

Mining Review

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



Overall, estimated value of nonfuel mineral production increased in 2018 to \$82.2 billion.

In 2018, the total estimated value of nonfuel mineral production in the United States increased by 3 percent from 2017 to \$82.2 billion. The estimated value of metals produced domestically decreased by 4 percent, and the estimated value of industrial minerals produced domestically increased by 7 percent (Table 1).

Some idle U.S. metal mines and processing facilities restarted in 2018, including two primary aluminum smelters in Indiana and Missouri, a rare-earths mine in California and a zinc mine in New York. In contrast, four iron ore mines in Minnesota and a pelletizing plant in Indiana were shut down. Increased oil and natural gas drilling activity in 2018 led to increased production of some industrial mineral commodities that are used for oil and gas drilling, including barite and industrial sand and gravel. Production of industrial minerals primarily used in infrastructure and residential construction — including, cement, construction sand and gravel, crushed stone and gypsum — increased in 2018. Overall, mining activity trended upward for the second consecutive year because of increases in oil and gas extraction and industrial mineral mining (Table 2).

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 very 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 larger than those for most other mineral commodities, thus making direct comparisons based on weight meaningless (Fig. 1).

The estimated value of domestic nonfuel mineral production, including metals (\$25.9 billion) and industrial minerals (\$56.3 billion), increased to \$82.2 billion in 2018, from the revised value of \$79.6 billion in 2017 (Table 1). As shown in Fig. 2, minerals remained 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 \$13 billion. Domestic raw materials, along with domestically recycled materials, were used to produce mineral materials worth \$766 billion. These mineral materials, including aluminum, brick, copper, fertilizers and steel, and net imports of processed

Table 1

U.S. mineral industry trends.

	2014	2015	2016	2017	2018*
Total mine production (million dollars):					
Metals	28,900	24,400	23,800	27,000	25,900
Industrial minerals	49,500	48,800	47,600	52,600	56,300
Coal	34,800	28,500	22,300	26,100	25,700
Employment (thousands of production workers):					
Coal mining	62	54	42	43	44
Nonfuel mineral mining	100	99	95	97	101
Chemicals and allied products	497	507	516	525	548
Stone, clay, and glass products	280	296	306	305	310
Primary metal industries	310	307	293	292	294
Average weekly earnings of production workers (dollars):					
Coal mining	1,434	1,383	1,336	1,432	1,437
Chemicals and allied products	917	927	950	1,011	1,073
Stone, clay, and glass products	828	843	850	873	945
Primary metal industries	990	987	1,002	995	1,035

*Estimated.

Sources: U.S. Geological Survey, U.S. Department of Energy, U.S. Department of Labor.

mineral materials (worth about \$57 billion) were, in turn, consumed by downstream industries with a value added to the GDP estimated to be \$3,020 billion.

In 2018, domestic mine production of 13 mineral commodities was valued at more than \$1 billion each. These were, in decreasing order of value, crushed stone, cement, construction sand and gravel, gold, copper, industrial sand and gravel, iron ore, zinc, lime, salt, phosphate rock, soda ash and clays (all types combined).

In 2018, 12 states each produced more than \$2 billion worth of nonfuel mineral commodities. These states were, in descending order of production value, Nevada, Arizona, Texas, California, Minnesota, Florida, Alaska, Utah, Missouri, Wisconsin, Michigan and Wyoming. Even when excluding data that were withheld to avoid disclosing company proprietary data, mineral production of these states, combined, accounted for about 60 percent of the U.S. total nonfuel mineral output value (Table 3, Fig. 3).

In 2018, the United States continued to rely on foreign sources for many raw and processed mineral materials. More than one-half of U.S. apparent consumption of 48 nonfuel mineral commodities was supplied by imports, and the United States was 100 percent import-reliant for

18 of those (Fig. 4). Figure 5 shows the countries from which the majority of these mineral commodities were imported and the number of mineral commodities for which each highlighted country was a leading supplier. China, followed by Canada, supplied the largest number of nonfuel mineral commodities. Of the 97 nonfuel mineral commodities evaluated, the United States was a net exporter of only 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

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, construction aggregates dwarf the performance of the other sectors.

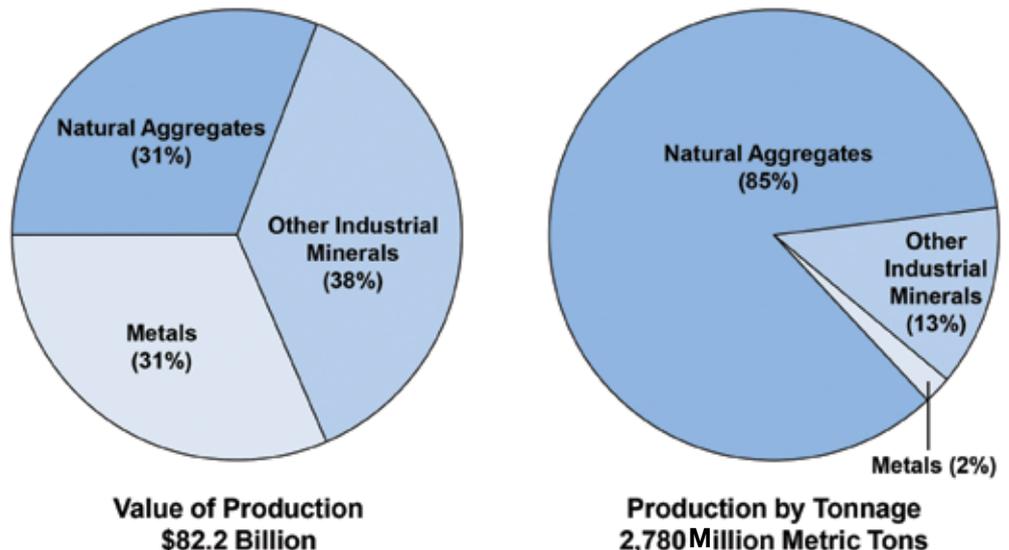


Table 2

U.S. mineral-related economic trends.

