U.S. Department of the Interior
U.S. Geological Survey

MINERAL COMMODITY SUMMARIES 2013

Abrasives
Aluminum
Antimony
Arsenic
Asbestos
Barite
Bauxite
Beryllium
Bismuth
Boron
Bromine
Cadmium
Cement
Cesium
Chromium
Clays
Cobalt
Copper
Diamond
Diatomite
Feldspar
Fluorspar
Gallium
Garnet
Gemstones
Germanium
Gold
Graphite
Gypsum
Hafnium
Helium
Indium
Iodine
Iron and Steel
Iron Ore
Iron Oxide Pigments
Kyanite
Lead
Lime
Lithium
Magnesium
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Molybdenum
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Soda Ash
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Stone
Strontium
Sulfur
Talc
Tantalum
Tellurium
Thallium
Thorium
Tin
Titanium
Tungsten
Vanadium
Vermiculite
Wollastonite
Yttrium
Zeolites
Zinc
Zirconium

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KEY PUBLICATIONS

Minerals Yearbook—These annual publications review the mineral industries of the United States and of more than 180 other countries. They contain statistical data on minerals and materials and include information on economic and technical trends and developments. The three volumes that make up the Minerals Yearbook are Volume I, Metals and Minerals; Volume II, Area Reports, Domestic; and Volume III, Area Reports, International.

Mineral Commodity Summaries—Published on an annual basis, this report is the earliest Government publication to furnish estimates covering nonfuel mineral industry data. Data sheets contain information on the domestic industry structure, Government programs, tariffs, and 5-year salient statistics for more than 90 individual minerals and materials.

Mineral Industry Surveys—These periodic statistical and economic reports are designed to provide timely statistical data on production, distribution, stocks, and consumption of significant mineral commodities. The surveys are issued monthly, quarterly, or at other regular intervals.

Metal Industry Indicators—This monthly publication analyzes and forecasts the economic health of three metal industries (primary metals, steel, and copper) using leading and coincident indexes.

Nonmetallic Mineral Products Industry Indexes—This monthly publication analyzes the leading and coincident indexes for the nonmetallic mineral products industry (NAICS 327).

Materials Flow Studies—These publications describe the flow of materials from source to ultimate disposition to help better understand the economy, manage the use of natural resources, and protect the environment.

Recycling Reports—These materials flow studies illustrate the recycling of metal commodities and identify recycling trends.

Historical Statistics for Mineral and Material Commodities in the United States (Data Series 140)—This report provides a compilation of statistics on production, trade, and use of approximately 90 mineral commodities since as far back as 1900.

WHERE TO OBTAIN PUBLICATIONS

- *Mineral Commodity Summaries* and the *Minerals Yearbook* are sold by the U.S. Government Printing Office. Orders are accepted over the Internet at <http://bookstore.gpo.gov>, by telephone toll free (866) 512–1800; Washington, DC area (202) 512–1800, by fax (202) 512–2104, or through the mail (P.O. Box 979050, St. Louis, MO 63197–9000).

- All current and many past publications are available in PDF format (and some are available in XLS format) through <http://minerals.usgs.gov/minerals>.

INTRODUCTION

Each chapter of the 2013 edition of the U.S. Geological Survey (USGS) Mineral Commodity Summaries (MCS) includes information on events, trends, and issues for each mineral commodity as well as discussions and tabular presentations on domestic industry structure, Government programs, tariffs, 5-year salient statistics, and world production and resources. The MCS is the earliest comprehensive source of 2012 mineral production data for the world. More than 90 individual minerals and materials are covered by two-page synopses.

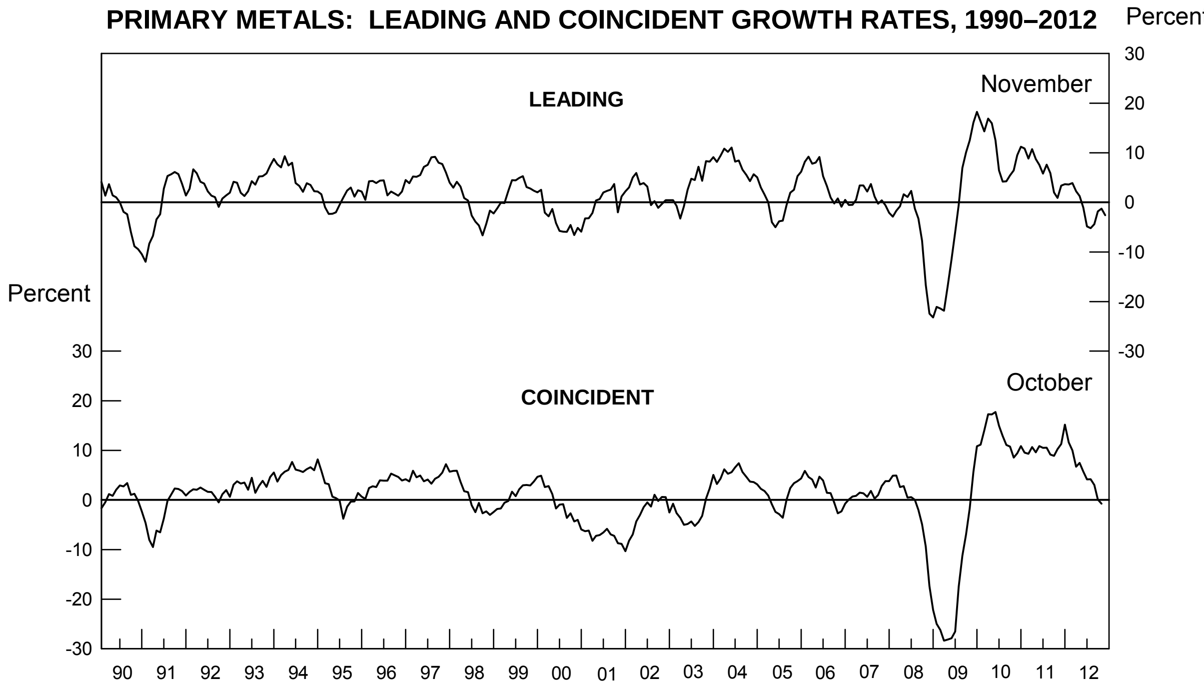
For mineral commodities for which there is a Government stockpile, detailed information concerning the stockpile status is included in the two-page synopsis.

Abbreviations and units of measure, and definitions of selected terms used in the report, are in Appendix A and Appendix B, respectively. “Appendix C—Reserves and Resources” includes “Part A—Resource/Reserve Classification for Minerals” and “Part B—Sources of Reserves Data.” A directory of USGS minerals information country specialists and their responsibilities is Appendix D.

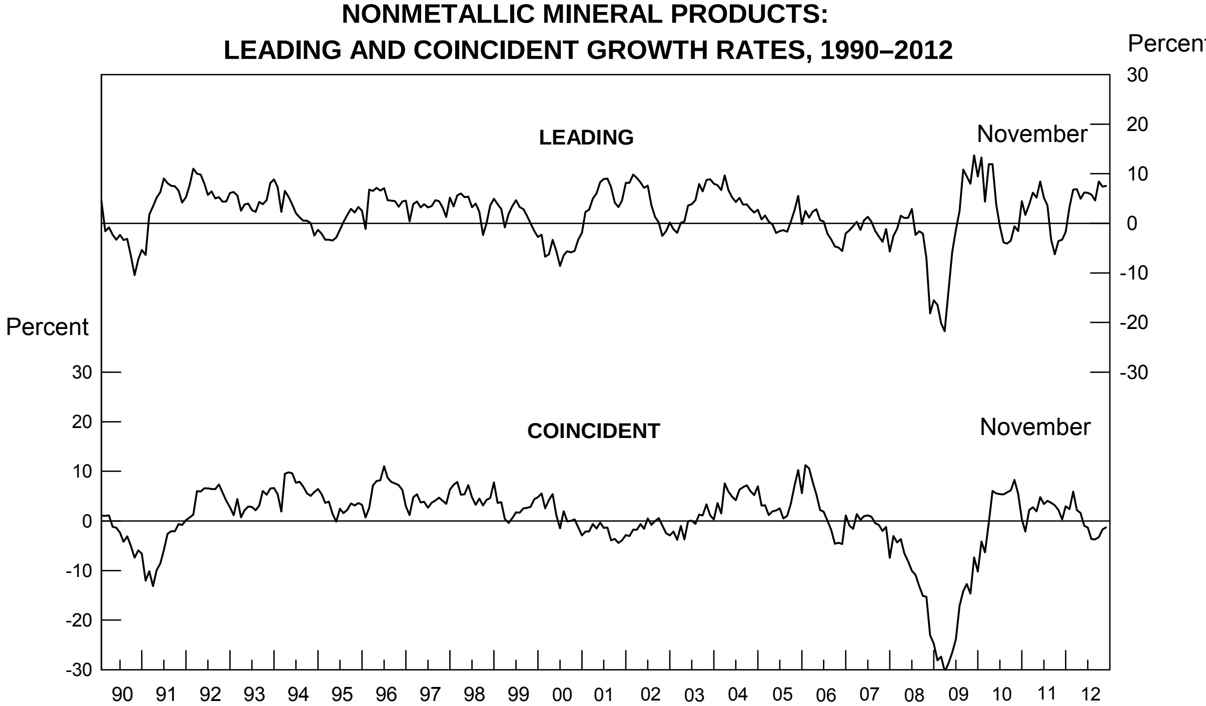
The USGS continually strives to improve the value of its publications to users. Constructive comments and suggestions by readers of the MCS 2013 are welcomed.

GROWTH RATES OF LEADING AND COINCIDENT INDEXES FOR MINERAL PRODUCTS

PRIMARY METALS: LEADING AND COINCIDENT GROWTH RATES, 1990–2012



NONMETALLIC MINERAL PRODUCTS: LEADING AND COINCIDENT GROWTH RATES, 1990–2012



The leading indexes historically give signals several months in advance of major changes in the corresponding coincident index, which measures current industry activity. The growth rates, which can be viewed as trends, are expressed as compound annual rates based on the ratio of the current month's index to its average level during the preceding 12 months.

Sources: U.S. Geological Survey, *Metal Industry Indicators* and *Nonmetallic Mineral Products Industry Indexes.*

THE ROLE OF NONFUEL MINERALS IN THE U.S. ECONOMY

(ESTIMATED VALUES IN 2012)

NET EXPORTS OF MINERAL RAW MATERIALS

GOLD, SODA ASH, ZINC CONCENTRATES, ETC.

Imports: $8.1 billion
Exports: $9.1 billion
Net exports: $1.0 billion

DOMESTIC MINERAL RAW MATERIALS FROM MINING

COPPER ORE, IRON ORE, SAND AND GRAVEL, STONE, ETC.

Value: $76.5 billion

METALS AND MINERAL PRODUCTS RECYCLED DOMESTICALLY

ALUMINUM, GLASS, STEEL, ETC.

Value of old scrap: $30.4 billion

NET EXPORTS OF OLD SCRAP

GOLD, STEEL, ETC.

Imports: $6.8 billion
Exports: $26.4 billion
Net exports: $19.6 billion

MINERAL MATERIALS PROCESSED DOMESTICALLY

ALUMINUM, BRICK, CEMENT, COPPER, FERTILIZERS, STEEL, ETC.

Value of shipments: $704 billion

NET IMPORTS OF PROCESSED MINERAL MATERIALS

METALS, CHEMICALS, ETC.

Imports: $147 billion
Exports: $120 billion
Net imports: $27 billion

VALUE ADDED TO GROSS DOMESTIC PRODUCT BY MAJOR INDUSTRIES THAT CONSUME PROCESSED MINERAL MATERIALS[1]

Value: $2,390 billion

U.S. ECONOMY

Gross Domestic Product: $15,700 billion

[1] Major consuming industries of processed mineral materials are construction, durable goods manufacturers, and some nondurable goods manufacturers. The value of shipments for processed mineral materials cannot be directly related to gross domestic product.

Sources: U.S. Geological Survey and U.S. Department of Commerce.

2012 U.S. NET IMPORT RELIANCE[1]

Commodity	Percent	Major Import Sources (2008–11)[2]
ARSENIC (trioxide)	100	Morocco, China, Belgium
ASBESTOS	100	Canada, Zimbabwe
BAUXITE and ALUMINA	100	Jamaica, Brazil, Guinea, Australia
CESIUM	100	Canada
FLUORSPAR	100	Mexico, China, South Africa
GRAPHITE (natural)	100	China, Mexico, Canada, Brazil
INDIUM	100	China, Canada, Japan, Belgium
MANGANESE	100	South Africa, Gabon, Australia, China
MICA, sheet (natural)	100	China, Brazil, Belgium, India
NIOBIUM (columbium)	100	Brazil, Canada, Germany
QUARTZ CRYSTAL (industrial)	100	China, Japan, Russia
RUBIDIUM	100	Canada
SCANDIUM	100	China
STRONTIUM	100	Mexico, Germany, China
TANTALUM	100	China, Estonia, Germany, Kazakhstan
THALLIUM	100	Germany, Russia
THORIUM	100	India, France
GALLIUM	99	Germany, United Kingdom, China, Canada
GEMSTONES	99	Israel, India, Belgium, South Africa
VANADIUM	96	Rep. of Korea, Canada, Austria, Czech Republic
BISMUTH	92	China, Belgium, United Kingdom
PLATINUM	91	Germany, South Africa, United Kingdom, Canada
GERMANIUM	90	China, Belgium, Russia, Germany
IODINE	88	Chile, Japan
ANTIMONY	87	China, Mexico, Belgium, Bolivia
DIAMOND (dust, grit, and powder)	85	China, Ireland, Republic of Korea, Russia
STONE (dimension)	85	China, Brazil, Italy, Turkey
POTASH	81	Canada, Russia
BARITE	80	China, India, Morocco
COBALT	78	China, Norway, Russia, Finland
RHENIUM	78	Chile, Netherlands, Germany
TITANIUM MINERAL CONCENTRATES	77	South Africa, Australia, Canada, Mozambique
TIN	75	Peru, Bolivia, Indonesia, China
SILICON CARBIDE (crude)	73	China, South Africa, Romania, Netherlands
ZINC	72	Canada, Mexico, Peru, Spain
CHROMIUM	70	South Africa, Kazakhstan, Russia, Mexico
GARNET (industrial)	65	India, Australia, China, Canada
TITANIUM (sponge)	64	Japan, Kazakhstan, China, Ukraine,
PEAT	62	Canada
SILVER	57	Mexico, Canada, Peru, Poland
PALLADIUM	54	Russia, South Africa, United Kingdom, Norway
NICKEL	49	Canada, Russia, Australia, Norway
MAGNESIUM COMPOUNDS	46	China, Canada, Brazil, Australia
TUNGSTEN	42	China, Bolivia, Canada, Germany
SILICON	36	Brazil, Russia, China, Canada
COPPER	35	Chile, Canada, Peru, Mexico
NITROGEN (fixed), AMMONIA	35	Trinidad and Tobago, Russia, Canada, Ukraine
MAGNESIUM METAL	31	Israel, Canada, China
MICA, scrap and flake (natural)	31	Canada, China, India, Finland
VERMICULITE	30	South Africa, China, Brazil, Australia
PERLITE	24	Greece
ALUMINUM	20	Canada, Russia, China, Mexico
SALT	19	Canada, Chile, Mexico, The Bahamas
SULFUR	19	Canada, Mexico, Venezuela
PUMICE	15	Greece, Iceland, Mexico, Montserrat
GYPSUM	12	Canada, Mexico, Spain
IRON and STEEL	11	Canada, European Union, Mexico, Rep. of Korea
BERYLLIUM	10	Russia, Kazakhstan, Japan, Kenya,
IRON and STEEL SLAG	9	Japan, Canada, Italy, South Africa
CEMENT	7	Canada, Republic of Korea, China, Mexico
PHOSPHATE ROCK	5	Morocco, Peru

[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 (for example, molybdenum) or less than 5% import reliant (for example, talc). For some mineral commodities (for example, rare earths), not enough information is available to calculate the exact percentage of import reliance; for others (for example, lithium), exact percentages may have been rounded to avoid disclosing company proprietary data.
[2]In descending order of import share.

SIGNIFICANT EVENTS, TRENDS, AND ISSUES

In 2012, the estimated value of mineral production increased in the United States for the third consecutive year. Production and prices increased for most industrial mineral commodities mined in the United States, but production and prices for nearly all metals declined. Minerals remained fundamental to the U.S. economy, contributing to the real gross domestic product (GDP) at several levels, including mining, processing, and manufacturing finished products. Minerals' contribution to the GDP increased for the second consecutive year. After continued decline following the 2008–09 recession, the construction industry began to show signs of improvement during 2012, with increased production and consumption of cement, construction sand and gravel, and gypsum, mineral commodities that are used almost exclusively in construction. Crushed stone production, however, continued to decline.

The figure on page 4 shows that the primary metals industry and the nonmetallic minerals products industry are intrinsically cyclical. Growth rates are directly affected by the U.S. business cycle as well as by global economic conditions. The U.S. Geological Survey (USGS) generates composite indexes to measure economic activity in these industries. The coincident composite indexes describe the current situation using production, employment, and shipments data. The leading composite indexes forecast major changes in the industry's direction by such variables as stock prices, commodity prices, new product orders, and other indicators, which are combined into one gauge. For each of the indexes, a growth rate is calculated to measure its change relative to the previous 12 months. Following a steep decline to -20% in early 2009, the leading index shows the growth of primary metals increased to almost 20% in late 2009. Since then, the index has steadily decreased. At the end of 2012, the growth rate was -2%. The primary metals industry was supported by modest metals demand generated from the manufacturing and construction sectors. This is likely to continue into 2013. The nonmetallic mineral products industry was boosted by the rebound in construction activity in 2012, with more than half of its output going to the construction sector. The recovery in the U.S. housing industry is fueling demand for industrial minerals and products. The nonmetallic mineral products leading index growth rate ended 2012 indicating that the nonmetallic mineral products industry is poised for a recovery in 2013.

As shown in the figure on page 5, the estimated value of mineral raw materials produced at mines in the United States in 2012 was $76.5 billion, a slight increase from $74.8 billion in 2011. Net exports of mineral raw materials and old scrap contributed an additional $21 billion to the U.S. economy. Domestic raw materials and domestically recycled materials were used to process mineral materials worth $704 billion. These mineral materials, including aluminum, brick, copper, fertilizers, and steel, and net imports of processed materials (worth about $27 billion) were, in turn, consumed by downstream industries with a value added of an estimated $2.4 trillion in 2012.

The estimated value of U.S. metal mine production in 2012 was $34.9 billion, about 3% less than that of 2011. Principal contributors to the total value of metal mine production in 2012 were gold (36%), copper (27%), iron ore (15%), molybdenum (10%), and zinc (4%). Average prices for most domestically mined metals decreased in 2012. The yearly average price of gold continued to climb, but no new alltime high was reached during the year. The estimated value of U.S. industrial minerals mine production in 2012 was $41.6 billion, more than 7% more than that of 2011. The value of industrial minerals mine production in 2012 was dominated by crushed stone (29%), cement (16%), and construction sand and gravel (16%). In general, industrial minerals prices were relatively stable, with modest price variations.

Mine production of 15 mineral commodities was worth more than $1 billion each in the United States in 2012. These were, in decreasing order of value, gold, crushed stone, copper, cement, construction sand and gravel, iron ore (shipped), molybdenum concentrates, phosphate rock, lime, industrial sand and gravel, soda ash, clays (all types), salt, zinc, and silver.

The figure on page 6 illustrates the reliance of the United States on foreign sources for raw and processed mineral materials. In 2012, the supply for more than one-half of U.S. apparent consumption of the 41 mineral commodities shown in the figure came from imports, and the United States was 100% import reliant for 18 of those. For the first time since 2002, the United States was not 100% import reliant for rare earths. Although not enough information was available to calculate the exact percentage of import reliance, rare earths mining resumed in Mountain Pass, CA. U.S. import reliance has increased significantly since 1978, the year that this information was first reported. At that time, the United States was 100% import reliant for 7 mineral commodities, and more than 50% import reliant for 25 mineral commodities. In 2012, the United States was a net exporter of 15 mineral commodities, meaning more of those domestically produced mineral commodities were exported than imported. That figure has remained relatively stable, with net exports of 18 mineral commodities in 1978.

In 2012, 11 States each produced more than $2 billion worth of nonfuel mineral commodities. These States were, in descending order of value—Nevada, Arizona, Minnesota, Florida, California, Alaska, Utah, Texas, Missouri, Michigan, and Wyoming. The mineral production of these States accounted for 64% of the U.S. total output value (table 3).

The Defense Logistics Agency (DLA) Strategic Materials is responsible for providing safe, secure and

TABLE 1.—U.S. MINERAL INDUSTRY TRENDS

	2008	2009	2010	2011	2012[e]
Total mine production (million dollars):					
Metals	27,300	22,000	30,300	36,000	34,900
Industrial minerals	43,900	37,000	36,100	38,800	41,600
Coal	36,600	35,700	38,600	44,900	41,100
Employment (thousands of production workers):					
Coal mining	71	71	70	77	73
Metal mining	32	28	29	[1]98	[1]102
Industrial minerals, except fuels	79	73	71	[2]NA	[2]NA
Chemicals and allied products	513	479	474	483	499
Stone, clay, and glass products	363	303	283	278	273
Primary metal industries	348	273	275	302	320
Average weekly earnings of production workers (dollars):					
Coal mining	1,138	1,250	1,365	1,404	1,352
Metal mining	1,195	1,096	[2]NA	[2]NA	[2]NA
Industrial minerals, except fuels	838	807	[2]NA	[2]NA	[2]NA
Chemicals and allied products	809	841	888	911	919
Stone, clay, and glass products	711	706	726	767	765
Primary metal industries	851	819	880	890	911

[e]Estimated. NA Not available.

[1]Metal mining and industrial minerals (except fuel), combined.

[2]Because of changes to U.S. Department of Labor reports, these data are no longer available.

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

TABLE 2.—U.S. MINERAL-RELATED ECONOMIC TRENDS

	2008	2009	2010	2011	2012[e]
Gross domestic product (billion dollars)	14,292	13,974	14,499	15,076	15,700
Industrial production (2007=100):					
Total index	96	85	90	94	97
Manufacturing:	95	82	87	90	94
Nonmetallic mineral products	88	67	69	71	71
Primary metals:	100	74	91	97	99
Iron and steel	106	68	89	97	101
Aluminum	93	76	90	96	100
Nonferrous metals (except aluminum)	103	94	112	110	108
Chemicals	92	83	86	87	87
Mining:	101	96	101	107	113
Coal	102	93	94	94	88
Oil and gas extraction	101	107	110	116	126
Metals	103	90	96	99	97
Nonmetallic minerals	90	72	72	71	73
Capacity utilization (percent):					
Total industry:	77	69	74	77	79
Mining:	90	80	84	87	90
Metals	79	70	75	76	74
Nonmetallic minerals	77	65	70	72	76
Housing starts (thousands)	900	554	586	612	772
Light vehicle sales (thousands)[1]	9,720	7,550	8,620	9,760	11,200
Highway construction, value, put in place (billion dollars)	81	82	82	79	79

[e]Estimated.

