent of the usable iron ore produced in the United States. Seven openpit iron ore mines (each with associated concentration and pelletizing plants) and four iron metallic plants, including direct-reduced iron and hot-briquetted iron producers, operated during the year to supply steelmaking raw materials. Almost all iron ore was concentrated before shipment. In November, one company petitioned the Minnesota Supreme Court for a review of state mineral leases that were terminated by the Minnesota Department of Natural Resources. In October, another company began construction on a $150 million project to build a direct-reduced grade pellet plant that could be sold or feed a potential future direct-reduced iron or

Magnesium	Metallurgy.
Manganese	Batteries and metallurgy.
Neodymium[2]	Catalysts, lasers, and permanent magnets.
Nickel	Batteries and metallurgy.
Niobium	Metallurgy.
Palladium[3]	Catalytic converters and catalysts.
Platinum[3]	Catalytic converters and catalysts.
Praseodymium[2]	Aerospace alloys, batteries, ceramics, colorants, and permanent magnets.
Rhodium[3]	Catalytic converters, catalysts, and electrical components.
Rubidium	Research and development.
Ruthenium[3]	Catalysts, electronic components, and computer chips.
Samarium[2]	Cancer treatments, nuclear, and permanent magnets.
Scandium	Ceramics, fuel cells, and metallurgy.
Tantalum	Capacitors and metallurgy.
Tellurium	Metallurgy, solar cells, and thermoelectric devices.
Terbium[2]	Fiber optics, lasers, permanent magnets, and solid state devices.
Thulium[2]	Lasers and metallurgy.
Tin	Metallurgy.
Titanium	Metallurgy and pigments.
Tungsten	Metallurgy.
Vanadium	Batteries, catalysts, and metallurgy.
Ytterbium[2]	Catalysts, lasers, metallurgy, and scintillators.
Yttrium	Catalysts, ceramics, lasers, metallurgy, and phosphors.
Zinc	Metallurgy.
Zirconium	Metallurgy and nuclear.

[1] The 2022 Final List of Critical Minerals published Feb. 24, 2022 by U.S. Geological Survey (87 FR 10381).
[2] Included in the Rare Earths chapter.
[3] Included in the Platinum-Group Metals chapter.

Figure 3

Map of the United States indicating the value of nonfuel mineral production by state in 2022, with charts ranking the states and showing the proportions of production by type of material.



hot-briquetted iron plant. The United States was estimated to have produced 1.8 percent of the 2.6 Gt (2.8 billion st) of global iron ore output in 2022.

The U.S. iron and steel industry produced raw steel in 2022 with an estimated value of about $132 billion, a 13 percent increase from $118 billion in 2021. Pig iron and raw steel were produced by three companies operating integrated steel mills in 11 locations. Raw steel was produced by 50 companies at 101 mini mills. Indiana accounted for an estimated 26 percent of total raw steel production, followed by Ohio, 12 percent; Pennsylvania and Illinois, 5 percent each; Texas, 4 percent and Michigan, 3 percent; with no other state having more than 3 percent of total domestic raw steel production. Construction accounted for an estimated 46 percent of total domestic shipments by market classification, followed by transportation (predominantly automotive), 26 percent. In the United States, the apparent consumption of finished steel products was estimated to have increased by 2 percent in 2022 owing to strong economic recovery from COVID-19 supply disruptions.

Nonferrous metals. The value of U.S. copper mine production decreased by 6 percent in 2022 to an estimated $11 billion, despite a 6 percent production increase to an estimated 1.3 Mt (1.4 million st). The reduced copper price was attributed primarily to widespread global expectations for reduced economic growth and lower demand for copper, COVID-19 mitigation measures in China, and increased strength of the U.S. dollar. Arizona was the leading copper-producing state and accounted for an estimated 70 percent of domestic output. Copper was also mined in Michigan, Missouri, Montana, Nevada, New Mexico and Utah. In the United States, copper was recovered or processed at 25 mines (17 of which accounted for 99 percent of mine production), two primary smelters, two electrolytic refineries and 14 electrowinning facilities. Globally, the United States was the fifth-leading producer of mined copper, accounting for about 6 percent of the total in 2022.