	2014	2015	2016	2017	2018*
Gross domestic product (billion dollars)	17,522	18,219	18,707	19,485	20,500
Industrial production (2012=100):					
Total index	105	104	102	104	108
Manufacturing:	102	102	101	103	105
Nonmetallic mineral products	109	110	111	114	120
Primary metals:	104	97	93	94	98
Iron and steel	101	92	87	92	97
Aluminum	106	107	106	103	108
Nonferrous metals (except aluminum)	108	98	95	92	92
Chemicals	96	98	95	96	99
Mining:	118	114	103	109	123
Coal	98	87	70	75	74
Oil and gas extraction	126	134	129	134	155
Metals	105	100	99	98	93
Nonmetallic minerals	112	116	114	114	117
Capacity utilization (percent):					
Total industry:	79	77	75	76	78
Mining:	90	84	78	84	92
Metals	77	75	75	73	69
Nonmetallic minerals	88	90	86	86	88
Housing starts (thousands)	999	1,107	1,177	1,208	1,264
Light vehicle sales (thousands) ¹	16,452	17,396	17,465	17,136	17,214
Highway construction, value, put in place (billion \$)	84	90	93	89	93

*Estimated.

Sources: U.S. Department of Commerce, Federal Reserve Board and U.S. Department of Transportation.

in the U.S. National Defense Stockpile (NDS). DLA Strategic Materials stores 44 commodities at 10 locations in the United States. In fiscal year 2018, DLA Strategic Materials acquired \$11.6 million of new materials and sold \$69.9 million of excess materials from the NDS. At the end of fiscal year 2018, materials valued at \$1.2 billion remained in the NDS. Of the remaining material, some was being held in reserve, some was offered for sale and sales of some of the materials were suspended. Under the authority of the Defense Production Act of 1950, the U.S. Geological Survey advises the DLA on acquisition and disposals of NDS mineral materials.

Tariff issues

In March 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 of 10 percent for aluminum articles from all countries of origin, except Canada and Mexico, and additional import duties of 25 percent for steel articles from all countries of origin, except Canada and Mexico, were implemented under Presidential Proclamations 9704 and 9705, respectively. Throughout the year, modifications and changes were made to the list of countries subject to the tariffs; for some countries, quotas were established in place of the additional duties, and exemptions for certain products were granted. Many countries responded to the increased

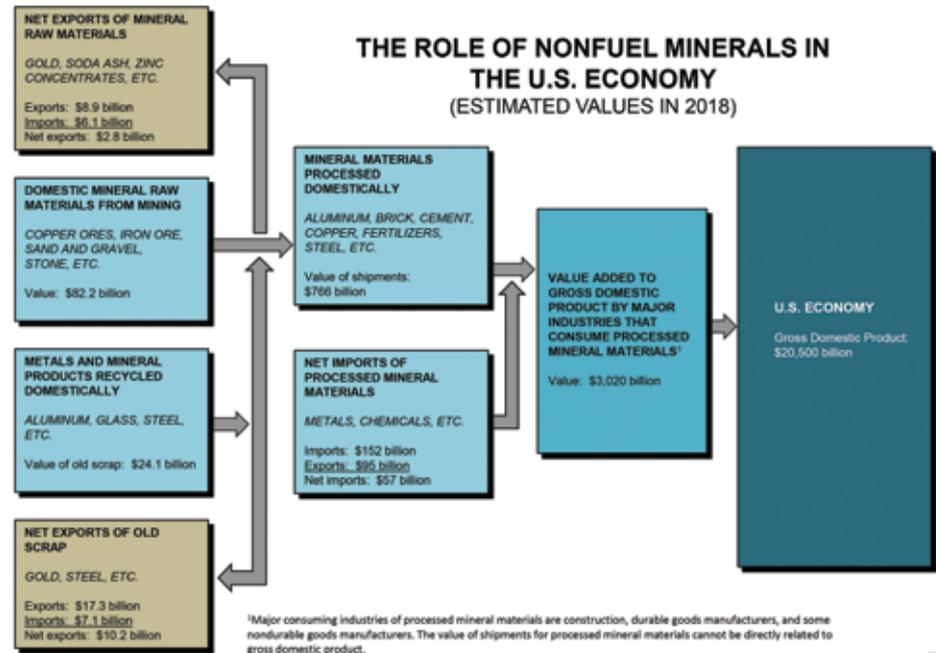
import duties by increasing the duties for imports of aluminum and steel articles of United States origin, including European Union countries, Canada, China, India, Japan, Mexico, Russia and Turkey. As of December 2018, the additional import duty for aluminum articles remained at 10 percent for most countries of origin and 20 percent for Turkey. The only countries that did not have the increased import duty for aluminum were Argentina, on which import quotas were in place, and Australia. The additional import duty for steel articles remained at 25 percent for most countries of origin and was 50 percent for Turkey. The only countries that did not have the increased import duty for steel were Argentina, Brazil and the Republic of Korea, all of which had import quotas in place, and Australia. As a result, U.S. aluminum imports were estimated to have decreased by 11 percent and steel mill product imports were estimated to have decreased by 8 percent in 2018.