[1]Excludes imports.

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

environmentally sound stewardship for strategic and critical materials in the U.S. National Defense Stockpile (NDS). DLA Strategic Materials stores 28 commodities at 15 locations in the United States. In fiscal year 2012, DLA Strategic Materials sold $1.5 million of excess mineral materials from the NDS. At the end of the fiscal year, mineral materials valued at $1.4 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. Additional detailed information can be found in the "Government Stockpile" sections in the mineral commodity reports that follow. 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.

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 2012[p, 1]

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	$1,010,000	23	1.32	Cement (portland), stone (crushed), lime, sand and gravel (construction), cement (masonry).
Alaska	3,500,000	6	4.58	Gold, zinc, silver, lead, sand and gravel (construction).
Arizona	8,050,000	2	10.52	Copper, molybdenum concentrates, sand and gravel (construction), cement (portland), silver.
Arkansas	800,000	26	1.05	Bromine, stone (crushed), sand and gravel (industrial), cement (portland), sand and gravel (construction).
California	3,580,000	5	4.68	Sand and gravel (construction), boron minerals, cement (portland), gold, stone (crushed).
Colorado	1,930,000	12	2.52	Molybdenum concentrates, gold, cement (portland), sand and gravel (construction), stone (crushed).
Connecticut[2]	173,000	43	0.23	Stone (crushed), sand and gravel (construction), clays (common), stone (dimension), gemstones (natural).
Delaware[2]	13,400	50	0.02	Magnesium compounds, sand and gravel (construction), stone (crushed), gemstones (natural).
Florida	3,640,000	4	4.76	Phosphate rock, stone (crushed), cement (portland), sand and gravel (construction), zirconium concentrates.
Georgia	1,440,000	15	1.89	Clays (kaolin), stone (crushed), clays (fuller's earth), cement (portland), sand and gravel (construction).
Hawaii	107,000	47	0.14	Stone (crushed), sand and gravel (construction), gemstones (natural).
Idaho	728,000	29	0.95	Molybdenum concentrates, phosphate rock, sand and gravel (construction), silver, stone (crushed).
Illinois	1,170,000	21	1.53	Stone (crushed), sand and gravel (industrial), cement (portland), sand and gravel (construction), tripoli.
Indiana	838,000	25	1.10	Stone (crushed), cement (portland), lime, sand and gravel (construction), cement (masonry).
Iowa	731,000	28	0.96	Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial), lime.
Kansas	1,220,000	20	1.60	Helium (Grade–A), stone (crushed), salt, cement (portland), helium (crude).
Kentucky	786,000	27	1.03	Stone (crushed), lime, cement (portland), sand and gravel (construction), clays (common).
Louisiana	492,000	34	0.64	Salt, sand and gravel (construction), stone (crushed), sand and gravel (industrial), lime.
Maine	133,000	45	0.17	Sand and gravel (construction), cement (portland), stone (crushed), stone (dimension), cement (masonry).
Maryland[2]	289,000	40	0.38	Cement (portland), stone (crushed), sand and gravel (construction), cement (masonry), stone (dimension).
Massachusetts[2]	209,000	41	0.27	Stone (crushed), sand and gravel (construction), stone (dimension), lime, clays (common).
Michigan	2,240,000	10	2.93	Iron ore (usable shipped), cement (portland), sand and gravel (construction), salt, stone (crushed).
Minnesota[2]	4,500,000	3	5.88	Iron ore (usable shipped), sand and gravel (industrial), sand and gravel (construction), stone (crushed), stone (dimension).
Mississippi	196,000	42	0.26	Sand and gravel (construction), stone (crushed), clays (fuller's earth), clays (ball), clays (bentonite).

See footnotes at end of table.

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 2012[p, 1]

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Missouri	2,640,000	9	3.45	Stone (crushed), cement (portland), lead, lime, sand and gravel (industrial).
Montana	1,420,000	16	1.86	Copper, palladium metal, molybdenum concentrates, platinum metal, gold.
Nebraska	335,000	37	0.44	Sand and gravel (construction), cement (portland), stone (crushed), sand and gravel (industrial), lime.
Nevada	11,200,000	1	14.58	Gold, copper, silver, lime, sand and gravel (construction).
New Hampshire[2]	157,000	44	0.21	Sand and gravel (construction), stone (crushed), stone (dimension), gemstones (natural).
New Jersey[2]	292,000	39	0.38	Stone (crushed), sand and gravel (construction), sand and gravel (industrial), greensand marl, peat.
New Mexico	1,490,000	14	1.95	Copper, potash, sand and gravel (construction), stone (crushed), molybdenum concentrates.
New York	1,270,000	17	1.66	Stone (crushed), salt, sand and gravel (construction), cement (portland), wollastonite.
North Carolina	911,000	24	1.19	Stone (crushed), phosphate rock, sand and gravel (construction), sand and gravel (industrial), feldspar.
North Dakota[2]	97,000	48	0.13	Sand and gravel (construction), lime, stone (crushed), clays (common), sand and gravel (industrial).
Ohio[2]	1,220,000	19	1.60	Stone (crushed), sand and gravel (construction), salt, lime, cement (portland).
Oklahoma	651,000	32	0.85	Stone (crushed), cement (portland), sand and gravel (industrial), sand and gravel (construction), iodine.
Oregon	316,000	38	0.41	Stone (crushed), sand and gravel (construction), cement (portland), diatomite, perlite (crude).
Pennsylvania[2]	1,790,000	13	2.35	Stone (crushed), cement (portland), lime, sand and gravel (construction), sand and gravel (industrial).
Rhode Island[2]	40,900	49	0.05	Stone (crushed), sand and gravel (construction), sand and gravel (industrial), gemstones (natural).
South Carolina[2]	498,000	33	0.65	Cement (portland), stone (crushed), sand and gravel (construction), clays (kaolin), cement (masonry).
South Dakota	364,000	35	0.48	Gold, stone (crushed), cement (portland), sand and gravel (construction), lime.
Tennessee	1,030,000	22	1.34	Stone (crushed), zinc, cement (portland), sand and gravel (industrial), sand and gravel (construction).
Texas	3,390,000	8	4.43	Cement (portland), stone (crushed), sand and gravel (construction), sand and gravel (industrial), salt.
Utah	3,490,000	7	4.56	Copper, molybdenum concentrates, gold, potash, magnesium metal.
Vermont[2]	117,000	46	0.15	Stone (crushed), sand and gravel (construction), stone (dimension), talc (crude), gemstones (natural).
Virginia	1,250,000	18	1.64	Zirconium concentrates, sand and gravel (construction), cement (portland), lime, titanium concentrates.
Washington	689,000	30	0.90	Gold, sand and gravel (construction), stone (crushed), cement (portland), diatomite.
West Virginia	341,000	36	0.45	Stone (crushed), cement (portland), lime, sand and gravel (industrial), cement (masonry).
Wisconsin[2]	660,000	31	0.86	Sand and gravel (industrial), stone (crushed), sand and gravel (construction), lime, stone (dimension).
Wyoming	2,220,000	11	2.90	Soda ash, clays (bentonite), helium (Grade–A), sand and gravel (construction), cement (portland).
Undistributed	880,000	XX	1.15	
Total	76,500,000	XX	100.00	

[p]Preliminary. XX Not applicable.

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

[2]Partial total; excludes values that must be withheld to avoid disclosing company proprietary data which are included with "Undistributed."

MAJOR METAL-PRODUCING AREAS

MAJOR INDUSTRIAL MINERAL-PRODUCING AREAS—PART I

SYMBOLS

Ba	Barite
B	Borates
Br	Bromine
Dia	Diatomite
Gar	Garnet
Gyp	Gypsum
He	Helium
Irz	Ilmenite, rutile, and zircon
I	Iodine
Ky	Kyanite
MgCp	Magnesium compounds
Mica	Mica
O	Olivine
Peat	Peat
P	Phosphate
K	Potash
Pyrp	Pyrophyllite
Salt	Salt
NaC	Soda ash
NaS	Sodium sulfate
S	Sulfur
Talc	Talc
Vm	Vermiculite
Wol	Wollastonite
Zeo	Zeolites

MAJOR INDUSTRIAL MINERAL-PRODUCING AREAS—PART II

ABRASIVES (MANUFACTURED)

(Fused aluminum oxide and silicon carbide)
(Data in metric tons unless otherwise noted)

Domestic Production and Use: Fused aluminum oxide was produced by two companies at three plants in the United States and Canada. Production of regular-grade fused aluminum oxide had an estimated value of $1.7 million. Silicon carbide was produced by two companies at two plants in the United States. Domestic production of crude silicon carbide had an estimated value of about $26 million. Bonded and coated abrasive products accounted for most abrasive uses of fused aluminum oxide and silicon carbide.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production,[1] United States and Canada (crude):					
Fused aluminum oxide, regular	10,000	10,000	10,000	10,000	10,000
Silicon carbide	35,000	35,000	35,000	35,000	35,000
Imports for consumption (U.S.):					
Fused aluminum oxide	285,000	64,200	185,000	223,000	193,000
Silicon carbide	127,000	78,000	143,000	129,000	113,000
Exports (U.S.):					
Fused aluminum oxide	21,900	12,300	20,000	19,900	19,500
Silicon carbide	17,000	20,700	23,100	27,800	19,000
Consumption, apparent (U.S.):					
Fused aluminum oxide	NA	NA	NA	NA	NA
Silicon carbide	145,000	92,300	155,000	136,000	130,000
Price, value of imports, dollars per ton (U.S.):					
Fused aluminum oxide, regular	512	608	555	627	555
Fused aluminum oxide, high-purity	1,230	1,170	1,300	1,360	1,180
Silicon carbide	835	557	793	1,260	1,280
Net import reliance[2] as a percentage of apparent consumption (U.S.):					
Fused aluminum oxide	NA	NA	NA	NA	NA
Silicon carbide	76	62	77	74	73

Recycling: Up to 30% of fused aluminum oxide may be recycled, and about 5% of silicon carbide is recycled.

Import Sources (2008–11): Fused aluminum oxide, crude: China, 81%; Venezuela, 8%; Canada, 8%; and other, 3%. Fused aluminum oxide, grain: Brazil, 28%; Germany, 22%; Austria, 19%; Italy, 7%; and other, 24%. Silicon carbide, crude: China, 68%; South Africa, 11%; Romania, 6%; Netherlands, 6%; and other, 9%. Silicon carbide, grain: China, 44%; Brazil, 23%; Norway, 7%; Russia, 6%; and other, 20%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Fused aluminum oxide, crude	2818.10.1000	Free.
White, pink, ruby artificial corundum, greater than 97.5% fused aluminum oxide, grain	2818.10.2010	1.3% ad val.
Artificial corundum, not elsewhere specified or included, fused aluminum oxide, grain	2818.10.2090	1.3% ad val.
Silicon carbide, crude	2849.20.1000	Free.
Silicon carbide, grain	2849.20.2000	0.5% ad val.

Depletion Allowance: None.

Government Stockpile: None.

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ABRASIVES (MANUFACTURED)

Events, Trends, and Issues: In 2012, China was the world's leading producer of abrasive fused aluminum oxide and abrasive silicon carbide, with production of nearly 695,000 tons and 450,000 tons, respectively, nearly at capacity. Imports and higher operating costs continued to challenge abrasives producers in the United States and Canada. Foreign competition, particularly from China, is expected to persist and further curtail production in North America. Abrasives markets are greatly influenced by activity in the manufacturing sector in the United States. During 2012, these manufacturing sectors included the aerospace, automotive, furniture, housing, and steel industries. The U.S. abrasive markets also are influenced by economic and technological trends.

World Production Capacity:

	Fused aluminum oxide		Silicon carbide	
	2011	2012	2011	2012
United States and Canada	60,400	60,400	42,600	42,600
Argentina	—	—	5,000	5,000
Australia	50,000	50,000	—	—
Austria	60,000	60,000	—	—
Brazil	50,000	50,000	43,000	43,000
China	700,000	700,000	455,000	455,000
France	40,000	40,000	16,000	16,000
Germany	80,000	80,000	36,000	36,000
India	40,000	40,000	5,000	5,000
Japan	25,000	25,000	60,000	60,000
Mexico	—	—	45,000	45,000
Norway	—	—	80,000	80,000
Venezuela	—	—	30,000	30,000
Other countries	80,000	80,000	190,000	190,000
World total (rounded)	1,190,000	1,190,000	1,010,000	1,010,000

World Resources: Although domestic resources of raw materials for the production of fused aluminum oxide are rather limited, adequate resources are available in the Western Hemisphere. Domestic resources are more than adequate for the production of silicon carbide.

Substitutes: Natural and manufactured abrasives, such as garnet, emery, or metallic abrasives, can be substituted for fused aluminum oxide and silicon carbide in various applications.

[e]Estimated. NA Not available. — Zero.
[1]Rounded to the nearest 5,000 tons to protect proprietary data.
[2]Defined as imports – exports.

ALUMINUM[1]

(Data in thousand metric tons of metal unless otherwise noted)

Domestic Production and Use: In 2012, 5 companies operated 10 primary aluminum smelters; 4 smelters were closed temporarily for the entire year. Based on published market prices, the value of primary metal production was $4.32 billion. Aluminum consumption was centered in the East Central United States. Transportation accounted for an estimated 34% of domestic consumption; the remainder was used in packaging, 26%; building, 12%; electrical, 9%; machinery, 8%; consumer durables, 7%; and other, 4%.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production:					
Primary	2,658	1,727	1,726	1,986	2,000
Secondary (from old scrap)	1,500	1,260	1,250	1,450	1,600
Imports for consumption	3,710	3,680	3,610	3,710	4,500
Exports	3,280	2,710	3,040	3,420	3,600
Consumption, apparent[2]	3,940	3,320	3,460	3,550	4,520
Price, ingot, average U.S. market (spot), cents per pound	120.5	79.4	104.4	116.1	98.0
Stocks:					
Aluminum industry, yearend	1,220	937	1,010	1,060	1,100
LME, U.S. warehouses, yearend[3]	1,290	2,200	2,230	2,360	2,300
Employment, number[4]	38,000	33,800	29,200	30,300	35,000
Net import reliance[5] as a percentage of apparent consumption	E	10	14	3	20

Recycling: In 2012, aluminum recovered from purchased scrap in the United States was about 3.4 million tons, of which about 53% came from new (manufacturing) scrap and 47% from old scrap (discarded aluminum products). Aluminum recovered from old scrap was equivalent to about 35% of apparent consumption.

Import Sources (2008–11): Canada, 62%; Russia, 7%; China, 5%; Mexico, 4%; and other, 22%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Unwrought (in coils)	7601.10.3000	2.6% ad val.
Unwrought (other than aluminum alloys)	7601.10.6000	Free.
Unwrought (billet)	7601.20.9045	Free.
Waste and scrap	7602.00.0000	Free.

Depletion Allowance: Not applicable.[1]

Government Stockpile: None.

Events, Trends, and Issues: During the first quarter of 2012, the leading U.S. aluminum producer announced that its smelter in Alcoa, TN, which had been closed temporarily in 2009, would be closed permanently. The same company also announced that two potlines at its Rockdale, TX, smelter also would be permanently closed. Failure to obtain favorable power supply contracts was cited as the reason for the permanent closures. Throughout the year, the owners of smelters in Hannibal, OH, Hawesville, KY, and Mt. Holly, SC, were negotiating power supply contracts to reduce costs. If power costs were not reduced, closures of these smelters would likely take place. During the third quarter of 2012, two potlines were closed temporarily at the Hannibal, OH, smelter. The owners of smelters in Columbia Falls, MT, and Ravenswood, WV, were negotiating power supply contracts to reopen those smelters, which had been temporarily shut down in 2009. Work on an expansion project continued at a smelter in New Madrid, MO, that would increase primary aluminum capacity to 279,000 tons per year from 263,000 tons per year by yearend 2012. An expansion of the smelter in Sebree, KY, also was expected to be completed by yearend 2012, increasing the aluminum smelting capacity to 210,000 tons per year from 196,000 tons per year. By the beginning of the fourth quarter of 2012, domestic smelters operated at about 70% of rated or engineered capacity.

Reliance upon imports of aluminum increased in 2012 as primary production remained near the level in 2011, and net imports increased to supply domestic manufacturers. Canada, Russia, and the United Arab Emirates accounted for about 72% of total U.S. imports. Total aluminum exports from the United States increased by 5% in 2012 compared

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ALUMINUM

with the amount exported in 2011, and imports of crude and semifabricated aluminum in 2012 were 21% higher than the amount imported in 2011. China, Canada, Mexico, and the Republic of Korea, in descending order, received approximately 85% of total United States exports. Scrap to China accounted for 40% of total aluminum exports.

The monthly average U.S. market price for primary ingot quoted by Platts Metals Week started the year at $1.034 per pound and reached a peak of $1.079 per pound in March. The monthly average price began a downward trend, reaching $0.939 per pound in August. The monthly average price increased to $1.033 per pound in September. Prices on the London Metal Exchange (LME) followed the trend of U.S. market prices.

World primary aluminum production increased slightly in 2012 compared with production in 2011. New capacity in China, India, and Qatar, and restarting smelters that had been shut down in 2008 and early in 2009, accounted for most of the increased production. The increased production from these smelters was partially offset by shutdowns primarily in the second half of the year as aluminum prices declined. Other factors cited for the shutdowns included currency valuations, labor disputes, power price increases, and power shortages, in Australia, Canada, the Netherlands, South Africa, the United Kingdom, the United States, and Venezuela. World inventories of metal held by producers, as reported by the International Aluminium Institute, remained in a narrow range through August at about 2.4 million tons since yearend 2011. Inventories of primary aluminum metal held by the LME worldwide increased slightly during the year to 5.1 million tons in mid-October from 5.0 million tons at yearend 2011.

World Smelter Production and Capacity:

	Production		Yearend capacity	
	2011	2012[e]	2011	2012[e]
United States	1,986	2,000	3,160	2,900
Argentina	440	455	455	455
Australia	1,950	1,900	1,980	1,980
Bahrain	881	900	900	970
Brazil	1,440	1,450	1,700	1,700
Canada	2,980	2,700	3,020	3,020
China	18,100	19,000	25,000	25,000
Germany	433	405	620	620
Iceland	800	800	800	800
India	1,670	1,700	2,310	3,150
Mozambique	562	550	570	570
Norway	1,070	1,000	1,230	1,230
Qatar	390	585	585	585
Russia	3,990	4,200	4,450	4,450
South Africa	809	600	900	900
United Arab Emirates	1,800	1,850	1,800	1,850
Other countries	5,100	4,760	6,540	6,250
World total (rounded)	44,400	44,900	56,000	56,400

World Resources: Domestic aluminum requirements cannot be met by domestic bauxite resources. Domestic nonbauxitic aluminum resources are abundant and could meet domestic aluminum demand. A process for recovering alumina from clay was being tested in Canada to prove if it would be economically competitive with the processes now used for recovering alumina from bauxite. Processes for using other aluminum-bearing resources have not been proven to be economically competitive with those now used for bauxite. The world reserves for bauxite are sufficient to meet world demand for metal well into the future.

Substitutes: Composites can substitute for aluminum in aircraft fuselages and wings. Glass, paper, plastics, and steel can substitute for aluminum in packaging. Magnesium, steel, and titanium can substitute for aluminum in ground transportation and structural uses. Composites, steel, vinyl, and wood can substitute for aluminum in construction. Copper can replace aluminum in electrical applications.

[e]Estimated. E Net exporter.
[1]See also Bauxite and Alumina.
[2]Domestic primary metal production + recovery from old aluminum scrap + net import reliance; excludes imported scrap.
[3]Includes aluminum alloy.
[4]Alumina and aluminum production workers (North American Industry Classification System—3313). Source: U.S. Department of Labor, Bureau of Labor Statistics.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.

ANTIMONY

(Data in metric tons of antimony content unless otherwise noted)

Domestic Production and Use: There was no antimony mine production in the United States in 2012. Primary antimony metal and oxide was produced by one company in Montana, using foreign feedstock. The estimated distribution of antimony uses was as follows: flame retardants, 35%; transportation, including batteries, 29%; chemicals, 16%; ceramics and glass, 12%; and other, 8%.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production:					
Mine (recoverable antimony)	—	—	—	—	—
Smelter:					
Primary	W	W	W	W	W
Secondary	3,180	3,020	3,520	3,230	3,100
Imports for consumption	29,000	20,200	26,200	23,500	24,000
Exports of metal, alloys, oxide, and waste and scrap[1]	2,200	2,100	2,550	4,170	3,900
Consumption, apparent[2]	30,400	21,200	27,000	22,700	23,100
Price, metal, average, cents per pound[3]	280	236	401	650	602
Stocks, yearend	1,490	1,420	1,560	1,430	1,520
Employment, plant, number[e]	10	15	15	20	20
Net import reliance[4] as a percentage of apparent consumption	90	86	87	86	87

Recycling: Traditionally, the bulk of secondary antimony has been recovered as antimonial lead, most of which was generated by and then consumed by the battery industry. Changing trends in that industry in recent years, however, have generally reduced the amount of secondary antimony produced; the trend to low-maintenance batteries has tilted the balance of consumption away from antimony and toward calcium as an additive.

Import Sources (2008–11): Metal: China, 74%; Mexico, 12%; Peru, 3%; and other, 11%. Ore and concentrate: Italy, 45%; Bolivia, 26%; China, 23%; and other, 6%. Oxide: China, 63%; Mexico, 15%; Belgium, 9%; Bolivia, 9%; and other, 4%. Total: China, 67%; Mexico, 15%; Belgium, 7%; Bolivia, 4%; and other, 7%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12–31–12**
Ore and concentrates	2617.10.0000	Free.
Antimony oxide	2825.80.0000	Free.
Antimony and articles thereof,		
Unwrought antimony; powder	8110.10.0000	Free.
Waste and scrap	8110.20.0000	Free.
Other	8110.90.0000	Free.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: None.

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ANTIMONY

Events, Trends, and Issues: In 2012, antimony production from domestic source materials was derived mostly from recycling lead-acid batteries. Recycling supplied only a minor portion of estimated domestic consumption, and the remainder came from imports. Only one domestic smelter in Montana continued to make antimony products. The company that operated the domestic smelter progressed further with the development of its Mexican operations. Its 150-ton Puerto Blanca mill and Madero smelter were being supplied by more than seven Mexican antimony mines. Four furnaces were operating at the Mexican smelter, and three of them were being retrofitted for increased production. They were designed to handle low-grade antimony oxide ore, which predominates in Mexico. The Mexican combination flotation and gravity mill was delivering concentrates to the smelter. The mill recovered the sulfides and some of the oxides not recoverable by flotation methods. A large precrusher was being installed to handle oversize rock from the Los Juarez property.