Five lead mines in Missouri, plus four mines in Alaska and Idaho that produced lead as a coproduct, accounted for all domestic lead mine production. The value of domestic lead

Figure 4

U.S. net import reliance for selected nonfuel minerals in 2022.

Commodity	Net import reliance as a percentage of apparent consumption	Major import sources (2018–21)[2]
ARSENIC, all forms	100	China, Morocco, Belgium
ASBESTOS	100	Brazil, Russia
CESIUM	100	Germany
FLUORSPAR	100	Mexico, Vietnam, South Africa, Canada
GALLIUM	100	China, Germany, Japan, Ukraine
GRAPHITE (NATURAL)	100	China, Mexico, Canada, Madagascar
INDIUM	100	Republic of Korea, Canada, China, France
MANGANESE	100	Gabon, South Africa, Australia, Georgia
MICA (NATURAL), sheet	100	China, Brazil, Belgium, Austria
NIOBIUM (COLUMBIUM)	100	Brazil, Canada
RUBIDIUM	100	Germany
SCANDIUM	100	Europe, China, Japan, Philippines
STRONTIUM	100	Mexico, Germany, China
TANTALUM	100	China, Germany, Australia, Indonesia
YTTRIUM	100	China, Germany, Republic of Korea, Japan
GEMSTONES	99	India, Israel, Belgium, South Africa
BISMUTH	96	China, Republic of Korea, Mexico, Belgium
NEPHELINE SYENITE	>95	Canada
RARE EARTHS,[3] compounds and metals	>95	China, Malaysia, Estonia, Japan
TITANIUM, sponge metal	>95	Japan, Kazakhstan, Ukraine
POTASH	94	Canada, Russia, Belarus
DIAMOND (INDUSTRIAL), stones	89	South Africa, Congo (Kinshasa), India, Sierra Leone
IRON OXIDE PIGMENTS, natural and synthetic	87	China, Germany, Brazil, Canada
ANTIMONY, metal and oxide	83	China, Belgium, India
CHROMIUM, all forms	83	South Africa, Kazakhstan, Russia, Germany
STONE (DIMENSION)	82	Brazil, China, Italy, India
PEAT	81	Canada
TITANIUM MINERAL CONCENTRATES	81	South Africa, Australia, Madagascar, Canada
ABRASIVES, silicon carbide	79	China, Brazil, Netherlands, South Africa
TIN, refined	77	Peru, Indonesia, Bolivia, Malaysia
COBALT	76	Norway, Canada, Finland, Japan
ZINC, refined	76	Canada, Mexico, Peru, Spain
ABRASIVES, fused aluminum oxide	>75	China, Canada, Brazil, Austria
BARITE	>75	China, India, Morocco, Mexico
BAUXITE	>75	Jamaica, Brazil, Guyana, Turkey
TELLURIUM	>75	Canada, Germany, China, Philippines
GARNET (INDUSTRIAL)	69	South Africa, China, India, Australia
RHENIUM	69	Chile, Canada, Germany, Kazakhstan
SILVER	69	Mexico, Canada, Poland, Chile
PLATINUM	66	South Africa, Germany, Switzerland, Italy
DIAMOND (INDUSTRIAL), bort, grit, dust, and powder	62	China, Republic of Korea, Ireland, Russia
ALUMINA	59	Brazil, Australia, Jamaica, Canada
NICKEL	56	Canada, Norway, Australia, Finland
ALUMINUM	54	Canada, United Arab Emirates, Russia, China
VANADIUM	54	Canada, China, Brazil, South Africa
MAGNESIUM COMPOUNDS	53	China, Israel, Canada, Brazil
GERMANIUM	>50	China, Belgium, Germany, Russia
IODINE	>50	Chile, Japan
MAGNESIUM METAL	>50	Canada, Israel, Mexico, Taiwan
SELENIUM	>50	Philippines, Mexico, Germany, China
TUNGSTEN	>50	China, Germany, Bolivia, Vietnam
ZIRCONIUM, ores and concentrates	<50	South Africa, Senegal, Australia, Russia
SILICON, metal and ferrosilicon	45	Russia, Brazil, Canada, Norway
LEAD, refined	42	Canada, Mexico, Republic of Korea
COPPER, refined	41	Chile, Canada, Mexico
FELDSPAR	39	Turkey, Mexico
SALT	29	Chile, Canada, Mexico, Egypt
PERLITE	28	Greece, China, Mexico
PALLADIUM	26	Russia, South Africa, Italy, Germany
LITHIUM	>25	Argentina, Chile, China, Russia
BROMINE	<25	Israel, Jordan, China
CADMIUM, unwrought	<25	Australia, Germany, China, Peru
MICA (NATURAL), scrap and flake	24	Canada, China, India, Finland
CEMENT	21	Canada, Turkey, Greece, Mexico
VERMICULITE	20	South Africa, Brazil