Under Section 301 (b) of the Trade Act of 1974, as amended, the Office of the United States Trade Representative (USTR) 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 (83 FR 14906). An initial list of 818 tariff lines became subject to an additional import duty of 25 percent in July 2018. In response to this action, China imposed additional import duties for certain items originating in the

Figure 2

United States. In August, the USTR imposed an additional 25 percent import duty on a second list of 279 tariff lines. China responded in kind and added more products of United States origin to its list of higher import duties. A third list of 5,745 full and partial tariff lines, including nonfuel mineral ores and concentrates and forms, became subject to an additional 10 percent import duty in late September. The duty rate for this third list was initially scheduled to increase to 25 percent on Jan. 1, 2019, but that action was delayed. Most mineral commodities were subject to the Section 301 actions. However, a few commodities were removed from proposed lists, including some of those considered critical minerals.

The role of nonfuel minerals in the U.S. economy in 2018. Values estimated by the USGS based on USGS surveys and U.S. Department of Commerce data. Major consuming industries of processed mineral materials are construction, durable goods, and some nondurable goods manufacturing.



Critical minerals

Pursuant to Executive Order 13817, A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals (EO), issued on Dec. 20, 2017, a list of critical minerals was published in the Federal Register on May 18, 2018 (83 FR 23295). A critical mineral, as defined by the EO, is a mineral identified to be (i) a nonfuel mineral or mineral material essential to the economic and national security of the United States, (ii) the supply chain of which is vulnerable to disruption and (iii) one that serves an essential function in the manufacturing of a product, the absence of which would have significant consequences for the U.S. economy or national security.

The list included 35 minerals or mineral material groups. These were aluminum (bauxite), antimony, arsenic, barite, beryllium, bismuth, cesium, chromium, cobalt, fluorspar, gallium, germanium, graphite (natural), hafnium, helium, indium, lithium, magnesium, manganese, niobium, platinum group metals, potash, the rare earth elements group, rhenium, rubidium, scandium, strontium, tantalum, tellurium, tin, titanium, tungsten, uranium, vanadium and zirconium. More detailed information on this topic can be found in the critical minerals article in this issue of *Mining Engineering* magazine.

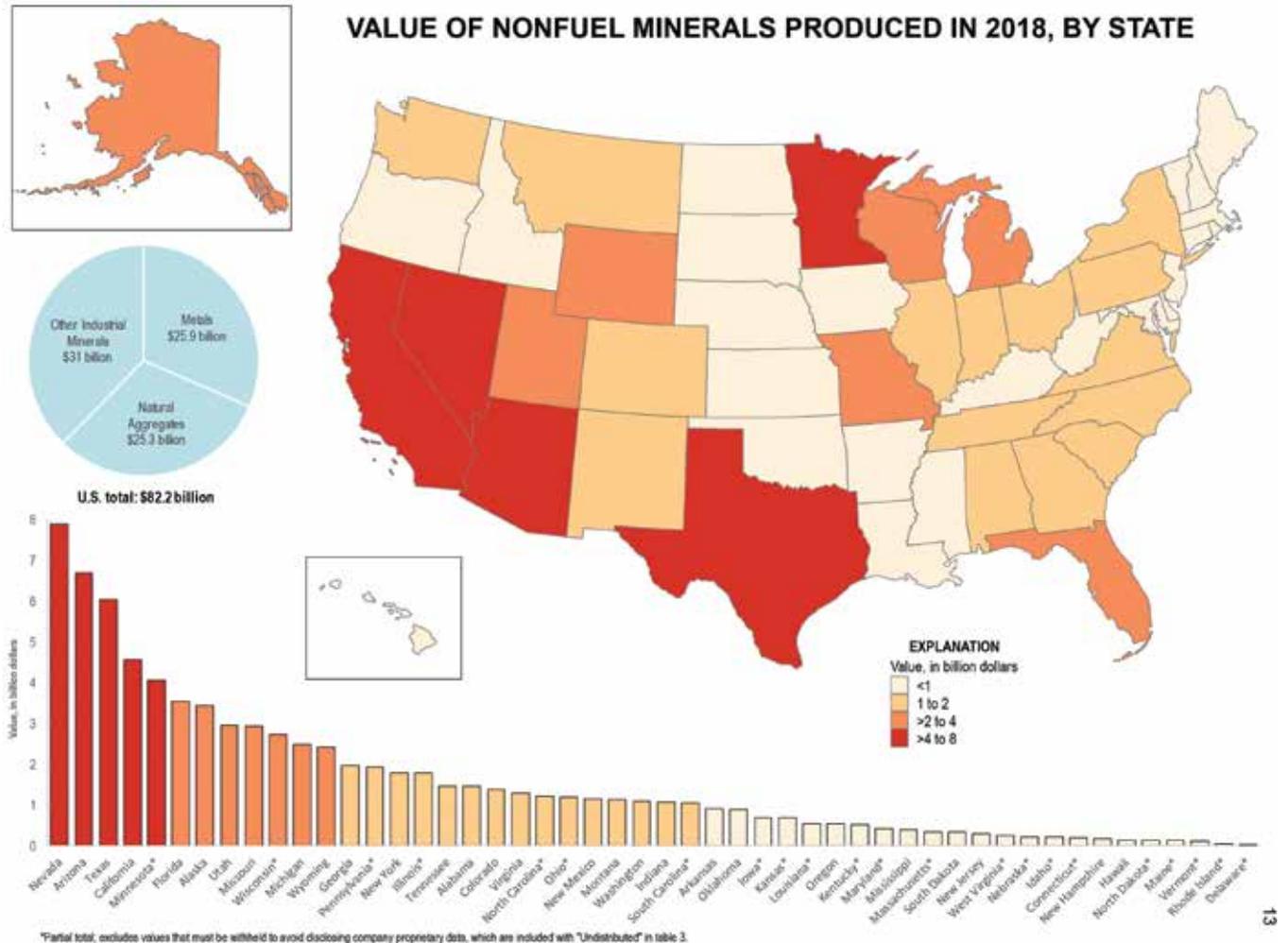
Metals

The estimated value of U.S. metal mine production in 2018 was \$25.9 billion, 4 percent less than that of 2017. Principal contributors to the total value of metal mine production in 2018 were gold (33 percent), copper (31 percent), iron ore (16 percent) and zinc (9 percent), all with production of more than \$2 billion. The remaining 11 percent of metal mine production value was from 13 other metals.