In China, the world's leading antimony producer, the Government continued to shut down antimony mines and smelters in an effort to control environmental issues and resolve safety problems. The price of antimony remained in a fairly narrow band during 2012. The price started the year at about $5.70 per pound, rose to $6.30 per pound by early July, and finished September at about $5.80 per pound. Prices continued to be influenced by production constrictions in China, combined with moderate world consumption increases.

Several new antimony mine projects were being evaluated and developed in Armenia, Australia, Canada, China, Georgia, Italy, Laos, Russia, and Turkey.

World Mine Production and Reserves: The reserves figure for South Africa was changed based on new information from official Government sources in that country.

	Mine production		Reserves[5]
	2011	2012[e]	
United States	—	—	—
Bolivia	3,900	4,000	310,000
China	150,000	150,000	950,000
Russia (recoverable)	3,300	3,300	350,000
South Africa	4,700	5,000	27,000
Tajikistan	2,000	2,000	50,000
Other countries	14,100	13,100	150,000
World total (rounded)	178,000	180,000	1,800,000

World Resources: U.S. resources of antimony are mainly in Alaska, Idaho, Montana, and Nevada. Principal identified world resources are in Bolivia, China, Russia, and South Africa. Additional antimony resources may occur in Mississippi Valley-type lead deposits in the Eastern United States.

Substitutes: Compounds of chromium, tin, titanium, zinc, and zirconium substitute for antimony chemicals in paint, pigments, and enamels. Combinations of cadmium, calcium, copper, selenium, strontium, sulfur, and tin can be used as substitutes for hardening lead. Selected organic compounds and hydrated aluminum oxide are widely accepted substitutes as flame retardants.

[e]Estimated. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Gross weight, for metal, alloys, waste, and scrap.
[2]Domestic mine production + secondary production from old scrap + net import reliance.
[3]New York dealer price for 99.5% to 99.6% metal, c.i.f. U.S. ports.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]See Appendix C for resource/reserve definitions and information concerning data sources.

ARSENIC

(Data in metric tons of arsenic unless otherwise noted)

Domestic Production and Use: Arsenic trioxide and primary arsenic metal have not been produced in the United States since 1985. However, limited quantities of arsenic metal have been recovered from gallium-arsenide (GaAs) semiconductor scrap. The principal use for arsenic trioxide was for the production of arsenic acid used in the formulation of chromated copper arsenide (CCA) preservatives for the pressure treating of lumber used primarily in nonresidential applications. Three companies produced CCA preservatives in the United States. Ammunition used by the United States military was hardened by the addition of less than 1% arsenic metal, and the grids in lead-acid storage batteries were strengthened by the addition of arsenic metal. Arsenic metal was also used as an antifriction additive for bearings, to harden lead shot, and in clip-on wheel weights. Arsenic compounds were used in fertilizers, fireworks, herbicides, and insecticides. High-purity arsenic (99.9999%) was used by the electronics industry for GaAs semiconductors that are used for solar cells, space research, and telecommunication. Arsenic was also used for germanium-arsenide-selenide specialty optical materials. Indium-gallium-arsenide was used for short-wave infrared technology. The value of arsenic compounds and metal consumed domestically in 2012 was estimated to be about $6 million.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Imports for consumption:					
Metal	376	438	769	628	950
Trioxide	4,810	4,660	4,530	4,990	5,950
Exports, metal	1,050	354	481	705	220
Estimated consumption[1]	4,130	4,740	4,820	4,910	6,680
Value, cents per pound, average:[2]					
Metal (China)	125	121	72	74	77
Trioxide (Morocco)	19	20	20	22	22
Net import reliance[3] as a percentage of estimated consumption	100	100	100	100	100

Recycling: Arsenic metal was recycled from GaAs semiconductor manufacturing, and arsenic contained in the process water at wood treatment plants where CCA was used was also recycled. Electronic circuit boards, relays, and switches may contain arsenic, though no arsenic was recovered from them during recycling to recover other contained metals. There was no domestic recovery of arsenic from arsenic-containing residues and dusts generated at nonferrous smelters in the United States.

Import Sources (2008–11): Metal: China, 86%; Japan, 13%; and other, 1%. Arsenic trioxide: Morocco, 70%; China, 18%; and Belgium, 12%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–12**
Metal	2804.80.0000	Free.
Acid	2811.19.1000	2.3% ad val.
Trioxide	2811.29.1000	Free.
Sulfide	2813.90.1000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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ARSENIC

Events, Trends, and Issues: Human health and environmental concerns led to a voluntary ban on the use of CCA wood preservatives in most residential applications at yearend 2003. However, because of known performance and lower cost, CCA was still allowed in treated wood for use in nonresidential applications. Owing to the residential ban, however, imports of arsenic trioxide declined to an average of 6,800 tons per year gross weight during 2007 to 2011, from an average of almost 28,000 tons per year during 1999 to 2003.

Arsenic metal exports from 2005 to 2008 were at extraordinary high levels. It is likely that much of the material reported as arsenic was arsenic compounds, including arsenic acid and CCA that became available for export following the phase-out of the residential use of CCA preserved wood. Other materials that were reported under this category included arsenical lead and residues containing arsenic, which continue to be reported under this category. As the United States does not produce arsenic metal, it is likely that only a small portion of material exported under this category was pure arsenic metal.

In 2008, the U.S. Environmental Protection Agency (EPA) issued a reregistration eligibility decision (RED) in which it determined that CCA wood preservatives were eligible for reregistration as a pesticide for use in treating lumber for certain outdoor applications, exclusive of those for use in most residential settings. The RED included labeling guidelines and detailed worker and environmental protection guidelines for wood-preserving plants using CCA. By December 31, 2013, all wood-preserving plants using CCA were to be upgraded to fully meet RED requirements.

In 2012, market conditions continued to improve for GaAs-based products. GaAs demand, while still driven mainly by cellular handsets and other high-speed wireless applications, increased owing to rapid growth of feature-rich, application-intensive, third- and fourth-generation “smartphones.” See the section on gallium for details.

World Production and Reserves:

	Production (arsenic trioxide) 2011	Production (arsenic trioxide) 2012[e]	Reserves[4]
United States	—	—	
Belgium	1,000	1,000	
Chile	10,000	10,000	World reserves are thought to be about 20 times annual world production.
China	25,000	25,000	
Morocco	8,000	6,000	
Russia	1,500	1,500	
Other countries[5]	300	300	
World total (rounded)	45,800	44,000	

World Resources: Arsenic may be obtained from copper, gold, and lead smelter flue dust as well as from roasting arsenopyrite, the most abundant ore mineral of arsenic. Arsenic has been recovered from realgar and orpiment in China, Peru, and the Philippines; from copper-gold ores in Chile; and was associated with gold occurrences in Canada. Orpiment and realgar from gold mines in Sichuan Province, China, were stockpiled for later recovery of arsenic. Arsenic also may be recovered from enargite, a copper mineral. Global resources of copper and lead contain approximately 11 million tons of arsenic.

Substitutes: Substitutes for CCA in wood treatment include alkaline copper quaternary, ammoniacal copper quaternary, ammoniacal copper zinc arsenate, copper azole, and copper citrate. Treated wood substitutes include concrete, steel, plasticized wood scrap, or plastic composite material.

[e]Estimated. — Zero.
[1]Estimated to be the same as net imports.
[2]Calculated from U.S. Census Bureau import data.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix C for resource/reserve definitions and information concerning data sources.
[5]In addition to Bolivia, Iran, Japan, and Portugal, which are included in “other countries,” Mexico and Peru have reported arsenic trioxide production in recent years, but information is inadequate to make estimates for production in current years, if any.

ASBESTOS

(Data in metric tons unless otherwise noted)

Domestic Production and Use: Asbestos has not been mined in the United States since 2002. The United States is dependent on imports to meet manufacturing needs. Asbestos consumption in the United States was estimated to be 1,060 tons, based on asbestos imports through July 2012. The chloralkali industry accounted for an estimated 57% of U.S. consumption; roofing products, about 41%; and unknown applications, 2%.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production (sales), mine	—	—	—	—	—
Imports for consumption	1,460	869	1,040	1,180	1,060
Exports[1]	368	59	171	169	55
Consumption, estimated	1,460	869	1,040	1,180	1,060
Price, average value, dollars per ton[2]	746	787	786	931	1,790
Net import reliance[3] as a percentage of estimated consumption	100	100	100	100	100

Recycling: None.

Import Sources (2008–11): Canada, 87%; Zimbabwe, 5%; and other, 8%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Crocidolite	2524.10.0000	Free.
Amosite	2524.90.0010	Free.
Chrysotile:		
Crudes	2524.90.0030	Free.
Milled fibers, group 3 grades	2524.90.0040	Free.
Milled fibers, group 4 and 5 grades	2524.90.0045	Free.
Other, chrysotile	2524.90.0055	Free.
Other	2524.90.0060	Free.

Depletion Allowance: 22% (Domestic), 10% (Foreign).

Government Stockpile: None.

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ASBESTOS

Events, Trends, and Issues: U.S. imports and consumption of asbestos declined 10% in 2012. All asbestos imported and used in the United States was chrysotile, solely sourced from Brazil. This is the first year in more than 100 years that chrysotile was not imported from Canada. There was no chrysotile produced in Canada in 2012 so domestic consumers sought other sources for their supply. The increase in the average value of all imported chrysotile was because only high-valued chrysotile was imported from Brazil; there were no imports of lower valued chrysotile from other countries in 2012. Based on current trends, U.S. asbestos consumption is likely to remain near the 1,000-ton level, as it has in the past 4 years.

World Mine Production and Reserves:

	Mine production		Reserves[4]
	2011	2012[e]	
United States	—	—	Small
Brazil	302,000	300,000	Moderate
Canada	50,000	—	Large
China	440,000	440,000	Large
Kazakhstan	223,000	240,000	Large
Russia	1,000,000	1,000,000	Large
Other countries	19,000	20,000	Moderate
World total (rounded)	2,030,000	2,000,000	Large

World Resources: The world has 200 million tons of identified resources of asbestos. U.S. resources are large but are composed mostly of short-fiber asbestos, for which use is more limited than long-fiber asbestos in asbestos-based products.

Substitutes: Numerous materials substitute for asbestos in products. Substitutes include calcium silicate, carbon fiber, cellulose fiber, ceramic fiber, glass fiber, steel fiber, wollastonite, and several organic fibers, such as aramid, polyethylene, polypropylene, and polytetrafluoroethylene. Several nonfibrous minerals or rocks, such as perlite, serpentine, silica, and talc, are considered to be possible asbestos substitutes for products in which the reinforcement properties of fibers were not required.

[e]Estimated. — Zero.
[1]Probably includes nonasbestos materials and reexports.
[2]Average Customs value for U.S. chrysotile imports, all grades combined. Prices for individual commercial products are no longer published.
[3]Defined as imports – exports.
[4]See Appendix C for resource/reserve definitions and information concerning data sources.

BARITE

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Domestic producers of crude barite sold or used for grinding an estimated 654,000 tons in 2012 valued at about $58 million, a decrease in production of about 8% compared with that of 2011. Most of the production came from four major mines in Nevada followed by a significantly smaller sales volume from a single mine in Georgia. In 2012, an estimated 3.5 million tons of barite (from domestic production and imports) was sold by crushers and grinders operating in nine States. Nearly 95% of the barite sold in the United States was used as a weighting agent in gas- and oil-well drilling fluids. The majority of Nevada crude barite was ground in Nevada and Wyoming and then sold primarily to gas-drilling customers in Colorado, New Mexico, North Dakota, Utah, and Wyoming. Crude barite was shipped to a Canadian grinding mill in Lethbridge, Alberta, which supplies the western Canada drilling mud market. The barite imports to Louisiana and Texas ports mostly went to offshore drilling operations in the Gulf of Mexico and to onshore operations in Louisiana, Oklahoma, and Texas.

Barite is also used as a filler, extender, or weighting agent in products such as paints, plastics, and rubber. Some specific applications include its use in automobile brake and clutch pads and automobile paint primer for metal protection and gloss, and to add weight to rubber mudflaps on trucks and to the cement jacket around underwater petroleum pipelines. In the metal-casting industry, barite is part of the mold-release compounds. Because barite significantly blocks x-ray and gamma-ray emissions, it is used as aggregate in high-density concrete for radiation shielding around x-ray units in hospitals, nuclear powerplants, and university nuclear research facilities. Ultrapure barite consumed as liquid is used as a contrast medium in medical x-ray examinations.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Sold or used, mine	648	396	662	710	654
Imports for consumption	2,620	1,430	2,110	2,320	2,810
Exports	62	49	109	98	150
Consumption, apparent[1] (crude and ground)	3,210	1,780	2,660	2,930	3,310
Consumption[2] (ground and crushed)	2,840	2,410	2,570	2,910	3,470
Estimated price, average value, dollars per ton, f.o.b. mine	73	80	77	86	89
Employment, mine and mill, number[e]	350	330	350	350	350
Net import reliance[3] as a percentage of apparent consumption	80	78	75	76	80

Recycling: None.

Import Sources (2008–11): China, 92%; India, 4%; Morocco, 2%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Crude barite	2511.10.5000	$1.25 per metric ton.
Ground barite	2511.10.1000	Free.
Oxide, hydroxide, and peroxide	2816.40.2000	2% ad val.
Other chlorides	2827.39.4500	4.2% ad val.
Other sulfates of barium	2833.27.0000	0.6% ad val.
Carbonate	2836.60.0000	2.3% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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BARITE

Events, Trends, and Issues: During 2012, the number of drill rigs operating in the United States decreased, mainly as a result of low natural gas prices. At the beginning of 2012, there were 2,007 rigs operating offshore and onshore in the United States, but by early November, the number had decreased to 1,800. Because oil and gas drilling is the dominant use of barite in the United States, the count of operating drill rigs is a good barometer of barite consumption or if the industry is stockpiling. Based on the decreased rig count and the estimated increase in barite imports, it is likely that the barite industry is stockpiling in order to provide adequate supplies when demand increases and as a hedge against rising barite prices.

With the worldwide oil and gas drilling boom, the demand for barite is strong. China and India hold a controlling position in barite supply and have increased prices substantially in recent years. As a result, there is an increased effort to discover and develop new barite resources. While China and India will continue to be the dominant barite producers and exporters, mine projects in various stages of development are ongoing in Kazakhstan, Liberia, Mexico, and Zimbabwe.

Barite prices increased in 2012 compared with those at yearend 2011. The October published price range for Chinese unground barite, free on board (f.o.b.) China, was in the range of $146 to $158 per ton, an increase of about $22 per ton. The price range for Indian unground barite, f.o.b. Chennai, was in the range of $160 to $170 per ton, an increase of about $21 per ton. The price range for Moroccan unground barite, f.o.b. Morocco, was in the range of $140 to $152 per ton, an increase of about $35 per ton.

World Mine Production and Reserves:

	Mine production		Reserves[4]
	2011	2012[e]	
United States	710	654	15,000
Algeria	40	60	29,000
China	4,100	4,000	100,000
Germany	70	70	1,000
India	1,350	1,400	32,000
Iran	350	350	NA
Kazakhstan	[5]200	200	NA
Mexico	157	160	7,000
Morocco	600	650	10,000
Pakistan	58	60	1,000
Peru	87	90	NA
Russia	62	60	12,000
Turkey	230	250	4,000
United Kingdom	50	50	100
Vietnam	85	85	NA
Other countries	220	220	24,000
World total (rounded)	8,370	8,400	240,000

World Resources: In the United States, identified resources of barite are estimated to be 150 million tons, and undiscovered resources include an additional 150 million tons. The world's barite resources in all categories are about 2 billion tons, but only about 740 million tons is identified resources.

Substitutes: In the drilling mud market, alternatives to barite include celestite, ilmenite, iron ore, and synthetic hematite that is manufactured in Germany. None of these substitutes, however, has had a major impact on the barite drilling mud industry.

[e]Estimated. NA Not available.
[1]Sold or used by domestic mines + imports – exports.
[2]Imported and domestic barite, crushed and ground, sold or used by domestic grinding establishments.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix C for resource/reserve definitions and information concerning data sources.
[5]Estimated marketable barite; however, reported production figures may be significantly higher.

BAUXITE AND ALUMINA[1]

(Data in thousand metric dry tons unless otherwise noted)

Domestic Production and Use: Nearly all bauxite consumed in the United States was imported; of the total, more than 95% was converted to alumina. Of the total alumina used, more than 90% went to primary aluminum smelters and the remainder went to nonmetallurgical uses. Annual alumina production capacity was 5.64 million tons, with four Bayer refineries operating throughout the year. Domestic bauxite was used in the production of nonmetallurgical products, such as abrasives, chemicals, and refractories.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production, bauxite, mine	NA	NA	NA	NA	NA
Imports of bauxite for consumption[2]	12,400	7,770	9,320	10,700	11,100
Imports of alumina[3]	2,530	1,860	1,790	2,280	1,850
Exports of bauxite[2]	31	45	54	75	52
Exports of alumina[3]	1,150	946	1,520	1,620	1,660
Consumption, apparent, bauxite and alumina (in aluminum equivalents)[4]	3,450	2,360	2,320	2,750	2,620
Price, bauxite, average value U.S. imports (f.a.s.) dollars per ton	26	30	29	39	36
Stocks, bauxite, industry, yearend[2]	W	1,780	1,450	1,500	1,500
Net import reliance,[5] bauxite and alumina, as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2008–11):[6] Bauxite: Jamaica, 43%; Guinea, 22%; Brazil, 19%; Guyana, 6%; and other, 10%. Alumina: Australia, 34%; Suriname, 22%; Brazil, 17%; Jamaica, 14%; and other, 13%. Total: Jamaica, 34%; Brazil, 20%; Guinea, 19%; Australia, 13%; and other, 14%.

Tariff: Import duties on bauxite and alumina were abolished in 1971 by Public Law 92–151. Duties can be levied only on such imports from nations with nonnormal trade relations. However, all countries that supplied commercial quantities of bauxite or alumina to the United States during the first 9 months of 2012 had normal-trade-relations status.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: None

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BAUXITE AND ALUMINA

Events, Trends, and Issues: The average monthly price (free alongside ship) for U.S. imports of metallurgical-grade alumina began the year at $383 per ton, and in July the price was $374 per ton. During the first 7 months of the year, the price ranged between $356 per ton to $463 per ton.

Based on production data from the International Aluminium Institute, world alumina production during 2012 increased by 5% compared with that in 2011. Bauxite production increased slightly in 2012 compared with production in 2011. Increases in bauxite production from expanded, new, and reopened mines in Australia, Brazil, China, Guinea, and India were mostly offset by declines in production from mines in Indonesia, which enacted strict mine export tariffs during 2012.

World Bauxite Mine Production and Reserves: Production and reserve estimates for Brazil and Indonesia have been revised or added based on new information available through Government reports and other sources.

	Mine production		Reserves[7]
	2011	2012[e]	
United States	NA	NA	20,000
Australia	70,000	73,000	6,000,000
Brazil	31,800	34,000	2,600,000
China	45,000	48,000	830,000
Greece	2,100	2,000	600,000
Guinea	17,600	19,000	7,400,000
Guyana	1,820	1,850	850,000
India	19,000	20,000	900,000
Indonesia	37,100	30,000	1,000,000
Jamaica	10,200	10,300	2,000,000
Kazakhstan	5,500	5,300	160,000
Russia	5,890	6,100	200,000
Sierra Leone	1,460	1,200	180,000
Suriname	4,000	4,200	580,000
Venezuela	4,500	4,500	320,000
Vietnam	600	300	2,100,000
Other countries	2,850	3,100	2,100,000
World total (rounded)	259,000	263,000	28,000,000

World Resources: Bauxite resources are estimated to be 55 to 75 billion tons, in Africa (32%), Oceania (23%), South America and the Caribbean (21%), Asia (18%), and elsewhere (6%). Domestic resources of bauxite are inadequate to meet long-term U.S. demand, but the United States and most other major aluminum-producing countries have essentially inexhaustible subeconomic resources of aluminum in materials other than bauxite.

Substitutes: Bauxite is the only raw material used in the production of alumina on a commercial scale in the United States. However, the vast U.S. resources of clay are technically feasible sources of alumina. Other domestic raw materials, such as alunite, anorthosite, coal wastes, and oil shales, offer additional potential alumina sources. Although it would require new plants using different technology, alumina from these nonbauxitic materials could satisfy the demand for primary metal, refractories, aluminum chemicals, and abrasives. A process for recovering alumina from clay was being tested in Canada to prove if it would be economically competitive with the processes now used for recovering alumina from bauxite. Processes for using other aluminum-bearing resources have not been proven to be economically competitive with those now used for bauxite. Synthetic mullite, produced from kyanite and sillimanite, substitutes for bauxite-based refractories. Although more costly, silicon carbide and alumina-zirconia can substitute for bauxite-based abrasives.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]See also Aluminum. As a general rule, 4 tons of dried bauxite is required to produce 2 tons of alumina, which, in turn, provides 1 ton of primary aluminum metal.
[2]Includes all forms of bauxite, expressed as dry equivalent weights.
[3]Calcined equivalent weights.
[4]The sum of U.S. bauxite production and net import reliance.
[5]Defined as imports – exports + adjustments for Government and industry stock changes (all in aluminum equivalents). Treated as separate commodities, the U.S. net import reliance as a percentage of apparent consumption equaled 100% for bauxite in 2008–11. For 2008–11, the U.S. net import reliance as a percentage of apparent consumption ranged from 4% to 35% for alumina.
[6]Based on aluminum equivalents.
[7]See Appendix C for resource/reserve definitions and information concerning data sources.

BERYLLIUM

(Data in metric tons of beryllium content unless otherwise noted)

Domestic Production and Use: One company in Utah mined bertrandite ore, which it converted, along with imported beryl, into beryllium hydroxide. Some of the beryllium hydroxide was shipped to the company's plant in Ohio, where it was converted into beryllium-copper master alloy, metal, and (or) oxide—some of which was sold. Estimated beryllium consumption of 220 tons was valued at about $103 million, based on the estimated unit value for beryllium in imported beryllium-copper master alloy. Based on sales revenues, 42% of beryllium use was estimated to be in consumer electronics and telecommunications products, 11% was estimated to be in defense-related applications, 11% was estimated to be in industrial components and commercial aerospace applications, 8% was estimated to be in energy applications, and the remainder was used in appliances, automotive electronics, medical devices, and other applications.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production, mine shipments[e]	175	120	180	235	200
Imports for consumption[1]	70	24	271	92	106
Exports[2]	112	23	39	21	63
Government stockpile releases[3]	47	19	29	22	([4])
Consumption:					
Apparent[5]	218	170	456	333	220
Reported, ore	220	150	200	250	190
Unit value, annual average, beryllium-copper master alloy, dollars per pound contained beryllium[6]	159	154	228	203	209
Stocks, ore, consumer, yearend	60	30	15	10	30
Net import reliance[7] as a percentage of apparent consumption	20	29	61	29	10

Recycling: Beryllium was recycled from new scrap generated during the manufacture of beryllium products, as well as old scrap. Detailed data on the quantities of beryllium recycled are not available but may represent as much as 30% of apparent consumption.