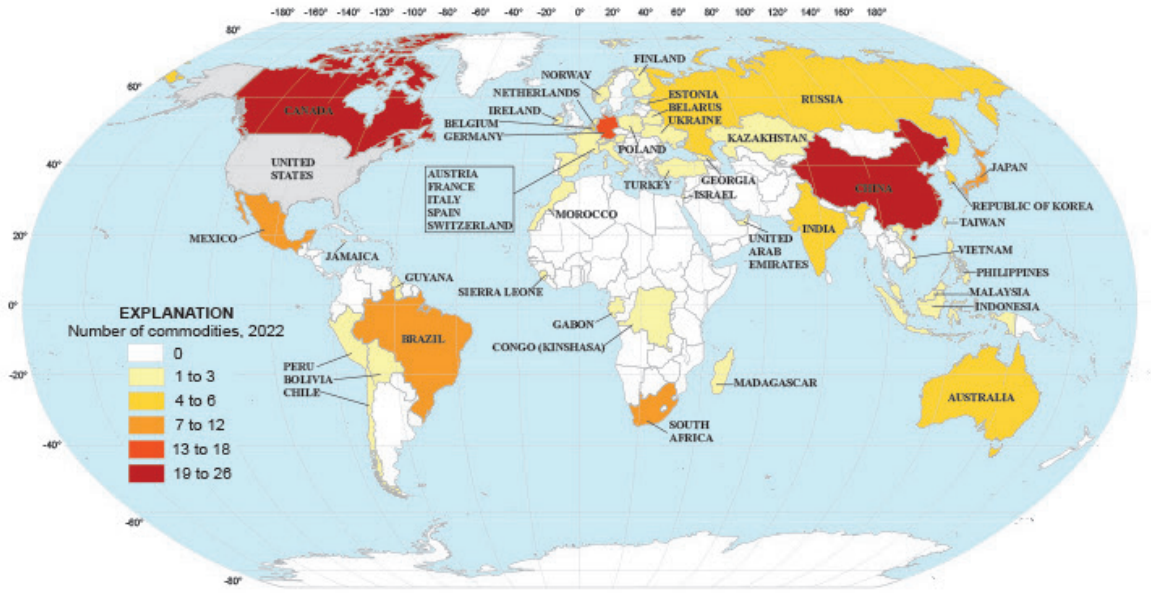
[1]Not all mineral commodities covered in this publication are listed here. Those not shown include mineral commodities for which the United States is a net exporter (abrasives, metallic; boron; clays; diatomite; gold; helium; iron and steel scrap; iron ore; kyanite; molybdenum; rare earths, mineral concentrates; sand and gravel, industrial; soda ash; titanium dioxide pigment; wollastonite; zeolites; and zinc, ores and concentrates) or less than 20% net import reliant (beryllium; gypsum; iron and steel; iron and steel slag; lime; nitrogen (fixed)—ammonia; phosphate rock; pumice and pumicite; sand and gravel, construction; stone, crushed; sulfur; and talc and pyrophyllite). For some mineral commodities (hafnium; mercury; quartz crystal, industrial; thallium; and thorium), not enough information is available to calculate the exact percentage of import reliance.