Ferrous metals. In 2018, mines in Michigan and Minnesota shipped 98 percent of the usable iron ore produced in the United States. Seven openpit iron ore mines and three iron metallic plants, including direct-reduced iron (DRI) and iron nugget producers, operated during the year to supply steelmaking raw materials. Almost all ore was concentrated before shipment. The United States was estimated to have produced 2 percent of the 2.5 Gt (2.75 billion st) of global iron ore output in 2018. U.S. iron ore production increased to an estimated 49 Mt (54 million st) in 2018 from 47.9 Mt (52.8 million st) in 2017 and domestic raw steel production increased to 86.6 Mt (95.4 million st) in 2018 from 81.6 Mt (90 million st) in 2017 as a result of increased steel-mill-capacity utilization, increased import

Figure 3

This map of the United States indicates the value of nonfuel mineral production by state, with charts ranking the states and proportions of production, by type of material.



duties on steel articles after the Section 232 investigation, and higher steel demand. The share of steel produced by basic oxygen furnaces, the process that uses iron ore, continued to decline to 33 percent in 2018 from 37.4 percent in 2017 owing to increased use of electric-arc furnaces, which use steel scrap and DRI, because of their energy efficiency and reduced environmental impacts, the ready supply of scrap, and stable scrap prices.

Nonferrous metals. U.S. production of primary aluminum metal increased for the first year since 2012, rising by about 20 percent in 2018 to an estimated 890 kt (981,000 st). This increase was partially attributed to the increase in import duties on aluminum articles after the Section 232 investigation. During the year, two aluminum smelters, one in Indiana and the other in Missouri, reopened, and idled capacity at a third smelter in Kentucky was restarted. Domestic smelters were operating at about 55 percent of 1.8 Mt/a (1.98 million stpy) capacity, as of October.

U.S. mine production of recoverable copper decreased by 5 percent in 2018 to an estimated 1.2 Mt (1.3 million st) primarily owing to reduced output from multiple mines in Arizona and New Mexico. Arizona was the leading copper-producing state and accounted for about 66 percent of domestic output, followed by Utah, New Mexico, Nevada, Montana, Michigan and Missouri, in descending order of production. Twenty-four mines recovered copper, 15 of which accounted for about 99 percent of production. One major copper producer operating in these states reported lower ore grades, and a landslide at an Arizona copper mine in March significantly affected operations throughout the year. Refined copper production in the United States increased by an estimated 6 percent in 2018 compared with 2017. Output in 2017 was negatively affected by planned smelter maintenance shutdowns and a six-week suspension of operations at one smelter following an accident.

Five lead mines in Missouri, plus five mines in Alaska, Idaho and Washington that produced lead as a coproduct, accounted for all domestic

lead mine production. In 2018, domestic mine production was estimated to have decreased from the previous year in all four lead-producing states. Production at a lead-producing mine in Idaho continued to be relatively low owing to an employee strike, which began in March 2017. All lead concentrates produced in the United States were exported for refining. The last primary lead smelter in the United States closed in 2013.

Domestic zinc mine production increased slightly in 2018 owing to the addition of production from a reopened zinc mine in New York. Ten zinc mines in Alaska, New York, Tennessee and Washington, plus five mines in Idaho and Missouri that produced zinc as a coproduct, accounted for all domestic zinc mine production. About 80 to 85 percent of domestic zinc mine production has been exported for refining in the past several years. The United States ranked fifth in world zinc mine production, accounting for about 6 percent of global production. Zinc metal production decreased slightly owing to maintenance outages at the sole domestic primary zinc smelter in Tennessee.

Precious metals. An 11-percent decrease in domestic gold mine production was attributed to decreased production from the Cortez Mine in Nevada, the Cresson Mine in Colorado, the Fort Knox Mine in Alaska, the Newmont mines in Nevada, and the shutdown of the Kettler River-Buckhorn Mine in Washington in 2017. The United States was the fourth-leading gold-producing country, accounting for about 6 percent of world production in 2018. Gold was produced at more than 40 lode mines, 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 produced more than 99 percent of the mined gold in the United States. About 6 percent of domestic gold was recovered as a byproduct of processing domestic base-metal ores, chiefly copper ores. Commercial-grade gold was produced at about 15 refineries. In 2018, worldwide gold mine production was estimated to have increased slightly from 2017. New mine production in Canada and Russia and increased production from the Grasberg Mine in Indonesia more than offset decreased gold mine production in China, which resulted from increased environmental regulations, and in the United States.

Domestic silver mine production decreased by 12 percent in 2018 compared with 2017 largely owing to a strike at one of the four primary silver mines in the United States, which began in the second quarter of 2017, and to decreased production at mining operations in Alaska. Silver was produced at four silver mines and as a byproduct or coproduct from 38 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 U.S. refiners. World silver mine production increased slightly in 2018, principally as a result of increased production from mines in Argentina, China and Russia. However, some of the world's top silver-producing companies experienced decreases in production owing to licensing issues, increasing tariffs, reduced ore grades and labor strikes at various projects.

Domestic mine production of platinum-group-metals (PGMs) increased slightly in 2018 from that in 2017. PGMs were produced at the East Boulder and Stillwater PGM mines in south-central Montana. Small quantities of primary PGMs also were recovered as byproducts of copper-nickel mining in Minnesota. However, this material was sold to foreign companies for refining. Progress continued at an expansion project at the Stillwater Mine. Full production is expected by the end of 2021.