Import Sources (2008–11):[1] Russia, 44%; Kazakhstan, 26%; Japan, 6%; Kenya, 5%; and other, 19%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Beryllium ores and concentrates	2617.90.0030	Free.
Beryllium oxide and hydroxide	2825.90.1000	3.7% ad val.
Beryllium-copper master alloy	7405.00.6030	Free.
Beryllium:		
Unwrought, including powders	8112.12.0000	8.5% ad val.
Waste and scrap	8112.13.0000	Free.
Other	8112.19.0000	5.5% ad val.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: The Defense Logistics Agency, U.S. Department of Defense, had a goal of retaining 45 tons of hot-pressed beryllium powder in the National Defense Stockpile. Disposal limits for beryllium materials in the fiscal year 2013 Annual Materials Plan are as follows: beryllium metal, 54 tons of contained beryllium.

Stockpile Status—9–30–12[8]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2012	Disposals FY 2012
Beryllium metal:				
Hot-pressed powder	83	38	—	3
Vacuum-cast	6	6	54	8

Events, Trends, and Issues: Market conditions weakened for beryllium-based products in 2012. During the first half of 2012, the leading U.S. beryllium producer reported volume shipments of strip and bulk beryllium-copper alloy products to be 29% and slightly lower, respectively, than those during the first half of 2011. Sales of beryllium

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products for key markets, including automotive electronics, consumer electronics, defense and science, industrial x-ray products, medical equipment, and telecommunications infrastructure were lower than those during the first half of 2011. Sales of beryllium hydroxide and beryllium products for commercial aerospace and industrial components, however, were higher than those during the first half of 2011.

In an effort to ensure current and future availability of high-quality domestic beryllium to meet critical defense needs, the U.S. Department of Defense in 2005, under the Defense Production Act, Title III, invested in a public-private partnership with the leading U.S. beryllium producer to build a new $90.4 million primary beryllium facility in Ohio. Construction of the facility was completed in 2011. The startup activities of the new facility continued throughout 2012, and the facility produced a small, nonproduction-level quantity of pure beryllium metal. Approximately two-thirds of the facility's output was to be allocated for defense and Government-related end uses, the remaining output going to the private sector. Plant capacity was reported to be 73 tons per year of high-purity beryllium metal. Primary beryllium facilities, the last of which closed in the United States in 2000, traditionally produced the feedstock used to make beryllium metal products.

Owing to several large shipments of beryllium metal imported from Russia in 2010, total beryllium imports in that year were more than 10 times higher than those of 2009, and 4 times higher than those of 2008. Although imported from Russia, the beryllium metal was most likely sourced from Kazakhstan, as beryllium purchase contracts were established in 2010 between companies in the United States and Kazakhstan.

Because of the toxic nature of beryllium, various international, national, and State guidelines and regulations have been established regarding beryllium in air, water, and other media. Industry is required to carefully control the quantity of beryllium dust, fumes, and mists in the workplace, which adds to the final cost of beryllium products.

World Mine Production and Reserves:

	Mine production[e]	
	2011	2012
United States	235	200
China[10]	22	25
Mozambique	2	2
Other countries	1	1
World total (rounded)	260	230

Reserves[9]

The United States has very little beryl that can be economically handsorted from pegmatite deposits. The Spor Mountain area in Utah, an epithermal deposit, contains a large bertrandite resource, which was being mined. Proven bertrandite reserves in Utah total about 15,200 tons of contained beryllium. World beryllium reserves are not sufficiently well delineated to report consistent figures for all countries.

World Resources: World identified resources of beryllium have been estimated to be more than 80,000 tons. About 65% of these resources is in nonpegmatite deposits in the United States—the Gold Hill and Spor Mountain areas in Utah and the Seward Peninsula area in Alaska account for most of the total.

Substitutes: Because the cost of beryllium is high compared with that of other materials, it is used in applications in which its properties are crucial. In some applications, certain metal matrix or organic composites, high-strength grades of aluminum, pyrolytic graphite, silicon carbide, steel, or titanium may be substituted for beryllium metal or beryllium composites. Copper alloys containing nickel and silicon, tin, titanium, or other alloying elements or phosphor bronze alloys (copper-tin-phosphorus) may be substituted for beryllium-copper alloys, but these substitutions can result in substantially reduced performance. Aluminum nitride or boron nitride may be substituted for beryllium oxide.

[e]Estimated.
[1]Includes estimated beryllium content of imported ores and concentrates, oxide and hydroxide, unwrought metal (including powders), beryllium articles, waste and scrap, and beryllium-copper master alloy.
[2]Includes estimated beryllium content of exported unwrought metal (including powders), beryllium articles, and waste and scrap.
[3]Change in total inventory level from prior yearend inventory.
[4]Less than ½ unit.
[5]The sum of U.S. mine shipments and net import reliance.
[6]Calculated from gross weight and customs value of imports; beryllium content estimated to be 4%.
[7]Defined as imports – exports + adjustments for Government and industry stock changes.
[8]See Appendix B for definitions.
[9]See Appendix C for resource/reserve definitions and information concerning data sources.
[10]Official sources for China's beryllium production in 2011 and 2012 reported lower figures than industry sources, which estimated that China produced more than 60 metric tons of contained beryllium for each year.

BISMUTH

(Data in metric tons of bismuth content unless otherwise noted)

Domestic Production and Use: The United States ceased production of primary refined bismuth in 1997 and is thus highly import dependent for its supply. A small amount of bismuth is recycled by some domestic firms. Bismuth is contained in some lead ores mined domestically, but the bismuth-containing residues are not processed domestically and may be exported. The value of reported consumption of bismuth was approximately $19 million.

The Safe Drinking Water Act Amendment of 1996 required that all new and repaired fixtures and pipes for potable water supply be lead free after August 1998. As a result, a wider market was opened for bismuth as a metallurgical additive to lead-free pipes. Bismuth use in water meters and fixtures is one particular application that has increased in recent years. An application with major growth potential is the use of zinc-bismuth alloys to achieve thinner and more uniform galvanization. Another promising new application is the use of a bismuth-tellurium oxide alloy in a film paste for use in the manufacture of semiconductor devices. Bismuth was also used domestically in the manufacture of ceramic glazes, crystal ware, and pigments; as an additive to free-machining steels; and as an additive to malleable iron castings.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production:					
Refinery	—	—	—	—	—
Secondary (old scrap)	100	60	80	80	80
Imports for consumption, metal	1,930	1,250	1,620	1,750	1,830
Exports, metal, alloys, and scrap	375	397	1,040	1,030	900
Consumption:					
Reported	1,080	820	884	715	840
Apparent	1,560	1,010	660	796	998
Price, average, domestic dealer, dollars per pound	12.73	7.84	8.76	11.47	10.17
Stocks, yearend, consumer	228	134	134	138	150
Net import reliance[1] as a percentage of apparent consumption	94	94	88	90	92

Recycling: All types of bismuth-containing new and old alloy scrap were recycled and contributed about 10% of U.S. bismuth consumption, or 80 tons.

Import Sources (2008–11): China, 52%; Belgium, 36%; United Kingdom, 5%; and other, 7%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12–31–12**
Bismuth and articles thereof, including waste and scrap	8106.00.0000	Free.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: None.

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BISMUTH

Events, Trends, and Issues: Owing to its unique properties, bismuth has a wide variety of applications, including use in free-machining steels, brass, pigments, and solders, as a nontoxic replacement for lead; in pharmaceuticals, including bismuth subsalicylate, the active ingredient in over-the-counter stomach remedies; in the foundry industry, as an additive to enhance metallurgical quality; in the construction field, as a triggering mechanism for fire sprinklers; and in holding devices for grinding optical lenses. Researchers in the European Union, Japan, and the United States are investigating the possibilities of using bismuth in lead-free solders. Researchers also are examining liquid lead-bismuth coolants for use in nuclear reactors. Work is proceeding toward developing a bismuth-containing metal-polymer bullet.

A strike, which lasted most of the past 3 years, at Peru's only bismuth producer eliminated Peru's bismuth output.

The price of bismuth started 2012 at $11.75 per pound and decreased slightly throughout the year, ending October at $9.25 per pound. The estimated average price of bismuth in 2012 was about 11% below that in 2011. Industry analysts attributed the lower price to decreased world demand.

World Mine Production and Reserves:

	Mine production		Reserves[2]
	2011	2012[e]	
United States	—	—	—
Bolivia	100	100	10,000
Canada	92	100	5,000
China	7,000	6,000	240,000
Mexico	980	1,000	10,000
Other countries	130	200	50,000
World total (rounded)	8,300	7,400	320,000

World Resources: Bismuth, at an estimated 8 parts per billion by weight, ranks 69th in elemental abundance in the Earth's crust and is about twice as abundant as gold. World reserves of bismuth are usually based on bismuth content of lead resources because bismuth production is most often a byproduct of processing lead ores; in China, bismuth production is a byproduct of tungsten and other metal ore processing. Bismuth minerals rarely occur in sufficient quantities to be mined as principal products; the Tasna Mine in Bolivia and a mine in China are the only mines that produced bismuth from a bismuth ore.

Substitutes: Bismuth can be replaced in pharmaceutical applications by alumina, antibiotics, and magnesia. Titanium dioxide-coated mica flakes and fish-scale extracts are substitutes in pigment uses. Indium can replace bismuth in low-temperature solders. Resins can replace bismuth alloys for holding metal shapes during machining, and glycerine-filled glass bulbs can replace bismuth alloys in triggering devices for fire sprinklers. Free-machining alloys can contain lead, selenium, or tellurium as a replacement for bismuth.

Bismuth, on the other hand, is an environmentally friendly substitute for lead in plumbing and many other applications, including fishing weights, hunting ammunition, lubricating greases, and soldering alloys.

[e]Estimated. — Zero.
[1]Defined as imports – exports + adjustments for Government and industry stock changes.
[2]See Appendix C for resource/reserve definitions and information concerning data sources.

BORON

(Data in thousand metric tons of boric oxide (B_2O_3) unless otherwise noted)

Domestic Production and Use: Two companies in southern California produced borates in 2012, and most of the boron products consumed in the United States were manufactured domestically. To avoid disclosing company proprietary data, U.S. boron production and consumption in 2012 were withheld. The leading boron producer mined borate ores containing kernite, tincal, and ulexite by open pit methods and operated associated compound plants. The kernite was used for boric acid production and the tincal was used as a feedstock for sodium borate production. A second company produced borates from brines extracted through solution mining techniques. Boron minerals and chemicals were principally consumed in the North Central and the Eastern United States. In 2012, the glass and ceramics industries remained the leading domestic users of boron products, consuming an estimated 80% of the total borates marketplace. Boron was also used as a component in abrasives, cleaning products, insecticides, and in the production of semiconductors.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production[1]	W	W	W	W	W
Imports for consumption, gross weight:					
Borax	1	1	([2])	([2])	([2])
Boric acid	50	36	50	57	57
Colemanite	30	31	50	20	20
Ulexite	75	28	1	5	5
Exports, gross weight:					
Boric acid	303	171	264	235	190
Refined sodium borates	519	417	423	492	398
Consumption:					
Apparent	W	W	W	W	W
Reported	W	W	W	W	W
Price, average value of mineral imports at port of exportation, dollars per ton	302	339	361	361	360
Employment, number	1,310	1,220	1,180	1,180	1,190
Net import reliance[3] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (2008–11): Borates: Turkey, 50%; Argentina, 15%; Chile, 13%; Russia, 10%; and other, 12%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–12**
Natural borates:		
Sodium	2528.00.0005	Free.
Calcium	2528.00.0010	Free.
Other	2528.00.0050	Free.
Boric acids	2810.00.0000	1.5% ad val.
Borates:		
Refined borax:		
Anhydrous	2840.11.0000	0.3% ad val.
Other	2840.19.0000	0.1% ad val.
Other	2840.20.0000	3.7% ad val.
Perborates:		
Sodium	2840.30.0010	3.7% ad val.
Other	2840.30.0050	3.7% ad val.

Depletion Allowance: Borax, 14% (Domestic and foreign).

Government Stockpile: None.

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BORON

Events, Trends, and Issues: Elemental boron is a metalloid that has limited commercial applications. Although the term "boron" is commonly referenced, it does not occur in nature in an elemental state. Boron combines with oxygen and other elements to form boric acid, or inorganic salts called borates. Boron compounds, chiefly borates, are commercially important; therefore, boron products were priced and sold based on their boric oxide content (B_2O_3), varying by ore and compound and by the absence or presence of calcium and sodium. The four borates—colemanite, kernite, tincal, and ulexite—make up 90% of the borates used by industry worldwide. Although borates were used in more than 300 applications, more than three-quarters of the world's supply is sold into the following four end uses: ceramics, detergents, fertilizer, and glass.

Consumption of borates is expected to increase in 2012 and the coming years, spurred by strong demand in the Asian and South American agricultural, ceramic, and glass markets. In particular, boron consumption in the global fiberglass industry was projected to increase by 7% annually through 2013, spurred by a projected 19% increase in Chinese consumption. World consumption of borates was projected to reach 2.0 million tons of B_2O_3 by 2014, compared with 1.5 million metric tons of B_2O_3 in 2010. Demand for borates was expected to shift slightly away from detergents and soaps toward glass and ceramics.

Because China has low-grade boron reserves and demand for boron is anticipated to rise in that country, Chinese imports from Chile, Russia, Turkey, and the United States were expected to increase during the next several years. European and emerging markets were requiring more stringent building standards with respect to heat conservation. Consequently, increased consumption of borates for fiberglass insulation was expected. Continued investment in new refineries and technologies and the continued rise in demand were expected to fuel growth in world production during the next several years.

World Production and Reserves:

	Production—All forms[4] 2011	Production—All forms[4] 2012[e]	Reserves[5]
United States	W	W	40,000
Argentina	600	600	2,000
Bolivia	135	140	NA
Chile	489	500	35,000
China	100	100	32,000
Iran	1	1	1,000
Kazakhstan	30	30	NA
Peru	293	300	4,000
Russia	400	400	40,000
Turkey	2,500	2,500	60,000
World total (rounded)	[6]4,550	[6]4,600	210,000

World Resources: Deposits of borates are associated with volcanic activity and arid climates, with the largest economically viable deposits located in the Mojave Desert of the United States, the Alpide belt in southern Asia, and the Andean belt of South America. U.S. deposits consist primarily of tincal, kernite, and borates contained in brines, and to a lesser extent ulexite and colemanite. About 70% of all Turkish deposits are colemanite. Small deposits are being mined in South America. At current levels of consumption, world resources are adequate for the foreseeable future.

Substitutes: The substitution of other materials for boron is possible in detergents, enamel, insulation, and soaps. Sodium percarbonate can replace borates in detergents and requires lower temperatures to undergo hydrolysis, which is an environmental consideration. Some enamels can use other glass-producing substances, such as phosphates. Insulation substitutes include cellulose, foams, and mineral wools. In soaps, sodium and potassium salts of fatty acids can act as cleaning and emulsifying agents.

[e]Estimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Minerals and compounds sold or used by producers; includes both actual mine production and marketable products.
[2]Less than ½ unit.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]Gross weight of ore in thousand metric tons.
[5]See Appendix C for resource/reserve definitions and information concerning data sources.
[6]Excludes U.S. production.

BROMINE

(Data in metric tons of bromine content unless otherwise noted)

Domestic Production and Use: Bromine was recovered from underground brines by two companies in Arkansas. Bromine was the leading mineral commodity, in terms of value, produced in Arkansas. The two bromine companies in the United States accounted for about one-third of world production capacity.

Primary uses of bromine compounds are in flame retardants, drilling fluids, brominated pesticides (mostly methyl bromide), and water treatment. Bromine is also used in the manufacture of dyes, insect repellents, perfumes, pharmaceuticals, and photographic chemicals. Other bromine compounds are used in a variety of applications, including chemical synthesis, mercury control, and paper manufacturing.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production	W	W	W	W	W
Imports for consumption, elemental bromine and compounds[1]	41,200	36,000	45,400	47,100	61,000
Exports, elemental bromine and compounds	9,640	6,130	8,150	7,150	5,000
Consumption, apparent	W	W	W	W	W
Employment, number[e]	1,000	1,000	950	950	950
Net import reliance[2] as a percentage of apparent consumption	<25	<25	<25	<25	<50

Recycling: Some bromide solutions were recycled to obtain elemental bromine and to prevent the solutions from being disposed of as hazardous waste. Hydrogen bromide is emitted as a byproduct in many organic reactions. This byproduct waste is recycled with virgin bromine brines and is a major source of bromine production. Plastics containing bromine flame retardants can be incinerated as solid organic waste, and the bromine can be recovered. This recycled bromine is not included in the virgin bromine production reported to the U.S. Geological Survey by companies but is included in data collected by the U.S. Census Bureau.

Import Sources (2008–11): Israel, 79%; China, 12%; Germany, 5%; and other, 4%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12–31–12**
Bromine	2801.30.2000	5.5% ad val.
Hydrobromic acid	2811.19.3000	Free.
Potassium or sodium bromide	2827.51.0000	Free.
Ammonium, calcium, or zinc bromide	2827.59.2500	Free.
Other bromides and bromide oxides	2827.59.5100	3.6% ad val.
Potassium bromate	2829.90.0500	Free.
Sodium bromate	2829.90.2500	Free.
Ethylene dibromide	2903.31.0000	5.4% ad val.
Methyl bromide	2903.39.1520	Free.
Bromochloromethane	2903.79.1000	Free.
Tetrabromobisphenol A	2908.19.2500	5.5% ad val.
Decabromodiphenyl and octabromodiphenyl oxide	2909.30.0700	5.5% ad val.

Depletion Allowance: Brine wells, 5% (Domestic and foreign).

Government Stockpile: None.

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BROMINE

Events, Trends, and Issues: Although one of the leading bromine producers in the world, the United States' dominance has decreased as other countries, such as Israel, Japan, and Jordan, strengthened their positions as world producers of elemental bromine. During 2012, construction began at a project in Jordan to double capacity to 200,000 tons per year at the joint-venture bromine operation of a United States bromine company and a Jordanian company. Phase one of the project was expected to be completed by yearend. China also is a significant bromine producer; environmental restrictions to protect farmland, limits to plant expansions, and shutdowns of unlicensed bromine operations have resulted in stable production levels. Companies announced price increases, although they did not announce prices, for bromine and bromine compound in 2012, but at a slower pace than the past few years. Price increases were influenced by increases in the costs of energy, raw materials, regulatory compliance, and transportation.

An official publication from the Government of Jordan listed unexpectedly high bromine production beginning in 2010. Discrepancies between reported capacity and production estimates possibly could be the result of double counting of bromine production and derivative compounds. The discrepancies remained unexplained.

The leading use of bromine is in flame retardants; however, this use is in decline because of the environmental considerations and potential health effects related to specific bromine flame-retardant compounds. In 2010, U.S. bromine chemical producers and importers reached an agreement with the U.S. Environmental Protection Agency to voluntarily phase out the production, importation, and use of decabromodiphenyl ether (Deca-BDE), a widely used flame retardant, in all consumer products by December 2012, and in all products yearend 2013.

The use of bromine to mitigate mercury emissions at powerplants was a growth market for bromine producers. Bromine compounds bond with mercury in flue gases from coal-fired powerplants creating mercuric bromide, a substance that is more easily captured in flue-gas scrubbers than the mercuric chloride that is produced at many facilities. Wide acceptance of the new technology would likely increase demand for bromine, counteracting, at least in part, the decline expected from the ban on Deca-BDE.

World Production and Reserves:

	Production 2011	Production 2012[e]	Reserves[3]
United States	W	W	11,000,000
Azerbaijan	3,500	3,500	300,000
China	150,000	150,000	NA
Germany	1,500	1,900	NA
India	1,500	1,500	NA
Israel	202,000	200,000	NA
Japan	20,000	20,000	NA
Jordan	300,000	200,000	NA
Spain	100	100	1,400,000
Turkmenistan	150	150	700,000
Ukraine	4,100	4,100	NA
World total (rounded)	[4]680,000	[4]580,000	Large

World Resources: Bromine is found principally in seawater, evaporitic (salt) lakes, and underground brines associated with petroleum deposits. In the Middle East, the Dead Sea is estimated to contain 1 billion tons of bromine. Seawater contains about 65 parts per million of bromine, or an estimated 100 trillion tons. Bromine is also recovered from seawater as a coproduct during evaporation to produce salt.

Substitutes: Chlorine and iodine may be substituted for bromine in a few chemical reactions and for sanitation purposes. There are no comparable substitutes for bromine in various oil and gas well completion and packer applications that do not harm the permeability of the production zone and that control well "blowouts." Because plastics have a low ignition temperature, alumina, magnesium hydroxide, organic chlorine compounds, and phosphorus compounds can be substituted for bromine as fire retardants in some uses. Bromine compounds and bromine acting as a synergist are used as fire retardants in plastics, such as those found in electronics.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Imports calculated from items shown in Tariff section.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix C for resource/reserve definitions and information concerning data sources.
[4]Excludes U.S. production.

CADMIUM

(Data in metric tons of cadmium content unless otherwise noted)

Domestic Production and Use: Two companies in the United States produced the majority of refined cadmium in 2012. One company, operating in Tennessee, recovered primary cadmium as a byproduct of zinc leaching from roasted sulfide concentrates. The other company, operating in Pennsylvania, thermally recovered secondary cadmium metal from spent nickel-cadmium (NiCd) batteries and other cadmium-bearing scrap. Cadmium metal and compounds are mainly consumed for alloys, coatings, nickel-cadmium batteries, pigments, and plastic stabilizers.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production, refinery[1]	777	633	637	W	W
Imports for consumption:					
Metal only	153	117	216	201	270
Metal, alloys, scrap	197	122	221	211	260
Exports:					
Metal only	295	276	40	63	260
Metal, alloys, scrap	421	661	306	271	730
Consumption of metal, apparent	528	199	477	W	W
Price, metal, annual average,[2] dollars per kilogram	5.92	2.87	3.90	2.76	1.98
Stocks, yearend, producer and distributor	132	27	102	W	W
Net import reliance[3] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Cadmium is mainly recovered from spent consumer and industrial NiCd batteries. Other waste and scrap from which cadmium can be recovered includes copper-cadmium alloy scrap, some complex nonferrous alloy scrap, and cadmium-containing dust from electric arc furnaces (EAF). The amount of cadmium recycled was not disclosed.

Import Sources (2008–11): Metal:[4] Australia, 24%; Mexico, 19%; Canada, 17%; Germany, 12%; and other, 28%.