[2]Listed in descending order of import share.

[3]Data include lanthanides.

Figure 5

A world map highlighting major import sources for mineral commodities for which the United States was more than 50 percent import dependent in 2022. The countries are color coded to indicate the number of mineral commodities for which the country was considered a major supplier to the United States. China, followed by Canada, supplied the largest number of nonfuel mineral commodities.



mine production in 2022 was an estimated $710 million, 3 percent less than that in 2021. Nearly all lead concentrate production has been exported since the last primary lead refinery in the United States closed in 2013. In 2022, domestic secondary smelter production of lead was 950 kt (1.1 million st), a decrease of 3 percent. Nearly all secondary smelter production was recovered from scrap, mostly lead-acid batteries.

The estimated value of zinc mined in 2022 was $3.2 billion. Zinc was mined in five states at seven mining operations by five companies. Three smelter facilities, one primary and two secondary, operated by three companies, produced commercial-grade zinc metal. Of the total reported zinc consumed, most was used in galvanizing. The United States ranked fifth in global zinc mine production, accounting for about 6 percent of the world total in 2022.

Precious metals. In 2022, domestic gold mine production was estimated to be 9 percent less than that in 2021, and the value was estimated to be about $10 billion. Gold was produced at more than 40 lode mines in 11 states, at several large placer mines in Alaska, and at numerous smaller placer mines (mostly in Alaska and in the Western states). The top 28 operations yielded about 98 percent of the mined gold produced in the United States. Nevada was the leading gold-producing state, accounting for about 72 percent of total domestic production. Commercial-grade gold was produced at about 15 refineries. A few dozen companies, out of several thousand companies and artisans, dominated the fabrication of gold into commercial products.

In 2022, U.S. mines produced silver worth an estimated value of $720 million. Silver was produced domestically at four silver mines and as a byproduct or coproduct from 31 base- and precious-metal mines. Alaska continued as the country's leading silver-producing state, followed by Nevada. Commercial-grade silver production was reported by 24 domestic refiners. The estimated domestic uses for silver were primarily physical investment (34 percent), followed by electrical and electronics (27 percent). World silver mine production increased by 4 percent in 2022, principally as a result of increased production from mines in Chile and other countries as silver mines were still recovering from shutdowns in 2020 in response to the global COVID-19 pandemic.

One company in Montana produced platinum-group metals (PGM) with an estimated value of $880 million in 2022. Small quantities of primary PGMs also were recovered as byproducts of nickel-copper mining in Michigan; however, this material was sold to foreign companies for refining. Production at a domestic mine continued but was constrained owing to operational challenges and flooding that took place in June 2022.

Refractory and specialty metals. The value of several refractory and specialty metals and minerals mined in the United States — including cobalt, nickel, molybdenum, rare earths and titanium — increased significantly in 2022.

In 2022, a mine in Michigan produced cobalt-bearing nickel concentrates, which were exported for processing. A company in Missouri built a flotation plant and produced nickel-copper-cobalt concentrates from historic mine tailings and was building a hydrometallurgical processing plant near the mine site. Most U.S. cobalt and nickel supplies were imported or recovered from domestically produced scrap materials. Globally, cobalt is mostly mined as a byproduct of copper or nickel. Congo (Kinshasa) continued to be the world's leading source of mined cobalt, supplying about 70 percent of the world cobalt mine production in 2022. China was the world's leading producer of refined cobalt, most of which was produced from partially refined cobalt imported from Congo (Kinshasa). The world's leading producer of nickel was Indonesia with 48 percent of world nickel mine production. Stainless and alloy steel and nickel-containing alloys typically account for more than 85 percent of domestic consumption of nickel, and superalloys, mainly in aircraft gas-turbine engines, was the main use for cobalt in the United States.