Refractory and specialty metals. In 2018, a nickel-copper mine in Michigan produced cobalt-bearing nickel concentrate, which was exported for processing. There are no domestic cobalt refineries, and most U.S. cobalt supply was comprised of imports and domestically produced scrap materials. Congo (Kinshasa) continued to be the world's leading source of mined cobalt, supplying more than 60 percent of world cobalt mine production. With the exception of production in Morocco and artisanally mined cobalt in Congo (Kinshasa), most cobalt is mined as a byproduct of copper or nickel. China was the world's leading producer of refined cobalt and has been a leading supplier of cobalt imports to the United States.

U.S. mine production of molybdenum in 2018 increased by an estimated 3 percent and accounted for about 14 percent of global molybdenum mine production. Molybdenum ore was produced as a primary product at two mines — both in Colorado — whereas seven copper mines (four in Arizona and one each in Montana, Nevada and Utah) recovered molybdenum as a byproduct. Increased production took place at both primary and byproduct mines.

Domestic rare-earths mining resumed in 2018. Bastnaesite, a rare-earth fluorocarbonate mineral, was mined as a primary product at a mine in Mountain Pass, CA, which was restarted in the first quarter of 2018 after being put on care-and-maintenance status in the fourth quarter of 2015. Monazite, a phosphate mineral, also may have been produced as a separated concentrate or included as an accessory mineral in heavy-mineral concentrates produced at other

Table 3

Value of nonfuel mineral production in the United States and principal nonfuel minerals produced in 2018^e.

State	Value (millions)	Rank ²	Percent of U.S. total	Principal minerals, in alphabetical order
Alabama	\$1,450	20	1.76	Cement (masonry), cement (portland), lime, sand and gravel (construction), stone (crushed).
Alaska	3,440	7	4.18	Gold, lead, sand and gravel (construction), silver, zinc.
Arizona	6,690	2	8.15	Cement (portland), copper, molybdenum concentrates, sand and gravel (construction), stone (crushed).
Arkansas	903	30	1.10	Bromine, cement (portland), sand and gravel (construction), sand and gravel (industrial), stone (crushed).
California	4,560	4	5.54	Boron minerals, cement (portland), gold, sand and gravel (construction), stone (crushed).
Colorado	1,380	21	1.68	Cement (portland), gold, molybdenum concentrates, sand and gravel (construction), stone (crushed).
Connecticut ³	200	43	0.24	Clay (common), sand and gravel (construction), stone (crushed), stone (dimension).
Delaware ³	31	50	0.04	Magnesium compounds, sand and gravel (construction), stone (crushed).
Florida	3,550	6	4.32	Cement (portland), phosphate rock, sand and gravel (construction), stone (crushed), zirconium mineral concentrates.
Georgia	1,960	13	2.39	Cement (portland), clay (kaolin and montmorillonite), sand and gravel (construction), stone (crushed).
Hawaii	141	47	0.17	Sand and gravel (construction), stone (crushed).
Idaho ³	208	35	0.25	Lead, lime, phosphate rock, sand and gravel (construction), stone (crushed).
Illinois ³	1,780	15	2.17	Cement (portland), sand and gravel (construction), sand and gravel (industrial), silica (tripoli), stone (crushed).
Indiana	1,060	27	1.29	Cement (portland), lime, sand and gravel (construction), stone (crushed), stone (dimension).
Iowa ³	680	29	0.83	Cement (portland), lime, sand and gravel (construction), sand and gravel (industrial), stone (crushed).
Kansas ³	672	28	0.82	Cement (portland), helium (crude), helium (Grade-A), salt, stone (crushed).
Kentucky ³	513	32	0.62	Cement (portland), lime, sand and gravel (construction), sand and gravel (industrial), stone (crushed).
Louisiana ³	536	34	0.65	Clay (common), salt, sand and gravel (construction), sand and gravel (industrial), stone (crushed).
Maine ³	135	44	0.16	Cement (portland), peat, sand and gravel (construction), stone (crushed), stone (dimension).
Maryland ³	410	33	0.50	Cement (masonry), cement (portland), sand and gravel (construction), stone (crushed), stone (dimension).
Massachusetts ³	340	40	0.41	Clay (common), lime, sand and gravel (construction), stone (crushed), stone (dimension).
Michigan	2,470	11	3.01	Cement (portland), iron ore, nickel, salt, sand and gravel (construction).
Minnesota ³	4,050	5	4.93	Iron ore, sand and gravel (construction), sand and gravel (industrial), stone (crushed), stone (dimension).
Mississippi	404	38	0.49	Clay (ball and montmorillonite), sand and gravel (construction), sand and gravel (industrial), stone (crushed).
Missouri	2,930	9	3.57	Cement (portland), lead, lime, sand and gravel (industrial), stone (crushed).
Montana	1,130	24	1.37	Cement (portland), copper, palladium metal, platinum metal, sand and gravel (construction).
Nebraska ³	209	39	0.25	Cement (portland), lime, sand and gravel (construction), sand and gravel (industrial), stone (crushed).
Nevada	7,880	1	9.58	Copper, gold, lime, sand and gravel (construction), silver.