Tariff: Item	Number	Normal Trade Relations[5] 12–31–12
Cadmium oxide	2825.90.7500	Free.
Cadmium sulfide	2830.90.2000	3.1% ad val.
Pigments and preparations based on cadmium compounds	3206.49.6010	3.1% ad val.
Unwrought cadmium and powders	8107.20.0000	Free.
Cadmium waste and scrap	8107.30.0000	Free.
Wrought cadmium and other articles	8107.90.0000	4.4% ad val.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: None.

Events, Trends, and Issues: Global production in 2012 increased compared with that of 2011 owing to a recovery in production in Japan following the Tohoku earthquake and tsunami, which caused several cadmium-producing refineries to temporarily close in 2011. Approximately 70% of the world's primary cadmium metal was produced in Asia. Leading producers were China, the Republic of Korea, and Japan.

Cadmium consumption remained flat in 2012 when compared with that of 2011 creating a surplus of metal in the market. According to data published by the World Bureau of Metal Statistics, cadmium was primarily consumed in China (33%), Belgium (32%), and Japan (12%). Cadmium for NiCd batteries accounted for the majority of global consumption. The remainder was distributed as follows, in order of descending consumption: pigments, coatings and plating, stabilizers for plastics, nonferrous alloys, and other specialized uses (including photovoltaic devices). The percentage of cadmium consumed globally for NiCd battery production has been increasing, while the percentages for the other traditional end uses of cadmium—specifically coatings, pigments, and stabilizers—have gradually decreased owing to environmental and health concerns.

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CADMIUM

A significant use for cadmium coatings is in the aerospace industry. Fasteners in landing gear and parachutes are commonly coated with cadmium for corrosion resistance. A U.S.-based company recently developed an ultrahigh-strength stainless steel for landing gear components that would eliminate the need for cadmium plating. The company is currently undertaking the multiyear process of qualifying the steel alloy for commercial use.

In China, the Ministry of Industry and Information Technology announced that the production, sale, and use of lead-acid batteries with a cadmium content of more than 0.002% would be prohibited by 2014. Lead-acid batteries used to power electric bicycles sold in China were reported to contain some cadmium.

World Refinery Production and Reserves: Reserve data were revised, excluding those for China, Germany, and Poland, based on new company information and country reports.

	Refinery production		Reserves[6]
	2011	2012[e]	
United States	W	W	32,000
Australia	390	390	NA
Canada	1,770	1,780	23,000
China	7,000	7,000	92,000
Germany	300	300	—
India	630	620	35,000
Japan	1,760	2,130	—
Kazakhstan	1,400	1,400	30,000
Korea, Republic of	4,000	4,100	—
Mexico	1,480	1,610	47,000
Netherlands	570	540	—
Peru	572	690	55,000
Poland	450	450	16,000
Russia	700	700	44,000
Other countries	1,190	1,200	130,000
World total (rounded)	22,200	23,000	500,000

World Resources: Cadmium is generally recovered as a byproduct from zinc concentrates. Zinc-to-cadmium ratios in typical zinc ores range from 200:1 to 400:1. Sphalerite (ZnS), the most economically significant zinc mineral, commonly contains minor amounts of other elements; cadmium, which shares certain similar chemical properties with zinc, will often substitute for zinc in the sphalerite crystal lattice. The cadmium mineral greenockite (CdS) is frequently associated with weathered sphalerite and wurtzite. Zinc-bearing coals of the Central United States and Carboniferous age coals of other countries also contain large subeconomic resources of cadmium.

Substitutes: Lithium-ion and nickel-metal hydride batteries are replacing NiCd batteries in some applications. However, the higher cost of these substitutes restricts their use in less-expensive products. Except where the surface characteristics of a coating are critical (for example, fasteners for aircraft), coatings of zinc or vapor-deposited aluminum can be substituted for cadmium in many plating applications. Cerium sulfide is used as a replacement for cadmium pigments, mostly in plastics. Barium/zinc or calcium/zinc stabilizers can replace barium/cadmium stabilizers in flexible polyvinylchloride applications.

[e]Estimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Cadmium metal produced as a byproduct of lead-zinc refining plus metal from recycling.
[2]Average New York dealer price for 99.95% purity in 5-short-ton lots. Source: Platts Metals Week.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]Imports for consumption of unwrought metal and metal powders (Tariff no. 8107.20.0000).
[5]No tariff for Australia, Canada, Mexico, and Peru for items shown.
[6]See Appendix C for resource/reserve definitions and information concerning data sources.

CEMENT

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: About 71 million tons of portland cement and 2.0 million tons of masonry cement were produced in 2012; the output was from 98 plants in 35 States. Cement also was produced at two plants in Puerto Rico. Production continued to be very low compared with levels in 2002–07, which exceeded 90 million tons per year, and reflected recent plant idlings and closures and idlings of spare kilns at active plants. Although somewhat higher than levels in 2009–11, sales volumes in 2012 were still nearly 51 million tons less than the record level in 2005. The overall value of sales was about $7.5 billion. Most of the cement was used to make concrete, worth at least $41 billion. About 70% of cement sales went to ready-mixed concrete producers, 11% to concrete product manufacturers, 9% to contractors (mainly road paving), 4% to oil and gas well drillers, and 3% each to building materials dealers and other users. Texas, Missouri, California, Michigan, and Florida were, in descending order, the five leading cement-producing States and accounted for about one-half of U.S. production.

Salient Statistics—United States:[1]	**2008**	**2009**	**2010**	**2011**	**2012**[e]
Production:					
Portland and masonry cement[2]	86,310	63,929	66,447	67,895	73,000
Clinker	78,382	56,116	59,802	61,241	66,500
Shipments to final customers, includes exports	97,322	71,489	71,169	73,402	79,100
Imports of hydraulic cement for consumption	10,744	6,211	6,013	5,812	6,200
Imports of clinker for consumption	621	556	613	606	750
Exports of hydraulic cement and clinker	823	884	1,178	1,414	1,800
Consumption, apparent[3]	96,800	71,500	71,200	72,200	79,100
Price, average mill value, dollars per ton	103.50	99.00	92.00	89.50	95.00
Stocks, cement, yearend	8,360	6,080	6,170	6,270	4,200
Employment, mine and mill, number[e]	15,000	13,000	12,000	11,500	10,500
Net import reliance[4] as a percentage of apparent consumption	11	8	8	7	7

Recycling: Cement kiln dust is routinely recycled to the kilns, which also can burn a variety of waste fuels and recycled raw materials such as slags and fly ash. Various secondary materials can be incorporated as supplementary cementitious materials in blended cements and in the cement paste in concrete. Cement is not directly recycled, but there is significant recycling of concrete for use as aggregate.

Import Sources (2008–11):[5] Canada, 45%; Republic of Korea, 15%; China, 12%; Mexico, 7%; and other, 21%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Cement clinker	2523.10.0000	Free.
White portland cement	2523.21.0000	Free.
Other portland cement	2523.29.0000	Free.
Aluminous cement	2523.30.0000	Free.
Other hydraulic cement	2523.90.0000	Free.

Depletion Allowance: Not applicable. Certain raw materials for cement production have depletion allowances.

Government Stockpile: None.

Events, Trends, and Issues: Cement sales improved modestly in 2012 owing to higher spending levels for new residential construction and for nonresidential buildings. Except for slightly higher levels of spending for roads, spending for public sector construction remained below the already low levels of 2011. High numbers of home foreclosures, high levels of unemployment, reduced tax revenues to the States, and tight credit continued to constrain spending levels in all construction sectors. Nevertheless, higher cement sales volumes allowed for a significant increase in cement imports and in cement production; the latter, however, remained well below capacity output at almost all plants. Most multikiln plants continued to operate only one kiln in 2012. One idle plant was formally closed in 2011, and at least one other plant that was idle in 2011 was formally closed in 2012. In addition, one plant that was active in 2011 closed in 2012. No new cement plants opened in 2012. Antidumping remedies were sought by one Texas cement producer against cement imports from Greece and the Republic of Korea.

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CEMENT

The manufacture of clinker for cement releases a great deal of carbon dioxide. The results of the first mandatory reporting survey (2010) of the cement industry's greenhouse gas emissions were released by the U.S. Environmental Protection Agency in early 2012. Carbon dioxide reduction strategies by the cement industry mainly aim at reducing emissions per ton of cement product rather than by a plant overall. Approaches include installation of more fuel-efficient kilns, partial substitution of noncarbonate sources of calcium oxide in the kiln raw materials, and partial substitution of supplementary cementitious materials (SCM), such as pozzolans, for portland cement in the finished cement products and in concrete. Because SCM do not require the energy-intensive clinker manufacturing (kiln) phase of cement production, their use, or the use of inert additives or extenders, reduces the unit monetary and environmental costs of the cement component of concrete. The ASTM C-595 standard for blended cement was amended in 2012 to allow for the addition of up to 15% limestone in some blends. Research continued toward developing cements that require less energy to manufacture than portland cement, and (or) that use more benign raw materials.

The cement industry was seeking a delay until 2015 in the implementation of the 2010 National Emissions Standards for Hazardous Air Pollutants (NESHAP) protocol for cement plants. The protocol would significantly lower the acceptable emissions levels of mercury and certain other pollutants. It was unclear how many plants would be able to comply with the new limits; the mercury limits were expected to make it difficult for cement plants to continue to burn fly ash as a raw material for clinker manufacture.

World Production and Capacity:

	Cement production		Clinker capacity[e]	
	2011	2012[e]	2011	2012
United States (includes Puerto Rico)	68,600	74,000	[6]106,000	[6]105,000
Brazil	64,100	70,000	56,000	57,000
China	2,100,000	2,150,000	1,700,000	1,750,000
Egypt	44,000	44,000	46,000	46,000
Germany	33,500	34,000	31,000	31,000
India	240,000	250,000	250,000	250,000
Indonesia	30,000	31,000	45,000	46,000
Iran	61,000	65,000	70,000	75,000
Italy	33,100	32,000	46,000	46,000
Japan	51,300	52,000	55,000	55,000
Korea, Republic of	48,300	49,000	50,000	50,000
Mexico	35,400	36,000	42,000	42,000
Pakistan	32,000	32,000	42,000	42,000
Russia	55,600	60,000	75,000	80,000
Saudi Arabia	48,400	43,000	55,000	55,000
Spain	22,200	20,000	42,000	41,000
Thailand	36,700	33,000	48,000	50,000
Turkey	63,400	60,000	65,000	66,000
Vietnam	59,000	65,000	65,000	68,000
Other countries (rounded)	470,000	500,000	440,000	450,000
World total (rounded)	3,600,000	3,700,000	3,300,000	3,400,000

World Resources: Although individual plant reserves are subject to exhaustion, cement raw materials, especially limestone, are geologically widespread and abundant, and overall shortages are unlikely in the future.

Substitutes: Most portland cement is used either in making concrete or mortars and, as such, competes in the construction sector with concrete substitutes, such as aluminum, asphalt, clay brick, rammed earth, fiberglass, glass, steel, stone, and wood. A number of materials, especially fly ash and ground granulated blast furnace slag, develop good hydraulic cementitious properties by reacting with the lime released by the hydration of portland cement. Where not constrained in supply, these SCM are increasingly being used as partial substitutes for portland cement in many concrete applications.

[e]Estimated.
[1]Portland plus masonry cement unless otherwise noted; excludes Puerto Rico.
[2]Includes cement made from imported clinker.
[3]Production of cement (including from imported clinker) + imports (excluding clinker) – exports + adjustments for stock changes.
[4]Defined as imports (cement and clinker) – exports.
[5]Hydraulic cement and clinker.
[6]Capacity includes nearly 3 million tons at plants classified as being in indefinite idle status rather than closed.

CESIUM

(Data in kilograms of cesium content unless otherwise noted)

Domestic Production and Use: The United States is 100% import reliant on the principal cesium mineral, pollucite; however, occurrences of pollucite are known in pegmatites in Maine and South Dakota. Pollucite occurs in zoned pegmatites worldwide, associated with lepidolite, petalite, and spodumene, with the largest known deposit at Bernic Lake, Manitoba, Canada. Canada is the leading producer and supplier of pollucite concentrate, which is imported for processing by one company in the United States. The principal end use of cesium is in formate brines, a high-density, low-viscosity fluid used for high-pressure/high-temperature (HPHT) oil and gas drilling and exploration. Other significant end uses of cesium are in biomedical, chemical, and electronic applications, as well as in research. Cesium nitrate is used as a colorant and oxidizer in the pyrotechnic industry, in petroleum cracking, in scintillation counters, and in x-ray phosphors.

Cesium is used as an atomic resonance frequency standard in atomic clocks, playing a vital role in global positioning satellites, Internet, and cellular telephone transmissions and aircraft guidance systems. Cesium clocks monitor the cycles of microwave radiation emitted by cesium's electrons and use these cycles as a time reference. Owing to the high accuracy of the cesium atomic clock, the international definition of a second is based on the cesium atom. The U.S. primary time and frequency standard is based on a cesium fountain clock at the National Institute of Standards and Technology in Boulder, CO.

Reactor-produced cesium-131 and cesium-137 are used primarily to treat cancer. Both have been used in brachytherapy, where the radioactive source is placed within the cancerous area. With a shorter half-life and higher energy, cesium-131 is used as an alternative to iodine-125 and palladium-103 in the treatment of prostate cancer. Cesium-137 also is widely used in industrial gauges, in mining and geophysical instruments, and for sterilization of food, sewage, and surgical equipment. Cesium can be used in ferrous and nonferrous metallurgy to remove gases and other impurities, as well as being a "getting" agent in vacuum tubes.

Salient Statistics—United States: Consumption, import, and export data for cesium have not been available since the late 1980s. Because cesium metal is not traded in commercial quantities, a market price is unavailable. Only a few thousand kilograms of cesium are consumed in the United States every year. In 2012, one company offered 1-gram ampoules of 99.8% (metal basis) cesium for $55.50 each and 99.98% (metal basis) cesium for $68.20, an increase of 3.5% from that of 2011 for both products. The price for 50 grams of 99.8% (metals basis) cesium was $684.00, and 100 grams of 99.98% (metal basis) cesium was priced at $1,876.00, an increase of 3.5% from that of 2011 for both products.

Recycling: Cesium formate brines are typically rented by oil and gas exploration clients. After completion of the well, the used cesium formate is returned and reprocessed for subsequent drilling operations. Approximately 85% of the cesium formate can be retrieved and recycled for further use. There is no data available on the amount used or recovered.

Import Sources (2008–11): Canada is the chief source of pollucite concentrate imported by the United States.

Tariff:

Item	Number	Normal Trade Relations 12–31–12
Alkali metals, other	2805.19.9000	5.5% ad val.
Chlorides, other	2827.39.9000	3.7% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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CESIUM

Events, Trends, and Issues: Domestic cesium occurrences will remain uneconomic unless market conditions change, such as the discovery of new end uses or increased consumption for existing end uses. Commercially useful quantities of inexpensive cesium are available as a byproduct of the production of lithium. Increases in lithium exploration may yield discoveries of additional cesium resources, which may lead to expanded commercial applications. No known human health issues are associated with naturally occurring cesium, and its use has minimal environmental impact. Radioactive isotopes of cesium have been known to cause adverse health effects.

The International Atomic Energy Agency has indicated that cesium-137 is one of several radioactive materials that may be used in radiological dispersion devices or “dirty bombs.” Cesium-137 is regulated in the United States by the U.S. Nuclear Regulatory Commission (NRC) and the Environmental Protection Agency (EPA). The NRC monitors devices containing cesium-137 and requires users to obtain specific licenses for these devices. The EPA places a maximum allowance of cesium-137 that can be released into the air by nuclear facilities and requires the cleanup of contaminated soil and groundwater. The NRC agreed to encourage research into finding and implementing alternatives but concluded that a near-term replacement was not practical and would be detrimental to current emergency medical capabilities.

Health officials in Japan have been monitoring radioactive cesium levels for food safety associated with the 2011 Fukushima nuclear disaster. Between April 1 and September 19, 2012, approximately 12% of the meat and produce inspected by local health ministry officials was found to exceed cesium levels designated as safe for human consumption. Of the contaminated food items, about one-half originated from the Fukushima Prefecture and were banned from shipment until the radiation levels drop to within normal limits. In September, independent researchers reported that cesium-137 and cesium-135 particles had been identified throughout the Northern Hemisphere as a result of the migration of radioactive materials from the Fukushima-Daiichi site through global wind currents.

World Mine Production and Reserves: Pollucite, mainly formed in association with lithium-rich, lepidolite-bearing or petalite-bearing zoned granite pegmatites, is the principal cesium ore mineral. Cesium reserves are therefore estimated based on the occurrence of pollucite, which is mined as a byproduct of the lithium mineral lepidolite. Most pollucite contains 5% to 32% Cs_2O. Data on cesium resources and mine production are either limited or not available. The main pollucite zone at Bernic Lake in Canada contains approximately 390,000 tons of pollucite, with an average Cs_2O content of 24%, and a secondary zone of approximately 100,000 tons of pollucite contains an average of 5% Cs_2O. Sites near Lake Ontario have identified cesium resources; plans for estimation and production are scheduled to begin spring of 2013. Zimbabwe currently produces cesium in small quantities as a byproduct of lithium operations. Reserve data were altered to reflect changes in estimates based on information from National Resources Canada.

	Reserves[1]
Canada	99,000,000
Zimbabwe	64,000,000
Other countries	NA
World total (rounded)	163,000,000

World Resources: World resources of cesium have not been estimated. Cesium is associated with lithium-bearing pegmatites worldwide, and cesium resources have been identified in the United States, Canada, Namibia, and Zimbabwe. Lower concentrations are also known in brines in Chile and China and in geothermal systems in Germany, India, and Tibet.

Substitutes: Cesium and rubidium can be used interchangeably in many applications because they have similar physical properties and atomic radii. Cesium, however, is more electropositive than rubidium, making it a preferred material for some applications.

NA Not available.
[1]See Appendix C for resource/reserve definitions and information concerning data sources.

CHROMIUM

(Data in thousand metric tons gross weight unless otherwise noted)

Domestic Production and Use: In 2012, the United States was expected to consume about 6% of world chromite ore production in various forms of imported materials, such as chromite ore, chromium chemicals, chromium ferroalloys, chromium metal, and stainless steel. One U.S. company mined chromite ore in Oregon from which it produced foundry sand. Imported chromite ore was consumed by one chemical firm to produce chromium chemicals. One company produced chromium metal. Stainless- and heat-resisting-steel producers were the leading consumers of ferrochromium. Superalloys require chromium. The value of chromium material consumption in 2011 was $1,010 million as measured by the value of net imports, excluding stainless steel, and was expected to be about $1,100 million in 2012.

Salient Statistics—United States:[1]	2008	2009	2010	2011	2012[e]
Production:					
Mine	—	—	—	—	NA
Recycling[2]	146	141	144	147	150
Imports for consumption	559	273	499	531	560
Exports	287	280	274	232	210
Government stockpile releases	11	25	15	4	4
Consumption:					
Reported (includes recycling)	401	369	396	401	400
Apparent[3] (includes recycling)	432	160	384	451	490
Unit value, average annual import (dollars per metric ton):					
Chromite ore (gross weight)	227	227	212	355	435
Ferrochromium (chromium content)	3,728	2,085	2,564	2,603	2,420
Chromium metal (gross weight)	11,078	9,896	11,322	14,090	13,981
Stocks, yearend, held by U.S. consumers	7	7	7	6	6
Net import reliance[4] as a percentage of apparent consumption	66	12	62	67	70

Recycling: In 2012, recycled chromium (contained in reported stainless steel scrap receipts) accounted for 30% of apparent consumption.

Import Sources (2008–11): Chromium contained in chromite ore, chromium ferroalloys and metal, and stainless steel mill products and scrap: South Africa, 34%; Kazakhstan, 17%; Russia, 10%; Mexico, 5%; and other, 34%.

Tariff:[5] Item	Number	Normal Trade Relations 12–31–12
Ore and concentrate	2610.00.0000	Free.
Ferrochromium:		
Carbon more than 4%	7202.41.0000	1.9% ad val.
Carbon more than 3%	7202.49.1000	1.9% ad val.
Other:		
Carbon more than 0.5%	7202.49.5010	3.1% ad val.
Other	7202.49.5090	3.1% ad val.
Ferrochromium silicon	7202.50.0000	10% ad val.
Chromium metal:		
Unwrought, powder	8112.21.0000	3% ad val.
Waste and scrap	8112.22.0000	Free.
Other	8112.29.0000	3% ad val.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: In fiscal year (FY) 2012, which ended on September 30, 2012, the Defense Logistics Agency, DLA Strategic Materials reported disposals of 190 tons of high-carbon ferrochromium, 4,268 tons of low-carbon ferrochromium, and 146 tons of chromium metal. Disposals in the following table are estimated as the change in DLA Strategic Materials' reported current year minus previous year physical inventory, with adjustments for accounting changes when appropriate. Metallurgical-grade chromite ore and ferrochromium silicon stocks were exhausted in FY 2002; chemical- and refractory-grade chromite ore stocks were exhausted in FY 2004. The DLA Strategic Materials announced that maximum disposal limits for FY 2013 were 59,152 tons of ferrochromium and 454 tons of chromium metal.

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CHROMIUM

Stockpile Status—9–30–12[6]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2012	Disposals FY 2012	Average chromium content
Ferrochromium:					
High-carbon	95.2	—	[7]90.7	—	71.4%
Low-carbon	50.8	—	([7])	4.27	71.4%
Chromium metal	4.09	—	0.454	0.146	100%

Events, Trends, and Issues: The chromium market was characterized as slow with escalating production cost and dismal demand while ferrochromium prices drifted downward for several months. Ferrochromium producers reduced production and closed furnaces. Several ferrochromium plants, or interest in plants, were made available in Albania, Russia, South Africa, and Zimbabwe. Nationalism in South Africa, India, and Turkey led to control of chromite ore exports, interest in export control, and raised the specter of nationalization yet again in South Africa, where labor relations have deteriorated. Eskom, the South African state electrical power agency, has been buying back electrical power in South Africa, which appears to mean that it has insufficient power for both the ferrochromium industry sector and other sectors. Transnet, South Africa's domestic transportation system, advanced plans to expand its rail, port, and transport infrastructure that should secure the transportation and export of chromite ore and ferrochromium. Chromite ore producers sought to export their ore, primarily to China, while the Governments of India, South Africa, and Zimbabwe preferred to process their ore domestically. Analysts predicted a 20% increase in the U.S. ferrochromium price in 2013 based on production cutbacks in South Africa and rising ferrochromium prices in Asia and Europe. The Defense Logistics Agency resumed the sale of ferrochromium in October 2012 after a 16-month hiatus.

World Mine Production and Reserves:

	Mine production[8] 2011	Mine production[8] 2012[e]	Reserves[9] (shipping grade)[10]
United States	—	NA	620
India	3,850	3,800	54,000
Kazakhstan	3,800	3,800	210,000
South Africa	10,200	11,000	200,000
Other countries	5,450	5,300	NA
World total (rounded)	23,300	24,000	>460,000

World Resources: World resources are greater than 12 billion tons of shipping-grade chromite, sufficient to meet conceivable demand for centuries. About 95% of the world's chromium resources is geographically concentrated in Kazakhstan and southern Africa; U.S. chromium resources are mostly in the Stillwater Complex in Montana.