Domestic mine production of molybdenum in 2022 increased slightly to 42 kt (46,300 st) of contained molybdenum in 2022 compared with 41.1 kt (45,300 st) in 2021. The estimated average molybdic oxide price increased by 11 percent compared with that in 2021. Molybdenum prices have not reached this high of a level since 2008. The United States ranked third in global mine production of molybdenum, behind China and Chile. Molybdenum ore was produced as a primary product at two mines — both in Colorado — and seven copper mines (four in Arizona and one each in Montana, Nevada and Utah) recovered molybdenum as a byproduct.

Domestic rare earths were mined as a primary product in Mountain Pass, CA and produced as a byproduct from heavy mineral sands mining and processing in the southeastern United States. An estimated 43 kt (47,400 st) of rare earths was mined in 2022, compared with 42 kt (46,300 st) in 2021. Additionally, an estimated 250 t (275 st) of mixed rare earth compounds were produced. Global mine production was estimated to have increased by 3 percent compared with that in 2021. The estimated value of rare earth compounds and metals imported by the United States in 2022 was $200 million, a 25 percent increase from $160 million in 2021.

Domestic production of titanium mineral concentrates took place at surface mining operations in Georgia and Florida. An additional company processed existing mine tailings to recover a mixed heavy-mineral concentrate in California. Abrasive sands, monazite and zircon were coproducts of these operations. An estimated 95 percent of titanium mineral concentrates were consumed domestically to produce titanium dioxide pigment. The remaining 5 percent was used in welding-rod coatings and for manufacturing carbides, chemicals, and titanium metal. Mining and heavy-mineral-sand-processing operations were expanded near Starke, FL, and preliminary technical and economic studies were completed at a heavy-mineral-sands project near Camden, TN.

Industrial minerals

The value of output of industrial minerals and materials from mines in the United States was $63.5 billion, 10 percent higher than it was in 2021. More than 6,500 companies contributed to this output, producing from more than 12,000 mines, quarries and processing facilities. Overall, in 2022, the production of industrial minerals, by tonnage, increased by 3 percent compared with that in 2021. In addition to mined materials, the United States is a major producer of industrial minerals that are recovered from processes other than mining. These materials, including iron and steel slag, nitrogen, sulfur and synthetic gypsum, contributed additional value to the industrial minerals industry.

Agricultural minerals. Overall industrial mineral use in agricultural production and consumption decreased in 2022 and was dominated by nitrogen, phosphate rock, potash and sulfur, the first three of which are used in fertilizers to provide nutrients for plants. Sulfur (as sulfuric acid) is essential for processing phosphate rock, but also plays a role in plant nutrition.

In 2022, phosphate rock ore was mined at nine mines in four states and processed into an estimated 19 Mt (21 million st) of marketable product, valued at $1.9 billion. Florida and North Carolina accounted for more than 75 percent of total domestic output; the remainder was produced in Idaho and Utah. Domestic production and consumption of phosphate rock were lower in 2022, owing to slightly lower production of elemental phosphorus and phosphoric acid. Domestic fertilizer production and consumption also were lower because of adverse weather conditions in some areas of the

United States during the spring planting season, rail delays, high fertilizer costs, and hurricane damage to some production facilities. World production was estimated to have decreased by about 3 percent, with China, Morocco and the United States remaining the leading producers.