State	Value (millions)	Rank ²	Percent of U.S. total	Principal minerals, in alphabetic order
New Hampshire	\$162	45	0.20	Sand and gravel (construction), stone (crushed), stone (dimension).
New Jersey	295	42	0.36	Peat, sand and gravel (construction), sand and gravel (industrial), stone (crushed).
New Mexico	1,160	23	1.42	Cement (portland), copper, potash, sand and gravel (construction), stone (crushed).
New York	1,790	16	2.18	Cement (portland), salt, sand and gravel (construction), stone (crushed), zinc.
North Carolina ³	1,210	18	1.47	Clay (common), phosphate rock, sand and gravel (construction), sand and gravel (industrial), stone (crushed).
North Dakota ³	136	46	0.17	Clay (common), lime, sand and gravel (construction), sand and gravel (industrial), stone (crushed).
Ohio ³	1,200	17	1.46	Cement (portland), lime, salt, sand and gravel (construction), stone (crushed).
Oklahoma	894	31	1.09	Cement (portland), iodine, sand and gravel (construction), sand and gravel (industrial), stone (crushed).
Oregon	530	36	0.64	Cement (portland), diatomite, perlite (crude), sand and gravel (construction), stone (crushed).
Pennsylvania ³	1,920	14	2.34	Cement (masonry), cement (portland), lime, sand and gravel (construction), stone (crushed).
Rhode Island ³	56	49	0.07	Sand and gravel (construction), sand and gravel (industrial), stone (crushed).
South Carolina ³	1,050	26	1.28	Cement (portland), clay (kaolin), gold, sand and gravel (construction), stone (crushed).
South Dakota	339	41	0.41	Cement (portland), gold, lime, sand and gravel (construction), stone (crushed).
Tennessee	1,460	19	1.77	Cement (portland), sand and gravel (construction), sand and gravel (industrial), stone (crushed), zinc.
Texas	6,030	3	7.34	Cement (portland), salt, sand and gravel (construction), sand and gravel (industrial), stone (crushed).
Utah	2,940	8	3.58	Cement (portland), copper, magnesium metal, salt, sand and gravel (construction).
Vermont ³	104	48	0.13	Sand and gravel (construction), stone (crushed), stone (dimension), talc (crude).
Virginia	1,290	22	1.57	Cement (portland), lime, sand and gravel (construction), sand and gravel (industrial), stone (crushed).
Washington	1,090	25	1.33	Cement (portland), diatomite, sand and gravel (construction), stone (crushed), zinc.
West Virginia ³	263	37	0.32	Cement (masonry), cement (portland), lime, sand and gravel (construction), stone (crushed).
Wisconsin ³	2,730	10	3.32	Lime, sand and gravel (construction), sand and gravel (industrial), stone (crushed), stone (dimension).
Wyoming	2,410	12	2.93	Cement (portland), clay (bentonite), helium (Grade-A), sand and gravel (construction), soda ash.
Undistributed	3,410	XX	4.15	
Total	82,200	XX	100.00	

^e Estimated. XX Not applicable.

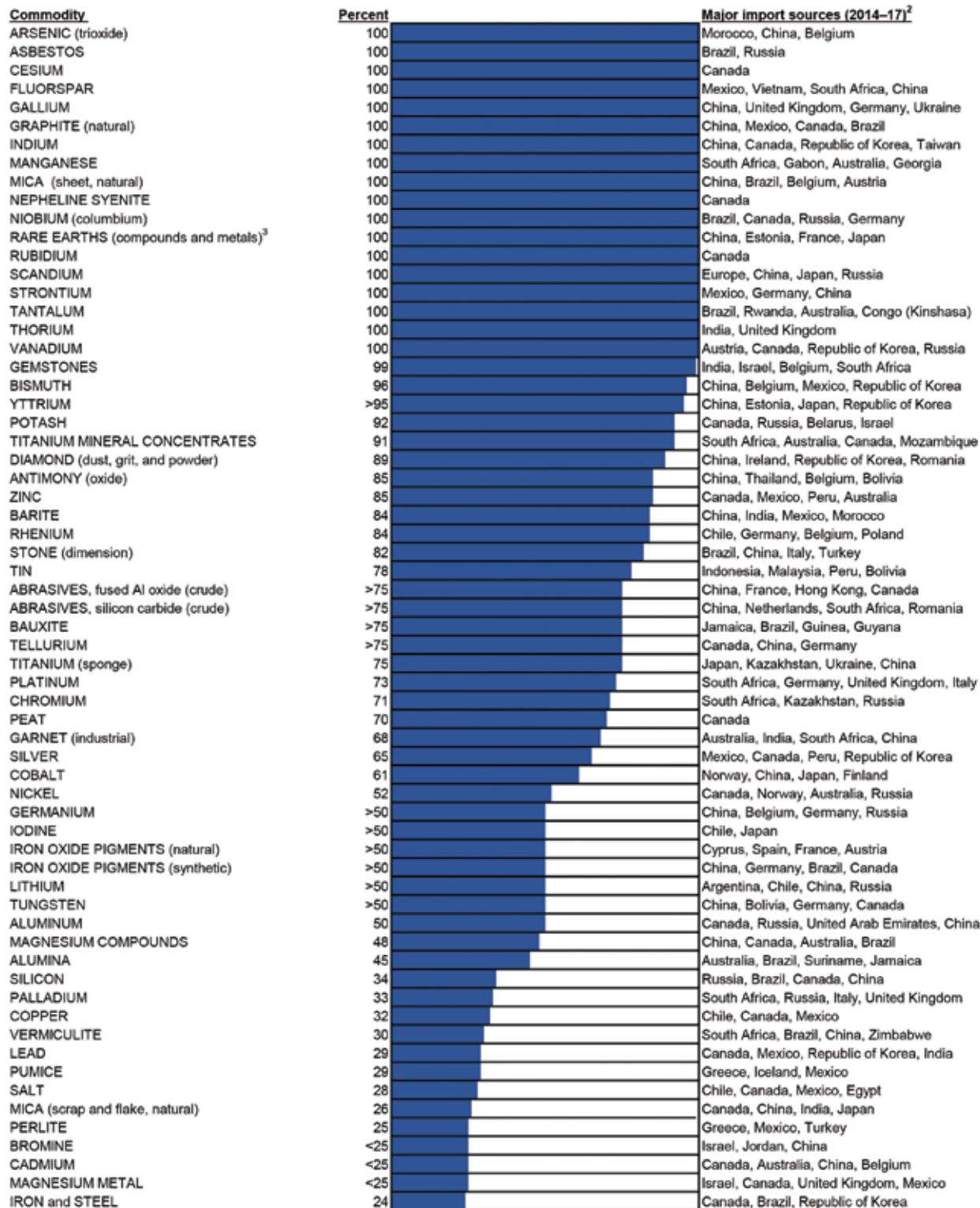
¹ Data are rounded to no more than three significant digits; may not add to totals shown.