Substitutes: Chromium has no substitute in stainless steel, the leading end use, or in superalloys, the major strategic end use. Chromium-containing scrap can substitute for ferrochromium in some metallurgical uses.

[e]Estimated. NA Not available. — Zero.
[1]Data in thousand metric tons of contained chromium unless otherwise noted.
[2]Recycling production is based on reported stainless steel scrap receipts.
[3]Calculated consumption of chromium; equal to production (from mines and recycling) + imports – exports + stock adjustments.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]In addition to the tariff items listed, certain imported chromium materials (see 26 U.S.C. sec. 4661, 4662, and 4672) are subject to excise tax.
[6]See Appendix B for definitions.
[7]Disposal plan for ferrochromium without distinction between high-carbon and low-carbon ferrochromium; total included in high-carbon.
[8]Mine production units are thousand metric tons, gross weight, of marketable chromite ore.
[9]See Appendix C for resource/reserve definitions and information concerning data sources.
[10]Reserves units are thousand metric tons of shipping-grade chromite ore, which is deposit quantity and grade normalized to 45% Cr_2O_3.

CLAYS

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2012, clay and shale production was reported in 40 States. About 180 companies operated approximately 750 clay pits or quarries. The leading 20 firms supplied about 55% of the tonnage and 85% of the value for all types of clay sold or used in the United States. In 2012, sales or use was estimated to be 25.7 million tons valued at $1.57 billion. Uses for specific clays were estimated to be as follows: ball clay—38% floor and wall tile, 20% sanitaryware, and 42% other uses; bentonite—30% drilling mud, 27% absorbents, 14% iron ore pelletizing, 16% foundry sand bond, and 13% other uses; common clay—46% brick, 24% lightweight aggregate, 20% cement, and 10% other uses; fire clay—57% heavy clay products, 43% refractory products and other uses; fuller's earth—75% absorbent uses and 25% other uses; and kaolin—50% paper and 50% other uses.

Salient Statistics—United States:[1]	**2008**	**2009**	**2010**	**2011**	**2012**[e]
Production (sold or used):					
Ball clay	967	831	912	886	900
Bentonite	4,910	3,650	4,630	4,810	4,800
Common clay	17,500	12,500	12,100	11,700	11,900
Fire clay	296	320	216	215	230
Fuller's earth[2]	2,340	2,010	2,040	1,950	2,000
Kaolin	6,740	5,290	5,420	5,770	5,900
Total[2, 3]	32,700	24,500	25,400	25,300	25,700
Imports for consumption:					
Artificially activated clay and earth	30	27	19	18	20
Kaolin	194	281	239	550	540
Other	13	17	26	33	100
Total[3]	237	325	284	601	660
Exports:					
Ball clay	65	35	45	49	70
Bentonite	1,090	709	953	1,020	1,000
Fire clay[4]	393	328	404	371	280
Fuller's earth	127	90	100	105	95
Kaolin	2,960	2,290	2,470	2,490	2,570
Clays, not elsewhere classified	466	374	383	565	590
Total[3]	5,100	3,830	4,360	4,600	4,600
Consumption, apparent	27,800	21,000	21,300	21,300	21,700
Price, average, dollars per ton:					
Ball clay	46	45	45	46	47
Bentonite	49	57	56	68	68
Common clay	12	12	12	12	12
Fire clay	40	38	28	29	30
Fuller's earth	98	102	98	100	102
Kaolin	134	135	145	142	145
Employment, number:					
Mine	1,060	875	828	810	900
Mill	5,020	4,540	4,400	4,200	4,300
Net import reliance[5] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (2008–11): Brazil, 80%; Mexico, 5%; Canada, 4%; United Kingdom, 2%; and other, 9%.

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CLAYS

Tariff: Item	Number	Normal Trade Relations 12–31–12
Kaolin and other kaolinitic clays, whether or not calcined	2507.00.0000	Free.
Bentonite	2508.10.0000	Free.
Fire clay	2508.30.0000	Free.
Common blue clay and other ball clays	2508.40.0110	Free.
Decolorizing and fuller's earths	2508.40.0120	Free.
Other clays	2508.40.0150	Free.
Chamotte or dina's earth	2508.70.0000	Free.
Activated clays and earths	3802.90.2000	2.5% ad val.
Expanded clays and other mixtures	6806.20.0000	Free.

Depletion Allowance: Ball clay, bentonite, fire clay, fuller's earth, and kaolin, 14% (Domestic and foreign); clay used in the manufacture of common brick, lightweight aggregate, and sewer pipe, 7.5% (Domestic and foreign); clay used in the manufacture of drain and roofing tile, flower pots, and kindred products, 5% (Domestic and foreign); clay from which alumina and aluminum compounds are extracted, 22% (Domestic); and ball clay, bentonite, china clay, sagger clay, and clay used or sold for use dependent on its refractory properties, 14% (Domestic).

Government Stockpile: None.

Events, Trends, and Issues: Increased commercial and residential housing construction is likely to result in slightly increased sales of common clay and fire clay for heavy clay products and ball clay for ceramic tile and sanitaryware manufacture. Bentonite sales may increase for foundry sand bond, although sales for drilling mud and pet litter were expected to decline. Fuller's earth could see slight gains as sales increase for agriculture and fluid purification applications. Kaolin production is likely to increase slightly as ceramic markets increase and paper markets stabilize.

World Mine Production and Reserves:[6] Reserves are large in many countries, but additional data are not available.

	Mine production					
	Bentonite		Fuller's earth		Kaolin	
	2011	2012[e]	2011	2012[e]	2011	2012[e]
United States (sales)	4,810	4,800	[2]1,950	[2]2,000	5,770	5,900
Brazil (beneficiated)	532	540	—	—	2,200	2,250
Czech Republic (crude)	160	180	—	—	3,610	3,600
Germany (sales)	350	350	—	—	4,900	4,500
Greece (crude)	850	900	—	—	—	—
Italy	110	110	3	3	640	640
Mexico	54	54	107	100	120	120
Spain	155	160	820	820	49	50
Turkey	1,000	1,000	—	—	700	1,000
Ukraine (crude)	185	210	—	—	1,100	1,300
United Kingdom (sales)	—	—	—	—	900	900
Uzbekistan (crude)	—	—	—	—	5,500	5,500
Other countries	2,100	2,000	330	300	8,410	8,300
World total (rounded)	10,300	10,000	[2]3,210	[2]3,200	33,900	34,000

World Resources: Resources of all clays are extremely large.

Substitutes: Clays compete with calcium carbonate in filler and extender applications; diatomite, organic litters, polymers, silica gel, and zeolites in absorbent applications; and various siding types in building construction.

[e]Estimated. E Net exporter. — Zero.
[1]Excludes Puerto Rico.
[2]Excludes attapulgite.
[3]Data may not add to totals shown because of independent rounding.
[4]Also includes refractory-grade kaolin.
[5]Defined as imports – exports.
[6]See Appendix C for resource/reserve definitions and information concerning data sources.

COBALT

(Data in metric tons of cobalt content unless otherwise noted)

Domestic Production and Use: Significant U.S. cobalt mine production has not been reported since 1971, and production of refined cobalt from imported nickel-copper-cobalt matte ceased in 1985. U.S. supply comprised imports, stock releases, and secondary (scrap) materials. The sole U.S. producer of extra-fine cobalt powder, in Pennsylvania, used cemented carbide scrap as feed. Seven companies were known to produce cobalt compounds. About 51% of the cobalt consumed in the United States was used in superalloys, mainly in aircraft gas turbine engines; 8% in cemented carbides for cutting and wear-resistant applications; 16% in various other metallic applications; and 25% in a variety of chemical applications. The total estimated value of cobalt consumed in 2012 was $275 million.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production:					
Mine	—	—	—	—	—
Secondary	1,930	1,790	2,000	2,210	2,100
Imports for consumption	10,700	7,680	11,100	10,600	11,000
Exports	2,850	2,440	2,640	3,390	3,700
Shipments from Government stockpile excesses[1]	203	180	-8	—	—
Consumption:					
Reported (includes secondary)	8,820	7,470	8,030	9,100	8,400
Apparent[2] (includes secondary)	10,100	7,580	10,300	9,230	9,400
Price, average, dollars per pound:					
Spot, cathode[3]	39.01	17.86	20.85	17.99	14.00
London Metal Exchange (LME), cash	XX	XX	XX	16.01	13.50
Stocks, yearend:					
Industry	1,160	780	880	1,040	990
LME, U.S. warehouse	XX	XX	23	43	50
Net import reliance[4] as a percentage of apparent consumption	81	76	81	76	78

Recycling: In 2012, cobalt contained in purchased scrap represented an estimated 25% of cobalt reported consumption.

Import Sources (2008–11): Cobalt contained in metal, oxide, and salts: China, 20%; Norway, 14%; Russia, 12%; Finland, 10%; and other, 44%.

Tariff: Item	Number	Normal Trade Relations[5] 12–31–12
Cobalt ores and concentrates	2605.00.0000	Free.
Chemical compounds:		
Cobalt oxides and hydroxides	2822.00.0000	0.1% ad val.
Cobalt chlorides	2827.39.6000	4.2% ad val.
Cobalt sulfates	2833.29.1000	1.4% ad val.
Cobalt carbonates	2836.99.1000	4.2% ad val.
Cobalt acetates	2915.29.3000	4.2% ad val.
Unwrought cobalt, alloys	8105.20.3000	4.4% ad val.
Unwrought cobalt, other	8105.20.6000	Free.
Cobalt mattes and other intermediate products; cobalt powders	8105.20.9000	Free.
Cobalt waste and scrap	8105.30.0000	Free.
Wrought cobalt and cobalt articles	8105.90.0000	3.7% ad val.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile:

Stockpile Status—9–30–12[6]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2012	Disposals FY 2012
Cobalt	301	301	301	—

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COBALT

Events, Trends, and Issues: In recent years, global cobalt production has been higher than consumption, resulting in a market surplus and downward pressure on prices. This trend is expected to continue in the near-term as production from new projects and expansions to existing operations adds to supply. China was the world's leading producer of refined cobalt, and much of its production was from cobalt-rich ore and partially refined cobalt imported from Congo (Kinshasa). In recent years, significant stocks of cobalt feed have accumulated in China. China is a leading supplier of cobalt imports to the United States.

During the first 6 months of 2012, world availability of refined cobalt (as measured by production and U.S. Government shipments) was 8% lower than that of the same period in 2011. China showed the largest decrease in production, which was attributed to a reduction in global demand for cobalt.

Worldwide cobalt inventories in London Metal Exchange (LME) warehouses increased to approximately 430 tons in early November 2012 from 304 tons at yearend 2011.

World Mine Production and Reserves: Reserves for Australia and Brazil were revised based on information from Government reports. Reserves for Canada and "Other countries" were revised based on company reports.

	Mine production		Reserves[7]
	2011	2012[e]	
United States	—	—	33,000
Australia	3,900	4,500	[8]1,200,000
Brazil	3,500	3,700	89,000
Canada	7,100	6,700	140,000
China	6,800	7,000	80,000
Congo (Kinshasa)	60,000	60,000	3,400,000
Cuba	4,000	3,700	500,000
Morocco	2,200	1,800	20,000
New Caledonia[9]	3,200	3,500	370,000
Russia	6,300	6,200	250,000
Zambia	5,400	3,000	270,000
Other countries	6,700	9,000	1,100,000
World total (rounded)	109,000	110,000	7,500,000

World Resources: Identified cobalt resources of the United States are estimated to be about 1 million tons. Most of these resources are in Minnesota, but other important occurrences are in Alaska, California, Idaho, Missouri, Montana, and Oregon. With the exception of resources in Idaho and Missouri, any future cobalt production from these deposits would be as a byproduct of another metal. Identified world cobalt resources are about 15 million tons. The vast majority of these resources are in nickel-bearing laterite deposits, with most of the rest occurring in nickel-copper sulfide deposits hosted in mafic and ultramafic rocks in Australia, Canada, and Russia, and in the sedimentary copper deposits of Congo (Kinshasa) and Zambia. In addition, as much as 1 billion tons of hypothetical and speculative cobalt resources may exist in manganese nodules and crusts on the ocean floor.

Substitutes: In some applications, substitution for cobalt would result in a loss in product performance. Potential substitutes include barium or strontium ferrites, neodymium-iron-boron, or nickel-iron alloys in magnets; cerium, iron, lead, manganese, or vanadium in paints; cobalt-iron-copper or iron-copper in diamond tools; copper-iron-manganese for curing unsaturated polyester resins; iron-cobalt-nickel, nickel, cermets, or ceramics in cutting and wear-resistant materials; iron-phosphorous, manganese, nickel-cobalt-aluminum, or nickel-cobalt-manganese in lithium-ion batteries; nickel-based alloys or ceramics in jet engines; nickel in petroleum catalysts; and rhodium in hydroformylation catalysts.

[e]Estimated. XX Not applicable. — Zero.
[1]Negative numbers are the result of inventory adjustments.
[2]The sum of U.S. net import reliance and secondary production, as estimated from consumption of purchased scrap.
[3]As reported by Platts Metals Week.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]Tariffs for certain countries and items may be eliminated under special trade agreements.
[6]See Appendix B for definitions.
[7]See Appendix C for resource/reserve definitions and information concerning data sources.
[8]For Australia, Joint Ore Reserves Committee (JORC)-compliant reserves were about 420,000 tons.
[9]Overseas territory of France.

COPPER

(Data in thousand metric tons of copper content unless otherwise noted)

Domestic Production and Use: U.S. mine production of copper in 2012 increased by 4% to about 1.15 million tons, and was valued at about $9 billion. Arizona, Utah, New Mexico, Nevada, and Montana—in descending order of production—accounted for more than 99% of domestic mine production; copper also was recovered in Alaska, Idaho, and Missouri. Twenty-eight mines recovered copper, 18 of which accounted for about 99% of production. Three primary smelters, 3 electrolytic and 4 fire refineries, and 15 electrowinning facilities operated during 2012. Refined copper and scrap were used at about 30 brass mills, 15 rod mills, and 500 foundries and miscellaneous consumers. Copper and copper alloys products were used in building construction, 45%; electric and electronic products, 23%; transportation equipment, 12%; consumer and general products, 12%; and industrial machinery and equipment, 8%.[1]

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production:					
Mine	1,310	1,180	1,110	1,110	1,150
Refinery:					
Primary	1,220	1,110	1,060	993	975
Secondary	54	46	38	37	60
Copper from all old scrap	156	138	143	153	170
Imports for consumption:					
Ores and concentrates	1	([2])	1	15	9
Refined	724	664	605	670	600
General imports, refined	721	645	583	649	600
Exports:					
Ores and concentrates	301	151	137	252	290
Refined	37	81	78	40	180
Consumption:					
Reported, refined	2,020	1,650	1,760	1,760	1780
Apparent, unmanufactured[3]	1,990	1,580	1,740	1,730	1770
Price, average, cents per pound:					
Domestic producer, cathode	319.2	241.2	348.3	405.9	370
London Metal Exchange, high-grade	315.5	233.6	341.7	399.8	363
Stocks, yearend, refined, held by U.S. producers, consumers, and metal exchanges	199	434	384	409	200
Employment, mine and mill, thousands	11.9	8.3	9.5	10.6	11.1
Net import reliance[4] as a percentage of apparent consumption	31	21	32	34	35

Recycling: Old scrap, converted to refined metal and alloys, provided 170,000 tons of copper, equivalent to 10% of apparent consumption. Purchased new scrap, derived from fabricating operations, yielded 650,000 tons of contained copper. Of the total copper recovered from scrap (including aluminum- and nickel-based scrap), brass mills recovered 71%; miscellaneous manufacturers, foundries, and chemical plants, 15%; ingot makers, 9%; and copper smelters and refiners, 5%. Copper in all old and new, refined or remelted scrap contributed about 33% of the U.S. copper supply.

Import Sources (2008–11): Unmanufactured: Chile, 43%; Canada, 32%; Peru, 12%; Mexico, 9%; and other, 4%. Refined copper accounted for 84% of unwrought copper imports.

Tariff: Item	Number	Normal Trade Relations[5] 12–31–12
Copper ores and concentrates	2603.00.0000	1.7¢/kg on lead content.
Unrefined copper anode	7402.00.0000	Free.
Refined and alloys; unwrought	7403.00.0000	1.0% ad val.
Copper wire (rod)	7408.11.6000	3.0% ad val.

Depletion Allowance: 15% (Domestic), 14% (Foreign).

Government Stockpile: None.

Events, Trends, and Issues: Although refined copper prices remained volatile during the first 10 months of 2012, they traded within a narrower range than in recent years. The COMEX spot copper price began 2012 at $3.53 per pound of copper, rose to $3.92 per pound in April, and declined to a low of $3.28 per pound in June before trending back to $3.85 per pound in September. The copper supply and demand balance remained tight, in part owing to an

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COPPER

80% year-on-year increase in China's net imports in the first half of 2012, well in excess of industrial demand. U.S. exports of refined copper through June were nearly four times those for all of 2011, and domestic stocks declined to about one-half those at yearend 2011. The International Copper Study Group (ICSG)[6] projected that global refined copper demand in 2012 would exceed production by about 400,000 tons, the third consecutive year of production deficit. Global consumption and production of copper were projected to increase by 1.5% and 2.6%, respectively.

U.S. mine production rose by about 4% in 2011, as increases in Arizona, New Mexico, and Nevada, were partially offset by lower production in Utah. Although total refined production remained unchanged, electrolytic refinery production declined by 9% owing to maintenance shutdowns at the three integrated domestic smelters. In June, a new integrated fire refinery and wire-rod mill were commissioned that were expected to increase domestic production of and consumption of fire-refined copper. In 2013, domestic mine and refined production of copper were expected to increase by more than 10%, and according to ICSG projections, global refined copper output was expected to exceed demand owing to more modest demand growth in China and a 6% growth in global refined production.

World Mine Production and Reserves: The reserve estimate for Peru was revised downward to reflect official reported numbers.

	Mine production		Reserves[7]
	2011	2012[e]	
United States	1,110	1,150	39,000
Australia	958	970	[8]86,000
Canada	566	530	10,000
Chile	5,260	5,370	190,000
China	1,310	1,500	30,000
Congo (Kinshasa)	520	580	20,000
Indonesia	543	430	28,000
Kazakhstan	417	420	7,000
Mexico	443	500	38,000
Peru	1,240	1,240	76,000
Poland	427	430	26,000
Russia	713	720	30,000
Zambia	668	675	20,000
Other countries	1,970	2,100	80,000
World total (rounded)	16,100	17,000	680,000

World Resources: A 1998 USGS assessment estimated 550 million tons of copper contained in identified and undiscovered resources in the United States.[9] Subsequent USGS reports estimated 1.3 billion tons and 196 million tons of copper in the Andes Mountains of South America and in Mexico, respectively, contained in identified, mined, and undiscovered resources.[10, 11] A preliminary assessment indicates that global land-based resources exceed 3 billion tons. Deep-sea nodules and submarine massive sulfides are unconventional copper resources.

Substitutes: Aluminum substitutes for copper in power cable, electrical equipment, automobile radiators, and cooling and refrigeration tube; titanium and steel are used in heat exchangers; optical fiber substitutes for copper in telecommunications applications; and plastics substitute for copper in water pipe, drain pipe, and plumbing fixtures.

[e]Estimated.
[1]Some electrical components are included in each end use. Distribution for 2010 by the Copper Development Association, Inc., 2011.
[2]Less than ½ unit.
[3]Defined as primary refined production + copper from old scrap converted to refined metal and alloys + refined imports – refined exports ± changes in refined stocks. General imports were used to calculate apparent consumption.
[4]Defined as imports – exports + adjustments for Government and industry stock changes for refined copper.
[5]No tariff for Canada, Chile, Mexico, and Peru for items shown. Tariffs for other countries may be eliminated under special trade agreements.
[6]International Copper Study Group, 2012, Forecast 2012–2013: Lisbon, Portugal, International Copper Study Group press release, October 10, 1 p.
[7]See Appendix C for resource/reserve definitions and information concerning data sources.
[8] For Australia, Joint Ore Reserves Committee (JORC)-compliant reserves were about 25 million tons.
[9]U.S. Geological Survey National Mineral Resource Assessment Team, 2000, 1998 assessment of undiscovered deposits of gold, silver, copper, lead, and zinc in the United States: U.S. Geological Survey Circular 1178, 21 p.
[10]Cunningham, C.G., and others, 2008, Quantitative mineral resource assessment of copper, molybdenum, gold, and silver in undiscovered porphyry copper deposits in the Andes Mountains of South America: U.S. Geological Survey Open-File Report 2008–1253, 282 p.
[11]Hammarstrom, J.M., and others, 2010, Global mineral resource assessment—Porphyry copper assessment of Mexico: U.S. Geological Survey Scientific Investigations Report 2010–5090–A, 176 p.

DIAMOND (INDUSTRIAL)

(Data in million carats unless otherwise noted)

Domestic Production and Use: In 2012, total domestic production of industrial diamond was estimated to be 104 million carats, and the United States was one of the world's leading markets. Domestic output was synthetic grit, powder, and stone. Two firms, one in Pennsylvania and another in Ohio, accounted for all of the production. Nine firms produced polycrystalline diamond from diamond powder. Three companies recovered used industrial diamond as one of their principal operations. Total domestic secondary production of industrial diamond was estimated to be 37 million carats. The following industry sectors were the major consumers of industrial diamond: computer chip production, construction, machinery manufacturing, mining services (drilling for mineral, oil, and gas exploration), stone cutting and polishing, and transportation systems (infrastructure and vehicles). Stone cutting and highway building, milling, and repair consumed most of the industrial diamond stone. About 97% of the U.S. industrial diamond market now uses synthetic industrial diamond because its quality can be controlled and its properties can be customized to fit specific requirements.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Bort, grit, and dust and powder; natural and synthetic:					
Production:					
Manufactured diamond[e]	48.3	38.3	39.3	41.5	44
Secondary	33.9	33.5	33.4	34.7	37
Imports for consumption	492	246	596	726	630
Exports[1]	116	67	113	148	160
Consumption, apparent	458	251	556	654	550
Price, value of imports, dollars per carat	0.15	0.17	0.14	0.13	0.13
Net import reliance[2] as a percentage of apparent consumption	82	71	87	88	85
Stones, natural and synthetic:					
Production:					
Manufactured diamond[e]	83.1	52.7	53.7	56.7	60
Secondary	0.36	0.46	0.46	0.31	0.33
Imports for consumption[3]	3.22	1.4	1.72	2.46	2.8
Exports[1]	—	—	—	—	—
Sales from Government stockpile excesses	0.47	—	—	—	—
Consumption, apparent	87.1	54.6	55.9	59.4	63
Price, value of imports, dollars per carat	12.89	13.31	18.78	19.67	12.90
Net import reliance[2] as a percentage of apparent consumption	4	3	3	4	4

Recycling: In 2012, the amount of diamond bort, grit, and dust and powder recycled was estimated to be 37 million carats. Lower prices of newly produced industrial diamond appear to be reducing the number and scale of diamond stone recycling operations. In 2012, it was estimated that 330,000 carats of diamond stone was recycled.