In 2022, the domestic sales value of marketable potash was estimated to have increased by 38 percent to $760 million. The majority of U.S. production was from southeastern New Mexico, where two companies operated two underground mines and one deep-well solution mine. A new potash mine was in the development stage in Osceola County, MI. The proposed solution mine would have an initial production capacity of 650 kt/a (716,000 stpy) of muriate of potash and was planned to increase to 1 Mt/a (1.1 million stpy). The company planned to start production in 2025. U.S. apparent consumption was estimated to have increased by about 3 percent compared with that in 2021. World potash consumption in 2022 for fertilizers was estimated to have decreased to between 35 and 39 Mt (38.5 million and 43 million st) from 40.6 Mt (44.7 million st) in 2021. Global potash production decreased by an estimated 14 percent in 2022 from that in 2021. Canada was the leading producer, accounting for about 40 percent of production, followed by China and Russia, accounting for 15 percent and 13 percent of the world total, respectively.

Nitrogen is commercially recovered from air as ammonia, which is produced by combining nitrogen in the atmosphere with hydrogen from natural gas. Nitrogen production was estimated to have increased slightly in 2022 compared with that in 2021. A long period of stable and low natural-gas prices in the United States made it economic for companies to upgrade existing ammonia plants and construct new nitrogen facilities. The additional capacity has reduced ammonia imports as expansion in the domestic ammonia industry took place throughout the past five years; however, no additional U.S. ammonia capacity increases have been announced. Global ammonia capacity is expected to increase by a total of 4 percent during the next four years. About one-third of the capacity additions were expected to take place in Russia and Belarus. As part of the capacity increase, several countries have proposed decarbonized ammonia plants. Consumption of ammonia for fertilizer is expected to increase by 1 percent per year depending on availability and cost, with the largest increases expected in Latin America.

Elemental sulfur is recovered as a byproduct of natural-gas processing and petroleum refining, and byproduct sulfuric acid is recovered at nonferrous metal smelters. Total U.S. sulfur production in 2022 was estimated to have increased by 7 percent from that in 2021, and shipments increased by 5 percent from those in 2021. Domestic production of elemental sulfur from petroleum refineries and recovery from natural-gas operations increased by 7 percent. Domestically, refinery sulfur production is expected to remain about the same as refining utilization remains high. Domestic byproduct sulfuric acid is expected to remain relatively constant, unless one or more of the remaining nonferrous-metal smelters close. World sulfur production was unchanged compared with that in 2021. In 2022, world sulfur supplies were hampered by a decrease in the sulfur trade in part related to sanctions on Russia. However, sulfur production from the Middle East will likely increase sulfur availability.

Chemical minerals. Many factors affect production and consumption of mineral materials used predominantly in the chemicals industry, including the state of the U.S. economy in general, the severity of winter conditions that determine the consumption of salt for deicing purposes, the performance of the steel industry and its need for lime and numerous other influences. Because several of these commodities have significant export components — for example, boron and soda ash — their domestic production also reflects the economic conditions in other regions of the world. Worldwide economic downturns or growth can have an impact on the domestic production of these export-dependent commodities.

The quantities of domestically produced minerals that are used extensively by the chemical industry ranged from 42 Mt (46.3 million st) of salt (reported as sold or used) to a group of other minerals that totaled about 2 kt (2,200 st). In addition to salt, major chemical minerals production included lime, 17 Mt (18.7 million st); soda ash, 11 Mt (12.1 million st); and sulfur for chemical uses not associated with agricultural uses. The combined value for all minerals predominantly used as raw materials for chemical products, excluding sulfur, which is not mined, was about $7.9 billion in 2022, 3 percent more than that in 2021. Salt was valued at $2.5 billion; lime, $2.3 billion; soda ash, $1.4 billion; and other materials combined, $1.7 billion (boron, bromine, iodine, lithium carbonate, magnesite, magnesium compounds and zeolites).