² Rank based on total, unadjusted State values.

³ Listed in alphabetical order for each State.

⁴ Partial total; excludes values that must be withheld to avoid disclosing company proprietary data, which are included in "Undistributed."

Figure 4
U.S. net import reliance for selected nonfuel minerals in 2018.¹



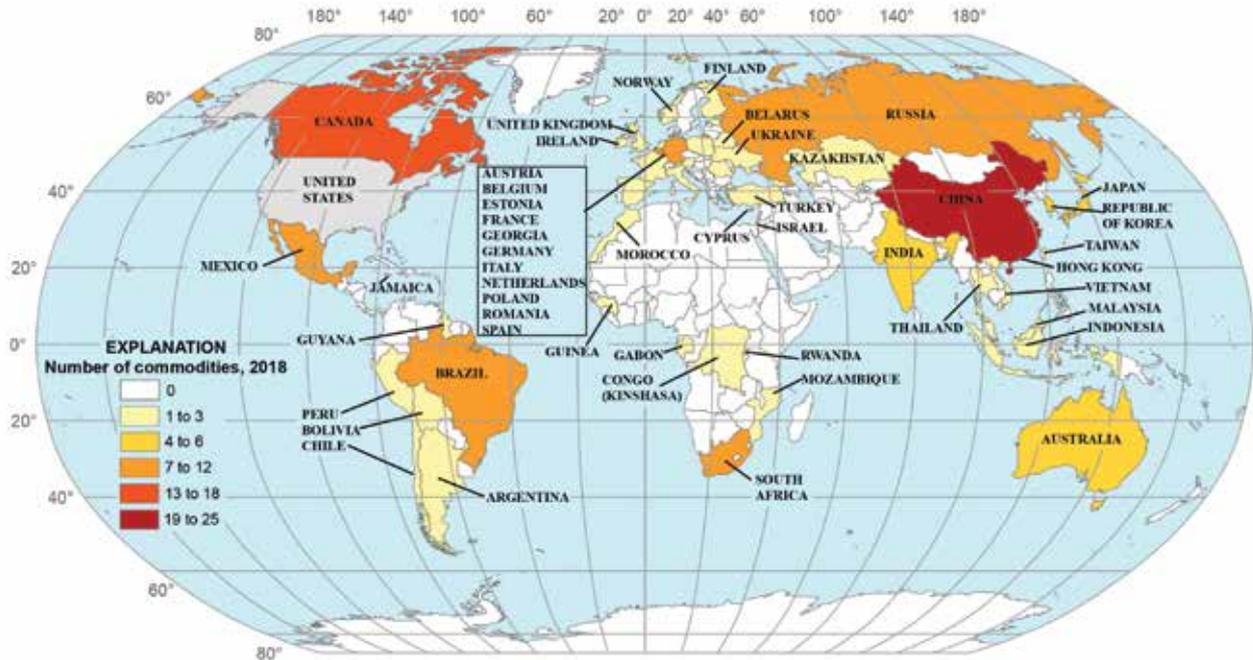
¹Not all mineral commodities covered in this publication are listed here. Those not shown include mineral commodities for which the United States is a net exporter (abrasives, metallic; boron; clays; diatomite; gold; helium; iron and steel scrap; iron ore; kyanite; molybdenum concentrates; sand and gravel, industrial; selenium; soda ash; titanium dioxide pigment; wollastonite; zeolites; and zirconium) or less than 24% import reliant (beryllium; cement; diamond, industrial stones; feldspar; gypsum; iron and steel slag; lime; nitrogen (fixed)-ammonia; phosphate rock; sand and gravel, construction; stone, crushed; sulfur; and talc and pyrophyllite). For some mineral commodities (hafnium; mercury; quartz crystal, industrial; and thallium), not enough information is available to calculate the exact percentage of import reliance.

²In descending order of import share.

³Data include lanthanides.

Figure 5

Major import sources of nonfuel mineral commodities for which the United States was greater than 50 percent net import reliant in 2018. Map highlighting the countries from which the majority of mineral commodities for which the United States was more than 50 percent net import dependent were imported. The color for each country indicates the number of mineral commodities for which each highlighted country was a leading supplier. China, followed by Canada, supplied the largest number of nonfuel mineral commodities.



Source: U.S. Geological Survey

domestic mines. All domestic production was exported in 2018. Globally, mining of rare earths increased with renewed production in the United States, supplemented with new and/or increased production in Australia, Burma (Myanmar) and Burundi. Domestic consumption of rare earths, which were primarily used in catalyst applications, was supplied by imported compounds and metals.

In 2018, rhenium was mined at six operations (four in Arizona and one each in Montana and Utah), and production was estimated to have increased slightly from that of 2017. Rhenium compounds are included in molybdenum concentrates derived from porphyry copper deposits, and rhenium is recovered as a byproduct from roasting such molybdenum concentrates. The United States accounted for about 17 percent of global mine production in 2018, ranking third behind Chile and Poland.