Import Sources (2008–11): Bort, grit, and dust and powder; natural and synthetic: China, 77%; Ireland, 12%; Republic of Korea, 4%; Russia, 3%; and other, 4%. Stones, primarily natural: Botswana, 45%; South Africa, 22%; India, 11%; Namibia, 8%; and other, 14%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12–31–12**
Industrial Miners' diamonds, carbonados	7102.21.1010	Free.
Industrial Miners' diamonds, other	7102.21.1020	Free.
Industrial diamonds, simply sawn, cleaved, or bruted	7102.21.3000	Free.
Industrial diamonds, not worked	7102.21.4000	Free.
Industrial diamonds, other	7102.29.0000	Free.
Grit or dust and powder of natural or synthetic diamonds	7105.10.0000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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DIAMOND (INDUSTRIAL)

Events, Trends, and Issues: In 2012, China was the world's leading producer of synthetic industrial diamond, with annual production exceeding 4 billion carats. The United States is likely to continue to be one of the world's leading markets for industrial diamond into the next decade and likely will remain a significant producer and exporter of synthetic industrial diamond as well. U.S. demand for industrial diamond is likely to continue in the construction sector as the United States continues building, milling, and repairing the Nation's highway system. Industrial diamond coats the cutting edge of saws used to cut cement in highway construction and repair work.

Demand for synthetic diamond grit and powder is expected to remain greater than that for natural diamond material. Constant-dollar prices of synthetic diamond products probably will continue to decline as production technology becomes more cost effective; the decline is even more likely if competition from low-cost producers in China and Russia continues to increase.

World Mine Production and Reserves:[4]

	Mine production		Reserves[5]
	2011	2012[e]	
United States	—	—	NA
Australia	8	8	110
Botswana	23	24	130
China	1	1	10
Congo (Kinshasa)	16	16	150
Russia	15	15	40
South Africa	4	4	70
Other countries	10	10	85
World total (rounded)	77	78	600

World Resources: Natural diamond resources have been discovered in more than 35 countries. Natural diamond accounts for about 3% of all industrial diamond used, while synthetic diamond accounts for the remainder. At least 15 countries have the technology to produce synthetic diamond.

Substitutes: Materials that can compete with industrial diamond in some applications include manufactured abrasives, such as cubic boron nitride, fused aluminum oxide, and silicon carbide. Globally, synthetic diamond rather than natural diamond is used for about 99% of industrial applications.

[e]Estimated. NA Not available. — Zero.
[1]Reexports no longer are combined with exports because increasing amounts of U.S. reexports obscure apparent consumption rates.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]May include synthetic miners' diamond.
[4]Natural industrial diamond only. Note that synthetic diamond production far exceeds natural industrial diamond output. Worldwide production of manufactured industrial diamond totaled at least 4.4 billion carats in 2012; the leading producers included Belarus, China, Ireland, Japan, Russia, South Africa, Sweden, and the United States.
[5]See Appendix C for resource/reserve definitions and information concerning data sources.

DIATOMITE

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2012, domestic production of diatomite was estimated at 820,000 tons with an estimated processed value of $226 million, f.o.b. plant. Seven companies produced diatomite at 10 mining areas and 9 processing facilities in California, Nevada, Oregon, and Washington. Diatomite is frequently used in filter aids, 75%; absorbents, 12%; fillers, 12%; and less than 1% for other applications, including specialized pharmaceutical and biomedical uses. The unit value of diatomite varied widely in 2012, from approximately $100.00 per ton for use as an absorbent to more than $400 per ton for limited specialty markets, including art supplies, cosmetics, and DNA extraction. The average unit value for filter-grade diatomite was $274 per ton.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production[1]	764	575	595	813	820
Imports for consumption	3	1	1	2	4
Exports	151	88	86	106	98
Consumption, apparent	616	488	510	709	726
Price, average value, dollars per ton, f.o.b. plant	224	255	299	269	275
Stocks, producer, yearend[e]	40	40	40	40	40
Employment, mine and plant, number[e]	700	670	660	660	660
Net import reliance[2] as a percentage of apparent consumption	E	E	E	E	E

Recycling: None.

Import Sources (2008–11): Italy, 23%; Spain, 20%; Netherlands, 14%; and other, 43%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–12**
Siliceous fossil meals, including diatomite	2512.00.0000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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DIATOMITE

Events, Trends, and Issues: The amount of domestically produced diatomite sold or used by producers in 2012 increased slightly compared with that of 2011. Apparent domestic consumption increased slightly in 2012, and exports decreased by 8%. Imports of diatomite increased by approximately 2 tons. Filtration (including the purification of beer, liquors, and wine, and the cleansing of greases and oils) continued to be the largest end use for diatomite, also known as diatomaceous earth. Domestically, production of diatomite used as an absorbent was the next largest use. An important application for diatomite is the removal of microbial contaminants, such as bacteria, protozoa, and viruses in public water systems. Other applications for diatomite include filtration of human blood plasma, pharmaceutical processing, and use as a nontoxic insecticide.

World Mine Production and Reserves:

	Mine production		Reserves[3]
	2011	2012[e]	
United States[1]	813	820	250,000
Argentina	62	60	NA
China	440	440	110,000
Denmark[4] (processed)	225	230	NA
France	75	75	NA
Japan	100	100	NA
Mexico	90	90	NA
Spain	50	50	NA
Turkey	45	50	NA
Other countries	160	170	NA
World total (rounded)	2,100	2,100	Large

World Resources: World resources of crude diatomite are adequate for the foreseeable future. Transportation costs will continue to determine the maximum economic distance most forms of diatomite may be shipped and still remain competitive with alternative materials.

Substitutes: Many materials can be substituted for diatomite. However, the unique properties of diatomite assure its continuing use in many applications. Expanded perlite and silica sand compete for filtration. Synthetic filters, notably ceramic, polymeric, or carbon membrane filters and filters made with cellulose fibers, are becoming competitive as filter media. Alternate filler materials include clay, ground limestone, ground mica, ground silica sand, perlite, talc, and vermiculite. For thermal insulation, materials such as various clays, exfoliated vermiculite, expanded perlite, mineral wool, and special brick can be used.

[e]Estimated. E Net exporter. NA Not available.
[1]Processed ore sold and used by producers.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix C for resource/reserve definitions and information concerning data sources.
[4]Includes sales of moler production.

FELDSPAR

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: U.S. feldspar production in 2012 was valued at about $39 million. The three leading producers accounted for about 83% of the production, with four other companies supplying the remainder. Producing States were North Carolina, Virginia, Idaho, California, Oklahoma, Georgia, and South Dakota, in descending order of estimated tonnage. Feldspar processors reported coproduct recovery of mica and silica sand.

Feldspar is ground to about 20 mesh for glassmaking and to 200 mesh or finer for most ceramic and filler applications. It was estimated that feldspar shipments went to at least 30 States and to foreign destinations, including Canada and Mexico. In pottery and glass, feldspar functions as a flux. The estimated 2012 end-use distribution of domestic feldspar was glass, 70%, and pottery and other uses, 30%.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production, marketable[e]	650	550	550	650	630
Imports for consumption	2	2	2	2	2
Exports	15	8	17	17	22
Consumption, apparent[e]	637	544	535	635	610
Price, average value, marketable production, dollars per ton	62	65	61	62	62
Employment, mine, preparation plant, and office, number[e]	400	350	340	380	370
Net import reliance[1] as a percentage of apparent consumption	E	E	E	E	E

Recycling: There is no recycling of feldspar by producers; however, glass container producers use cullet (recycled glass), thereby reducing feldspar consumption.

Import Sources (2008–11): Mexico, 71%; Germany, 25%; Australia, 2%; and other, 2%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–12**
Feldspar	2529.10.0000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: Glass, including beverage containers and insulation for housing and building construction, continued to be the leading end use of feldspar in the United States. Most feldspar consumed by the glass industry is for the manufacture of container glass. The glass container industry was moderately stable, although competing materials in some market segments, such as baby food, fruit juices, mineral water, and wine, and a recent trend to import less expensive containers from China, continued to present challenges. Additionally, increasing use of post-consumer glass collected through local government and neighborhood recycling programs continued to provide additional competition for traditional raw materials, such as feldspar in the manufacture of glass containers.

While recovery for world economic markets from the economic recession in 2008 and 2009 continued to be slow, gradual improvements of 2010 and 2011 continued in 2012. Residential flat glass markets improved slightly in 2012, but remained somewhat sluggish. Housing starts and completions were expected to continue to increase during 2012, based on the increases in each during the first 6 months of 2012. Spending on commercial construction, which had decreased in the first 8 months of 2010 and 2011 from each prior year, increased by 20% in 2012 for the same period. Automotive glass markets increased also.

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FELDSPAR

Fiberglass consumption for thermal insulation was forecast to expand in line with housing and commercial building construction in the United States through 2013. Domestic feldspar consumption has been gradually shifting from ceramics toward glass markets. Another growing segment in the glass industry was solar glass, used in the production of solar cells.

Feldspar use in tile and sanitaryware in the United States and Western Europe continued to be sluggish because of the slow rebound of the housing market from the economic recession, some closures of plants, and increased imports. The main growth of sanitaryware continued to be in China, Mexico, the Middle East, South America, and South East Asia.

World Mine Production and Reserves:

	Mine production		Reserves[2]
	2011	2012[e]	
United States[e]	650	630	NA
Argentina	215	200	NA
Brazil	115	115	NA
Bulgaria	80	80	NA
China	2,100	2,200	NA
Colombia	85	NA	NA
Czech Republic	407	420	28,000
Egypt	406	400	5,000
France	650	650	NA
Germany	218	220	NA
India	420	410	38,000
Iran	500	500	NA
Italy	4,700	4,700	NA
Iraq	NA	NA	[3]3,200
Japan	650	600	NA
Korea, Republic of	500	400	NA
Malaysia	400	400	NA
Mexico	382	380	NA
Poland	450	450	10,600
Portugal	113	115	11,000
Saudi Arabia	50	50	NA
South Africa	95	100	NA
Spain	590	600	NA
Thailand	600	600	NA
Turkey	6,000	4,000	NA
Venezuela	200	250	NA
Other countries	580	750	NA
World total (rounded)	21,200	19,000	Large

World Resources: Identified and hypothetical resources of feldspar are more than adequate to meet anticipated world demand. Quantitative data on resources of feldspar existing in feldspathic sands, granites, and pegmatites generally have not been compiled. Ample geologic evidence indicates that resources are large, although not always conveniently accessible to the principal centers of consumption.

Substitutes: Imported nepheline syenite was the major alternative material. Feldspar also can be replaced in some of its end uses by clays, electric furnace slag, feldspar-silica mixtures, pyrophyllite, spodumene, or talc.

[e]Estimated. E Net exporter. NA Not available.
[1]Defined as imports – exports + adjustments for Government and industry stock changes.
[2]See Appendix C for resource/reserve definitions and information concerning data sources.
[3]Feldspathic sand.

FLUORSPAR

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Fluorspar (calcium fluoride) production was expected to begin at the Klondike II fluorspar mine in Kentucky. In addition, some fluorspar was sold from stockpiles produced as a byproduct of limestone quarrying. Byproduct calcium fluoride was recovered from industrial waste streams, although data are not available on exact quantities. Domestically, production of hydrofluoric acid (HF) in Louisiana and Texas was by far the leading use for acid-grade fluorspar. HF is the primary feedstock for the manufacture of virtually all fluorine-bearing chemicals and is also a key ingredient in the processing of aluminum and uranium. Other uses included as a flux in steelmaking, in iron and steel casting, primary aluminum production, glass manufacture, enamels, welding rod coatings, cement production, and other uses or products. In 2012, an estimated 73,000 tons of fluorosilicic acid (equivalent to about 128,000 tons of 92% fluorspar) was recovered from phosphoric acid plants processing phosphate rock. Fluorosilicic acid was used primarily in water fluoridation.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production:					
Finished, all grades	NA	NA	NA	NA	NA
Fluorspar equivalent from phosphate rock	111	114	128	124	128
Imports for consumption:					
Acid grade	496	417	442	560	475
Metallurgical grade	76	58	97	167	145
Total fluorspar imports	572	475	539	727	620
Fluorspar equivalent from hydrofluoric acid plus cryolite	209	175	209	209	220
Exports	19	14	18	24	21
Consumption:					
Apparent[1]	529	473	492	672	605
Reported	506	400	446	454	480
Stocks, yearend, consumer and dealer[2]	115	103	131	162	156
Net import reliance[3] as a percentage of apparent consumption	100	100	100	100	100

Recycling: A few thousand tons per year of synthetic fluorspar is recovered—primarily from uranium enrichment, but also from petroleum alkylation and stainless steel pickling. Primary aluminum producers recycle HF and fluorides from smelting operations. HF is recycled in the petroleum alkylation process.

Import Sources (2008–11): Mexico, 69%; China, 20%; South Africa, 8%; and other, 3%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–12**
Acid grade (97% or more CaF_2)	2529.22.0000	Free.
Metallurgical grade (less than 97% CaF_2)	2529.21.0000	Free.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: The last of the Government stocks of fluorspar officially were sold in fiscal year 2007.

Events, Trends, and Issues: Development work continued on the Klondike II Mine in Livingston County, KY. The incline being driven from the surface was expected to hit the vein orebody by yearend 2012. In addition, exploration work began in adjoining Crittenden County, KY, by parties unrelated to the Klondike II Mine project. The drilling program was targeting southern Crittenden County, an area that had limited fluorspar production in the past.

After a long, slow development process, the Nui Phao fluorspar mining project in Vietnam made major progress in 2012 and commissioning of the mine and mill is scheduled for the end of the first quarter in 2013. At full production, the project was expected to produce more than 200,000 tons per year of acid-grade fluorspar for export.

Other noteworthy developments in the international fluorspar industry included the sale of the United Kingdom's sole fluorspar producer, which shut down yearend 2010, and the announcement that it would reopen in early 2013. Russia's primary fluorspar producer became a wholly owned subsidiary of Russia's leading aluminum company, which announced plans to invest about $3 million to modernize the fluorspar mining operation north of Vladivostok.

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FLUORSPAR

In September 2011, China appealed the World Trade Organization (WTO) ruling that its export restrictions on several industrial raw materials (including fluorspar) were inconsistent with WTO rules. In January 2012, the WTO Appellate Body affirmed a WTO dispute settlement panel's July 2011 finding that found China's export restraints on these materials to be inconsistent with China's WTO obligations and rejected China's attempts to portray its export restraints as conservation or environmental protection measures or measures taken to manage critical shortages of supply.

Fluorspar prices remained relatively stable in 2012 despite weak demand, especially by the global fluorochemicals industry. The price of Chinese acid-grade fluorspar (free on board China), however, had decreased by at least $30 per ton by the summer of 2012.

World Mine Production and Reserves: Production estimates for individual countries were made using country or company specific data where available; other estimates were made based on general knowledge of end-use markets. The reserve estimate for Mongolia has been revised based on new information.

	Mine production		Reserves[4, 5]
	2011	2012[e]	
United States	NA	NA	NA
Brazil	26	25	1,000
China	4,700	4,200	24,000
Kazakhstan	67	60	NA
Kenya	117	107	2,000
Mexico	1,207	1,200	32,000
Mongolia	416	420	22,000
Morocco	79	75	NA
Namibia	80	80	3,000
Russia	260	150	NA
South Africa	240	220	41,000
Spain	124	120	6,000
Other countries	200	190	110,000
World total (rounded)	7,520	6,850	240,000

World Resources: Identified world fluorspar resources were approximately 500 million tons of contained fluorspar. The quantity of fluorine present in phosphate rock deposits is enormous. Current U.S. reserves of phosphate rock are estimated to be 1.4 billion tons, which at 3.5% fluorine would contain about 101 million tons of 100% calcium fluoride (fluorspar) equivalent. World reserves of phosphate rock are estimated to be 65 billion tons, equivalent to about 4.7 billion tons of 100% calcium fluoride equivalent.

Substitutes: Aluminum smelting dross, borax, calcium chloride, iron oxides, manganese ore, silica sand, and titanium dioxide have been used as substitutes for fluorspar fluxes. Byproduct fluorosilicic acid has been used as a substitute in aluminum fluoride production and also has the potential to be used as a substitute in HF production.

[e]Estimated. NA Not available.

[1]Excludes fluorspar production withheld for proprietary reasons and fluorspar equivalent of fluorosilicic acid, hydrofluoric acid, and cryolite.

[2]Industry stocks for two leading consumers and fluorspar distributors.

[3]Defined as imports – exports + adjustments for Government and industry stock changes.

[4]See Appendix C for resource/reserve definitions and information concerning data sources.

[5]Measured as 100% calcium fluoride.

GALLIUM

(Data in kilograms of gallium content unless otherwise noted)

Domestic Production and Use: No domestic primary gallium recovery was reported in 2012. One company in Utah recovered and refined gallium from scrap and impure gallium metal. Imports of gallium, which supplied most of U.S. gallium consumption, were valued at about $32 million. Gallium arsenide (GaAs) and gallium nitride (GaN) electronic components represented about 99% of domestic gallium consumption. About 71% of the gallium consumed was used in integrated circuits (ICs). Optoelectronic devices, which include laser diodes, light-emitting diodes (LEDs), photodetectors, and solar cells, represented the remaining 29% of gallium consumption. Optoelectronic devices were used in areas such as aerospace, consumer goods, industrial equipment, medical equipment, and telecommunications. Uses of ICs included defense applications, high-performance computers, and telecommunications.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production, primary	—	—	—	—	—
Imports for consumption	41,100	35,900	59,200	85,700	58,000
Exports	NA	NA	NA	NA	NA
Consumption, reported	28,700	24,900	33,500	35,300	35,000
Price, yearend, dollars per kilogram[1]	579	449	600	688	556
Stocks, consumer, yearend	3,820	4,100	4,970	6,850	7,350
Employment, refinery, number	20	20	20	20	20
Net import reliance[2] as a percentage of reported consumption	99	99	99	99	99

Recycling: Old scrap, none. Substantial quantities of new scrap generated in the manufacture of GaAs-base devices were reprocessed.

Import Sources (2008–11): Germany, 32%; United Kingdom, 27%; China, 15%; Canada, 11%; and other, 15%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Gallium arsenide wafers, undoped	2853.00.0010	2.8% ad val.
Gallium arsenide wafers, doped	3818.00.0010	Free.
Gallium metal	8112.92.1000	3.0% ad val.

Depletion Allowance: Not applicable.

Government Stockpile: None.

Events, Trends, and Issues: Imports of gallium and GaAs wafers continued to supply almost all U.S. demand for gallium. Gallium prices decreased throughout 2012 when significant increases in gallium production exceeded the declining demand from LED producers. Chinese gallium capacity expanded tremendously in 2011 and 2012 on the expectation of a strong LED-based backlighting market, which failed to materialize. In January, the price for low-grade (99.99%-pure) gallium in Asia and Europe averaged $580 per kilogram. By July, the average low-grade price had decreased to $320 per kilogram. By early October, the average low-grade price had decreased to $280 per kilogram.

Market conditions continued to improve for GaAs- and GaN-based products in 2012. GaAs demand, while still driven mainly by cellular handsets and other high-speed wireless applications, increased owing to rapid growth of feature-rich, application-intensive, third- and fourth-generation “smartphones,” which employ up to 10 times the amount of GaAs content than standard cellular handsets. Smartphones accounted for 37% of all handset sales in 2012. Owing to the rise of GaAs content in smartphones and increased penetration of GaAs-based LEDs in general lighting and automotive applications, the GaAs substrate market was forecast to increase at a compound annual growth rate of nearly 11%, increasing to $650 million by 2017.

Owing to the large power-handling capabilities, high-switching frequencies, and higher voltage capabilities of GaN technology, GaN-based products, which historically have been used in defense and military applications, have begun to gain acceptance in cable television transmission, commercial wireless infrastructure, power electronics, and satellite markets. The GaN power device market was forecast to increase at an average growth rate of nearly 29%, to reach $178 million in 2015.

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GALLIUM

In 2012, the worldwide LED market, a significant driver for GaN-based technologies, increased by only 1.5% in revenues from that of 2011 owing to slower-than-expected growth in LED backlighting, LED supply outpacing demand, and to lower LED prices. Although televisions were increasingly built with LED backlighting in 2012, improvements in technology required up to 50% fewer LEDs. LED-backlit televisions accounted for 63% of the television market in 2012, and were forecast to account for 93% of the market in 2013. By 2014, the strongest segments of the LED market were expected to be in general lighting, followed by signs and automotive applications.

A Colorado-based rare-earth mining company purchased the parent company of the largest gallium refiner in Canada and the United States. The gallium refinery purchase was expected to enhance the specialty value-added rare metals-processing capability of the Colorado company. It also commenced operations of a new gallium trichloride plant in the Republic of Korea, which would primarily supply Asian markets.

Sustained high-energy prices continued to spark interest in solar energy in 2012. Copper-indium-gallium diselenide (CIGS), a thin-film photovoltaic technology, has been slow to enter the commercial market owing to a complicated manufacturing process that has impeded commercial mass production of CIGS panels. Decreased prices of silicon-based solar cells also slowed demand for the more expensive CIGS technology. These two factors resulted in a large oversupply of CIGS modules that caused prices to be reduced by 20% in 2011 and remain low throughout 2012. In an effort to keep CIGS technology viable and competitive, CIGS manufacturers, beginning in 2011, trimmed production costs, increased production capacities, improved module conversion efficiencies, and increased CIGS adoption in commercial rooftops.

World Production and Reserves:[3] In 2012, world primary gallium production was estimated to be 273 metric tons, 7% less than the 2011 world primary production of 292 tons. China, Germany, Kazakhstan, and Ukraine were the leading producers; countries with lesser output were Hungary, Japan, the Republic of Korea, and Russia. Refined gallium production was estimated to be about 354 tons; this figure includes primary gallium production and some possible scrap refining. China, Japan, the United Kingdom, and the United States were the principal producers of refined gallium. Gallium was recycled from new scrap in Canada, Germany, Japan, the United Kingdom, and the United States. World primary gallium production capacity in 2012 was estimated to be 474 tons; refinery capacity, 270 tons; and recycling capacity, 198 tons.

Gallium occurs in very small concentrations in ores of other metals. Most gallium is produced as a byproduct of treating bauxite, and the remainder is produced from zinc-processing residues. Only part of the gallium present in bauxite and zinc ores is recoverable, and the factors controlling the recovery are proprietary. Therefore, an estimate of current reserves comparable to the definition of reserves of other minerals cannot be made. The world bauxite reserves are so large that much of them will not be mined for many decades; hence, most of the gallium in the bauxite reserves cannot be considered to be available in the short term.