Commercial-scale lithium production in the United States was from one continental brine operation in Nevada. Lithium was also commercially produced from the brine-sourced waste tailings of a Utah-based magnesium producer. Two companies produced a wide range of downstream lithium compounds in the United States from domestic or imported lithium carbonate, lithium chloride and lithium hydroxide. Excluding U.S. production, worldwide lithium production in 2022 increased by 21 percent to approximately 130 kt (143,000 st), from 107 kt (118,000 st) in 2021, in response to strong demand from the lithium-ion battery market and increased prices of lithium. Six mineral operations in Australia, one mineral tailings operation in Brazil, two brine operations each in Argentina and Chile, and three mineral and two brine operations in China accounted for the majority of world lithium production. Owing to the resurgence in demand and increased prices of lithium in 2021, established lithium operations worldwide resumed capacity expansion plans, which were postponed in 2020 in response to the global COVID-19 pandemic. Lithium supply security has become a top priority for technology companies in Asia, Europe and the United States. Strategic alliances and joint ventures among technology companies and exploration companies continued to be established to ensure a reliable, diversified supply of lithium for battery suppliers and vehicle manufacturers.

Construction minerals and materials. More than 2.6 Gt (2.86 billion st) of construction minerals and materials, which were dominated by cement, construction sand and gravel, and crushed stone, were mined and processed in the United States during 2022, a slight increase from 2021. Other minerals used in construction include certain types of clays, diatomite, dimension stone, gypsum, iron oxide pigments, mica, perlite, pumice and pumicite, staurolite, talc and pyrophyllite, tripoli, vermiculite and wollastonite. The estimated value of these materials was $46 billion.

Natural aggregates (crushed stone and construction sand and gravel) were mined or processed in all 50 states and were valued at $31.4 billion, 68 percent of the total value of construction minerals. Nearly three-quarters of the aggregates sold were used in road construction. Of the 2.5 Gt (2.75 billion st) of natural aggregates produced (slightly more than the quantity in 2021), crushed stone accounted for 61 percent of the tonnage of aggregates, and construction sand and gravel accounted for 39 percent. Consumption of natural aggregates increased in 2022 because of growth in the private and public construction markets. Changes in commercial and heavy-industrial construction activity, infrastructure funding, labor availability, new single-family housing unit starts, and weather affect natural aggregates production and consumption.

Cement was produced in 34 states and Puerto Rico with the four leading states (in descending order of production), Texas, Missouri, California and Florida, accounting for nearly 43 percent of U.S. production. Cement production accounted for 26 percent of the value of construction materials in 2022. The value of production of portland cement increased by 8 percent in 2022 compared with that in 2021, and the value of masonry cement increased by 5 percent. Increased cement apparent consumption in 2022 resulted from the continued economic recovery from the effects of the global COVID-19 pandemic, and the November 2021 passage of the Bipartisan Infrastructure Law. In 2022, regulators implemented new measures designed to aid industry decarbonization efforts, including green procurement strategies and research investments. However, cement industry growth continued to be constrained by increased costs for energy, material and service inputs; labor and production shortages; and ongoing supply-chain disruptions. Overall, the U.S. cement industry's growth continued to be constrained by closed or idle plants, underutilized capacity at others, production disruptions from plant upgrades, and relatively inexpensive imports.

About 26 Mt (28.6 million st) of all varieties of clays, valued at about $1.7 billion, was mined in the United States. Not all clays are used in construction. Common clay, which was used mainly for brick, cement and lightweight aggregates, accounted for 50 percent of the tonnage of all clays. Kaolin accounted for 4.6 Mt (5.1 million st) or 18 percent of the total clay tonnage. Fillers, extenders and binders accounted for 52 percent of kaolin use.

Other industrial minerals. The United States produced several other industrial minerals that are not listed separately in any of these categories but are essential in abrasives, absorbents, catalysts, ceramics and glass, coatings, cryogenics, fillers and extenders, filtering agents, grinding and polishing materials, hydraulic fracturing, optoelectronics, pigments, and refractories. ■