Industrial minerals

The value of output of industrial minerals and materials from mines in the United States was \$56.3 billion, 7 percent higher than it was in 2017. More than 6,500 companies contributed to this output, producing from more than 12,000 mines, quarries and processing facilities. Overall in 2018, the production of industrial minerals, by tonnage, increased by 5 percent compared with 2017. 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 an estimated additional \$5.2 billion of value to the industrial

minerals industry.

Agricultural minerals. Industrial mineral use in agriculture is 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. Nitrogen and sulfur were not mined domestically, but the United States is a significant producer of both materials. Nitrogen is commercially recovered from air as ammonia, which is produced by combining nitrogen in the atmosphere with hydrogen from natural gas. Elemental sulfur is recovered as a byproduct of natural gas processing and petroleum refining, and byproduct sulfuric acid is recovered at nonferrous metal smelters.

Domestic phosphate rock production and consumption in 2018 were estimated to be lower than in 2017, owing to a decrease in phosphoric acid production caused in part by the temporary closure of a phosphate plant in Florida. Phosphate rock ore was mined at 10 mines in Florida, Idaho, North Carolina and Utah. U.S. annual mine production capacity was expected to remain steady during the next five years. All three producers in Idaho were developing new mines to replace existing mines as they become exhausted over the next decade.

U.S. potash production and sales increased in 2018 owing to increased output of potassium sulfate and potassium magnesium sulfate and apparent consumption of potash was estimated to have increased slightly because of

stronger demand for fertilizers and for oil well drilling fluid additives. The majority of U.S. production was from southeastern New Mexico, where two companies operated two underground mines and one deep-well solution mine. Global potash production increased slightly in 2018 from 2017. Several new potash mines started production in Russia. Between 2019 and 2022, other new mines were planned to start production in Belarus, China, Laos and Spain, and expansion projects at existing facilities were ongoing in Belarus, China and Russia.

A long period of stable and low natural gas prices in the United States has made it economic for companies to upgrade existing ammonia plants and plan for the construction of new nitrogen projects. The additional capacity has reduced ammonia imports. In 2017, ammonia facilities in Iowa, Louisiana and Texas became operational, and, in 2018, one new ammonia facility in Texas became operational. No other ammonia plants are expected to be commissioned domestically before 2022. Two U.S. ammonia producers completed their merger in January 2018, and the new company accounted for 18 percent of the U.S. ammonia production capacity. Global ammonia capacity is expected to increase by a total of 6 percent in the next three years. In addition to increases in North America, capacity additions are expected in Africa, Central Asia, Eastern Europe and Southeast Asia.

U.S. sulfur production in 2018 was estimated to have increased slightly from 2017 and shipments were essentially unchanged from those of 2017. Domestic production of elemental sulfur from petroleum refineries and recovery from natural gas operations decreased slightly. Refinery sulfur production is expected to remain relatively constant in the next few years as well as byproduct sulfuric acid, unless one or more of the remaining nonferrous metal smelters close.

Chemical minerals. The quantities of domestically produced minerals that are used extensively by the chemical industry ranged from 41 Mt (45.2 million st) of salt (reported as sold or used) to a group of other minerals that totaled less than 2 kt (2,200 st). In addition to salt, major chemical minerals used included lime, 19 Mt (21 million st); soda ash, 12 Mt (13.2 million st); and sulfur for chemical uses not associated with agricultural uses, about 3.4 Mt (3.7 million st). The combined value for all minerals predominantly used as raw materials for chemical products, excluding sulfur, which is not mined, was about \$7.8 billion in 2018, slightly more than in 2017. Lime was valued at \$2.4 billion; salt, \$2.3 billion; soda ash, \$1.8 billion and other, \$1.3 billion (boron, bromine, iodine, lithium carbonate, magnesite, magnesium compounds and zeolites).

Lithium production in the United States was from one brine operation in Nevada, and two companies produced a wide range of downstream lithium compounds in the United States from domestic or imported lithium carbonate. Excluding U.S. production, worldwide lithium production in 2018 increased by 23 percent from 2017, in response to increased lithium

demand for battery applications. This follows an increase of 74 percent in worldwide production in 2017 from that of 2016, owing primarily to a threefold increase in Australia's spodumene production.

Many factors affect production and consumption of these mineral materials, 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, boron and soda ash, for example, their domestic production also reflects the economic conditions in other regions of the world. Economic downturns worldwide can have a negative impact on the production of these export-dependent commodities.

Construction minerals and materials. Nearly 2.5 Gt (2.7 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 2018. 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 value of these materials was an estimated \$38 billion.

Natural aggregates (crushed stone and construction sand and gravel) were mined or processed in all 50 states and were valued at \$25 billion, 67 percent of total value of construction minerals. More than three-quarters of the aggregates sold were used in road construction. Of the 2.4 Gt (2.6 billion st) produced (5 percent more than the amount in 2017), crushed stone accounted for 59 percent of the tonnage of aggregates used in construction; sand and gravel, 41 percent. Potential increases in construction aggregates demand will be influenced by activity in the public and private construction sectors, especially road construction.

Cement production accounted for 29 percent of the value of construction materials in 2018. The values of production of portland and masonry cement increased by 7 percent and 5 percent, respectively, in 2018 compared with 2017. The quantities of both increased slightly.

About 27 Mt (30 million st) of all varieties of clays, valued at about \$1.6 billion, were mined in the United States. Although not all clays are used in construction, common clay, which was used mainly for brick, cement and lightweight aggregates, accounted for 48 percent of the tonnage but only 14 percent of the value of all clays. Kaolin accounted for 7.3 Mt (8 million st) or 27 percent of the total clay tonnage and 55 percent of the value. Paper coating and filling accounted for 60 percent of kaolin use.

Other industrial minerals. The United States produced several other industrial minerals that are not listed 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. ■