World Resources: The average content of gallium in bauxite is 50 parts per million (ppm). U.S. bauxite deposits consist mainly of subeconomic resources that are not generally suitable for alumina production owing to their high silica content. Recovery of gallium from these deposits is therefore unlikely. Some domestic zinc ores contain as much as 50 ppm gallium and, as such, could be a significant resource. World resources of gallium in bauxite are estimated to exceed 1 billion kilograms, and a considerable quantity could be present in world zinc reserves. The foregoing estimate applies to total gallium content; only a small percentage of this metal in bauxite and zinc ores is economically recoverable.

Substitutes: Liquid crystals made from organic compounds are used in visual displays as substitutes for LEDs. Researchers also are working to develop organic-based LEDs that may compete with GaAs in the future. Indium phosphide components can be substituted for GaAs-based infrared laser diodes in some specific-wavelength applications, and GaAs competes with helium-neon lasers in visible laser diode applications. Silicon is the principal competitor with GaAs in solar-cell applications. GaAs-based ICs are used in many defense-related applications because of their unique properties, and there are no effective substitutes for GaAs in these applications. GaAs in heterojunction bipolar transistors is being challenged in some applications by silicon-germanium.

[e]Estimated. NA Not available. — Zero.

[1]Estimated based on the average values of U.S. imports for 99.9999%- and 99.99999%-pure gallium.

[2]Defined as imports – exports + adjustments for Government and industry stock changes.

[3]See Appendix C for resource/reserve definitions and information concerning data sources.

GARNET (INDUSTRIAL)[1]

(Data in metric tons of garnet unless otherwise noted)

Domestic Production and Use: Garnet for industrial use was mined in 2012 by four firms—one in Idaho, one in Montana, and two in New York. The estimated value of crude garnet production was about $9.8 million, while refined material sold or used had an estimated value of $9.7 million. Major end uses for garnet were waterjet cutting, 35%; abrasive blasting media, 30%; water filtration, 20%; abrasive powders, 10%; and other end uses, 5%.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production (crude)	62,900	45,600	52,600	56,400	56,000
Sold by producers	49,800	22,100	28,900	33,700	34,000
Imports for consumption[e]	92,300	71,100	79,700	116,000	120,000
Exports[e]	12,500	13,200	11,700	14,500	15,000
Consumption, apparent[e, 2]	143,000	104,000	121,000	158,000	159,000
Price, range of value, dollars per ton[3]	50–2,000	50–2,000	50–2,000	50–2,000	50–2,000
Employment, mine and mill, number[e]	160	160	160	160	160
Net import reliance[4] as a percentage of apparent consumption	56	56	56	64	65

Recycling: Small amounts of garnet reportedly are recycled.

Import Sources (2008–11):[e] India, 45%; Australia, 34%; China, 15%; Canada, 5%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Emery, natural corundum, natural garnet, and other natural abrasives, crude	2513.20.1000	Free.
Emery, natural corundum, natural garnet, and other natural abrasives, other than crude	2513.20.9000	Free.
Natural abrasives on woven textile	6805.10.0000	Free.
Natural abrasives on paper or paperboard	6805.20.0000	Free.
Natural abrasives sheets, strips, disks, belts, sleeves, or similar form	6805.30.1000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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GARNET (INDUSTRIAL)

Events, Trends, and Issues: During 2012, domestic U.S. production of crude garnet concentrates was essentially the same as the production in 2011. U.S. garnet consumption increased slightly compared with that of 2011. In 2012, imports were estimated to have increased slightly compared with those of 2011, and exports were estimated to have increased 5% from those of 2011. The 2012 estimated domestic sales of garnet was essentially the same as the sales in 2011. In 2012, the United States remained a net importer. Garnet imports have supplemented U.S. production in the domestic market; Australia, Canada, China, and India were major garnet suppliers.

The garnet market is very competitive. To increase profitability and remain competitive with foreign imported material, production may be restricted to only high-grade garnet ores or other salable mineral products that occur with garnet, such as kyanite, marble, mica minerals, sillimanite, staurolite, wollastonite, or metallic ores.

World Mine Production and Reserves: The reserve data for India were revised based on information reported by the Government of India.

	Mine production		Reserves[5]
	2011	2012[e]	
United States	56,400	56,000	5,000,000
Australia	263,000	260,000	Moderate to Large
China	506,000	510,000	Moderate to Large
India	800,000	800,000	6,700,000
Other countries	36,000	36,000	6,500,000
World total (rounded)	1,660,000	1,700,000	Moderate to Large

World Resources: World resources of garnet are large and occur in a wide variety of rocks, particularly gneisses and schists. Garnet also occurs in contact-metamorphic deposits in crystalline limestones, pegmatites, serpentinites, and vein deposits. In addition, alluvial garnet is present in many heavy-mineral sand and gravel deposits throughout the world. Large domestic resources of garnet also are concentrated in coarsely crystalline gneiss near North Creek, NY; other significant domestic resources of garnet occur in Idaho, Maine, Montana, New Hampshire, North Carolina, and Oregon. In addition to those in the United States, major garnet deposits exist in Australia, Canada, China, and India, where they are mined for foreign and domestic markets; deposits in Russia and Turkey also have been mined in recent years, primarily for internal markets. Additional garnet resources are in Chile, Czech Republic, Pakistan, South Africa, Spain, Thailand, and Ukraine; small mining operations have been reported in most of these countries.

Substitutes: Other natural and manufactured abrasives can substitute to some extent for all major end uses of garnet. In many cases, however, the substitutes would entail sacrifices in quality or cost. Fused aluminum oxide and staurolite compete with garnet as a sandblasting material. Ilmenite, magnetite, and plastics compete as filtration media. Diamond, corundum, and fused aluminum oxide compete for lens grinding and for many lapping operations. Emery is a substitute in nonskid surfaces. Finally, quartz sand, silicon carbide, and fused aluminum oxide compete for the finishing of plastics, wood furniture, and other products.

[e]Estimated.
[1]Excludes gem and synthetic garnet.
[2]Defined as crude production – exports + imports.
[3]Includes crude and refined garnet; most crude concentrate is $75 to $210 per ton, and most refined material is $75 to $290 per ton.
[4]Defined as imports – exports.
[5]See Appendix C for resource/reserve definitions and information concerning data sources.

GEMSTONES[1]

(Data in million dollars unless otherwise noted)

Domestic Production and Use: The combined value of U.S. natural and synthetic gemstone output decreased by about 3% in 2012 from that of 2011. The natural gemstone production value increased slightly from that of 2011, while synthetic gemstone production value decreased by nearly 5% during the same period. Domestic gemstone production included agate, beryl, coral, garnet, jade, jasper, opal, pearl, quartz, sapphire, shell, topaz, tourmaline, turquoise, and many other gem materials. In decreasing order, Arizona, North Carolina, Oregon, Utah, California, Tennessee, Montana, Colorado, Arkansas, and Idaho produced 87% of U.S. natural gemstones. Laboratory-created gemstones were manufactured by five firms in Florida, New York, Massachusetts, North Carolina, and Arizona, in decreasing order of production. Major gemstone uses were carvings, gem and mineral collections, and jewelry. The apparent consumption in the table below is much lower than the actual consumption, owing to the exports, including reexports.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production:[2]					
Natural[3]	11.5	9.3	10.0	11.0	11
Laboratory-created (synthetic)	51.4	27.2	30.8	31.9	30
Imports for consumption	20,900	13,600	19,600	23,500	22,000
Exports, including reexports[4]	15,300	10,500	14,100	18,200	18,000
Consumption, apparent	5,670	3,080	5,510	5,360	4,300
Price	Variable, depending on size, type, and quality				
Employment, mine, number[e]	1,200	1,000	1,100	1,100	1,100
Net import reliance[5] as a percentage of apparent consumption	99	99	99	99	99

Recycling: Gemstones are often recycled by being resold as estate jewelry, reset, or recut, but this report does not account for those stones.

Import Sources (2008–11 by value): Israel, 44%; India, 25%; Belgium, 17%; South Africa, 5%; and other, 9%. Diamond imports accounted for 95% of the total value of gem imports.

Tariff:

Item	Number	Normal Trade Relations 12–31–12
Pearls, imitation, not strung	7018.10.1000	4.0% ad val.
Imitation precious stones	7018.10.2000	Free.
Pearls, natural	7101.10.0000	Free.
Pearls, cultured	7101.21.0000	Free.
Diamond, unworked or sawn	7102.31.0000	Free.
Diamond, ½ carat or less	7102.39.0010	Free.
Diamond, cut, more than ½ carat	7102.39.0050	Free.
Precious stones, unworked	7103.10.2000	Free.
Precious stones, simply sawn	7103.10.4000	10.5% ad val.
Rubies, cut	7103.91.0010	Free.
Sapphires, cut	7103.91.0020	Free.
Emeralds, cut	7103.91.0030	Free.
Other precious stones, cut but not set	7103.99.1000	Free.
Other precious stones	7103.99.5000	10.5% ad val.
Synthetic, cut but not set	7104.90.1000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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GEMSTONES

Events, Trends, and Issues: In 2012, the U.S. market for gem-quality diamonds was estimated to be about $22 billion, accounting for more than 35% of world demand. This was an increase of about 20% compared with that of 2011. The domestic market for natural, nondiamond gemstones was estimated to be about $1 billion, which was a 20% increase from that of 2011. The United States is expected to continue dominating global gemstone consumption.

World Gem Diamond Mine Production[6] and Reserves:

	Mine production		Reserves[7]
	2011	2012[e]	
Angola	7,500	7,200	World reserves of diamond-bearing deposits are substantial. No reserve data are available for other gemstones.
Australia	86	70	
Botswana	22,900	24,000	
Brazil	25	25	
Canada	10,800	10,500	
Central African Republic	240	200	
China	100	100	
Congo (Kinshasa)	3,900	3,900	
Ghana	240	180	
Guinea	230	200	
Guyana	50	50	
Lesotho	450	450	
Namibia	1,130	1,400	
Russia	17,800	18,500	
Sierra Leone	280	300	
South Africa	2,800	2,800	
Tanzania	51	51	
Other countries	1,350	1,350	
World total (rounded)	69,900	71,000	

World Resources: Most diamond-bearing ore bodies have a diamond content that ranges from less than 1 carat per ton to about 6 carats per ton. The major gem diamond reserves are in southern Africa, Australia, Canada, and Russia.

Substitutes: Plastics, glass, and other materials are substituted for natural gemstones. Synthetic gemstones (manufactured materials that have the same chemical and physical properties as gemstones) are common substitutes. Simulants (materials that appear to be gems, but differ in chemical and physical characteristics) also are frequently substituted for natural gemstones.

[e]Estimated.
[1]Excludes industrial diamond and garnet. See Diamond (Industrial) and Garnet (Industrial).
[2]Estimated minimum production.
[3]Includes production of freshwater shell.
[4]Reexports account for between 78% and 83% of the totals.
[5]Defined as imports – exports and reexports.
[6]Data in thousands of carats of gem diamond.
[7]See Appendix C for resource/reserve definitions and information concerning data sources.

GERMANIUM

(Data in kilograms of germanium content unless otherwise noted)

Domestic Production and Use: Germanium production in the United States comes from either the refining of imported germanium compounds or domestic industry-generated scrap. Germanium for domestic consumption also was obtained from materials imported in chemical form and either directly consumed or consumed in the production of other germanium compounds. Germanium was recovered from zinc concentrates produced at a domestic zinc mine in Alaska. These concentrates were exported to Canada for processing.

A germanium refinery in Utica, NY, produced germanium tetrachloride for optical fiber production. Another refinery in Quapaw, OK, produced refined germanium compounds for the production of fiber optics, infrared devices, and substrates for electronic devices. The major end uses for germanium, worldwide, were estimated to be fiber-optic systems, 30%; infrared optics, 25%; polymerization catalysts, 25%; electronics and solar electric applications, 15%; and other (phosphors, metallurgy, and chemotherapy), 5%. Domestically, the end use distribution was different and was estimated to be infrared optics, 50%; fiber-optic systems, 30%; electronics and solar electric applications, 15%; and other (phosphors, metallurgy, and chemotherapy), 5%. Germanium is not used in polymerization catalysts in the United States. The estimated value of germanium metal consumed in 2012, based on the annual average U.S. producer price, was about $55 million.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production, refinery[e]	4,600	4,600	3,000	3,000	3,000
Total imports[1]	67,600	60,200	44,700	38,500	49,500
Total exports[1]	17,900	21,200	8,000	5,900	12,800
Shipments from Government stockpile excesses	102	68	—	—	—
Consumption, estimated	54,000	44,000	40,000	36,000	40,000
Price, producer, yearend, dollars per kilogram:					
Zone refined	1,490	940	1,200	1,450	1,680
Dioxide, electronic grade	960	580	720	1,250	1,380
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant,[2] number[e]	70	70	100	100	100
Net import reliance[3] as a percentage of estimated consumption	90	90	90	90	90

Recycling: Worldwide, about 30% of the total germanium consumed is produced from recycled materials. During the manufacture of most optical devices, more than 60% of the germanium metal used is routinely recycled as new scrap. Germanium scrap was also recovered from the window blanks in decommissioned tanks and other military vehicles.

Import Sources (2008–11):[4] China, 51%; Belgium, 24%; Russia, 16%; Germany, 6%; and other, 3%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–12**
Germanium oxides	2825.60.0000	3.7% ad val.
Metal, unwrought	8112.92.6000	2.6% ad val.
Metal, powder	8112.92.6500	4.4% ad val.
Metal, wrought	8112.99.1000	4.4% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: The Defense Logistics Agency, DLA Strategic Materials did not allocate any germanium for sale in the fiscal year 2013 Annual Materials Plan.

Stockpile Status—9–30–12[5]

Material	**Uncommitted inventory**	**Authorized for disposal**	**Disposal plan FY 2012**	**Disposals FY 2012**
Germanium	16,362	16,362	3,000	—

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GERMANIUM

Events, Trends, and Issues: Germanium prices were relatively stable during the first quarter of 2012 following increases in 2011. They declined during the late spring and summer months and then increased substantially during the third quarter of the year. Tightness in the global germanium market, particularly for germanium dioxide, pushed prices higher in 2012 compared to those in 2011. This was not necessarily a reflection of significant increases in global germanium consumption but more likely a sign of temporary supply disruptions and speculation of further tightness. Germanium dioxide prices increased by 49% to $1,375 per kilogram in late September from $925 per kilogram in mid-March. Factors that contributed to the germanium dioxide price increase included an export tax on germanium dioxide produced in China that tightened global supply, coupled with the shutdown of three Chinese germanium dioxide plants owing to environmental concerns in early 2012. Prices also increased owing to speculation of increased germanium dioxide consumption for use in polymerization catalysts by Japanese beverage bottle manufacturers after the 2011 earthquake and tsunami, and this was partially reflected in a 46% increase in germanium dioxide imports in Japan in 2011 compared with 2010 imports. Japanese consumption of germanium tetrachloride, used in production of fiber-optic cores, increased substantially during the first half of 2012 compared with that of the same period of 2011. In September 2012, China's State Reserve Bureau announced plans to purchase 20 metric tons of germanium metal for its national stockpile. It had not been able to acquire that quantity of germanium as of early October owing to several Chinese germanium plants being closed for installation of environmental protection equipment. Contributing to the perceived supply tightness in the global germanium market, in mid-2012, a leading Chinese germanium dioxide producer entered into an agreement to sell 375 metric tons of germanium dioxide during a 6-year period to a single consumer that specializes in hydro and solar projects.

In the third quarter of 2012, a smelter in Tennessee began to process zinc concentrates from a mine complex in Tennessee into an intermediate germanium concentrate product. Also in 2012, the U.S. germanium tetrachloride producer announced that it had acquired a new manufacturing plant in Rome, NY, to produce gallium-, germanium-, indium-, and tin-based compounds for use in semiconductors, solar cells, and optical fibers. The Oklahoma germanium refiner consolidated global production of germanium blanks for infrared optics to its Quapaw plant. According to leading producers of germanium-related products, consumption of germanium substrates used in light-emitting diodes and solar cells increased during the first half of 2012 compared with that of the same period of 2011. During the same period, consumption of substrates for use in space-based applications declined owing to delays in satellite programs. Cuts in defense spending have reduced consumption of germanium for infrared optical devices for military use; however, more commercial applications for infrared detectors have emerged in recent years.

World Refinery Production and Reserves:

	Refinery production[e]		Reserves[6]
	2011	2012	
United States	3,000	3,000	450,000
China	80,000	90,000	NA
Russia	5,000	5,000	NA
Other countries	30,000	30,000	NA
World total	118,000	128,000	NA

World Resources: The available resources of germanium are associated with certain zinc and lead-zinc-copper sulfide ores. Significant amounts of germanium are contained in ash and flue dust generated in the combustion of certain coals for power generation. Reserves exclude germanium contained in coal ash.

Substitutes: Silicon can be a less-expensive substitute for germanium in certain electronic applications. Some metallic compounds can be substituted in high-frequency electronics applications and in some light-emitting-diode applications. Zinc selenide and germanium glass substitute for germanium metal in infrared applications systems but often at the expense of performance. Titanium has the potential to be a substitute as a polymerization catalyst.

[e]Estimated. NA Not available. — Zero.

[1]In addition to the gross weight of wrought and unwrought germanium and waste and scrap that comprise these figures, this series includes estimated germanium content of germanium dioxide. This series does not include germanium tetrachloride and other germanium compounds for which data are not available.

[2]Employment related to primary germanium refining is indirectly related to zinc refining.

[3]Defined as imports – exports + adjustments for Government stock changes; rounded to nearest 5%.

[4]Imports are based on the gross weight of wrought and unwrought germanium and waste and scrap, but not germanium tetrachloride and other germanium compounds for which data are not available.

[5]See Appendix B for definitions.

[6]See Appendix C for resource/reserve definitions and information concerning data sources.

GOLD

(Data in metric tons[1] of gold content unless otherwise noted)

Domestic Production and Use: Gold was produced at about 50 lode mines, a few large placer mines (all in Alaska), and numerous smaller placer mines (mostly in Alaska and in the Western States). In addition, a small amount of domestic gold was recovered as a byproduct of processing base metals, chiefly copper. Thirty operations yielded more than 99% of the gold produced in the United States. In 2012, the value of mine production was about $12.6 billion. Commercial-grade refined gold came from about 2 dozen producers. A few dozen companies, out of several thousand companies and artisans, dominated the fabrication of gold into commercial products. U.S. jewelry manufacturing was heavily concentrated in New York, NY, and Providence, RI, areas, with lesser concentrations in California, Florida, and Texas. Estimated uses were jewelry and arts, 66%; dental, 12%; electrical and electronics, 5%; and other, 17%.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production:					
Mine	233	223	231	234	230
Refinery:					
Primary	168	170	175	220	220
Secondary (new and old scrap)	181	189	198	263	240
Imports for consumption[2]	231	320	604	*535	330
Exports[2]	567	381	383	*514	710
Consumption, reported	176	150	180	168	150
Stocks, yearend, Treasury[3]	8,140	8,140	8,140	8,140	8,140
Price, dollars per ounce[4]	874	975	1,227	1,572	1,700
Employment, mine and mill, number[5]	9,560	9,650	10,300	11,200	12,000
Net import reliance[6] as a percentage of apparent consumption	E	E	40	E	E

Recycling: In 2012, 240 tons of new and old scrap was recycled, more than the reported consumption.

Import Sources (2008–11):[2] Mexico, 57%; Canada, 20%; Colombia, 9%; Peru, 3%; and other, 11%.

Tariff: Most imports of unwrought gold, including bullion and doré, enter the United States duty free.

Depletion Allowance: 15% (Domestic), 14% (Foreign).

Government Stockpile: The U.S. Department of the Treasury maintains stocks of gold (see salient statistics above), and the U.S. Department of Defense administers a Governmentwide secondary precious-metals recovery program.

Events, Trends, and Issues: Domestic gold mine production in 2012 was estimated to be slightly less than the level of 2011. The decreases were mainly from one mine in Nevada and one mine in Utah. These decreases were partly offset by several mines in Nevada that increased the tonnage of ore processed, and one mine in Montana that reached normal operations level after a period of redevelopment in 2010 and 2011.

Worldwide gold production was flat because increases in production from Canada, China, Ghana, Mali, Mexico, Russia, and Tanzania were offset by production losses in Argentina, Australia, Papua New Guinea, and South Africa. Gold production in China continued to increase, and the country remained the leading gold-producing nation, followed by Australia, the United States, Russia, and South Africa.

Domestic and global jewelry consumption continued to drop because the price of gold continued to increase and a depressed economic environment curtailed consumer spending. In 2012, other industrial applications for gold also dropped as consumers found cheaper substitutes. The estimated gold price in 2012 was 8% higher than the price in 2011. In the first 10 months of 2012, Engelhard’s daily price of gold ranged from a low of $1,543.27 per troy ounce on May 30 to a high of $1,795.45 per troy ounce in early October. The price increased steadily until March, when the price fell through May, before recovering and starting to increase again until October when it started to decline again.

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GOLD

With the increase in the price of gold and the global economic instability that began in 2008, investment in gold continued to increase, as investors seek safe-haven investments. Gold Exchange-Traded Funds (ETFs) have gained popularity with investors. According to some industry analysts, investing in gold in the traditional manner is not as accessible and carries higher costs owing to insurance, storage, and higher markups. The claimed advantage of the ETF is that the investor can purchase gold ETF shares through a stockbroker without being concerned about these problems. Each share represents one-tenth of an ounce of allocated gold.

World Mine Production and Reserves: Reserve data for Brazil, Chile, Ghana, and Peru were revised based on information from the respective country Governments.

	Mine production		Reserves[7]
	2011	2012[e]	
United States	234	230	3,000
Australia	258	250	7,400
Brazil	62	56	2,600
Canada	97	102	920
Chile	45	45	3,900
China	362	370	1,900
Ghana	80	89	1,600
Indonesia	96	95	3,000
Mexico	84	87	1,400
Papua New Guinea	66	60	1,200
Peru	164	165	2,200
Russia	200	205	5,000
South Africa	181	170	6,000
Uzbekistan	91	90	1,700
Other countries	640	645	10,000
World total (rounded)	2,660	2,700	52,000

World Resources: An assessment of U.S. gold resources indicated 33,000 tons of gold in identified (15,000 tons) and undiscovered (18,000 tons) resources.[8] Nearly one-quarter of the gold in undiscovered resources was estimated to be contained in porphyry copper deposits. The gold resources in the United States, however, are only a small portion of global gold resources.

Substitutes: Base metals clad with gold alloys are widely used in electrical and electronic products, and in jewelry to economize on gold; many of these products are continually redesigned to maintain high-utility standards with lower gold content. Generally, palladium, platinum, and silver may substitute for gold.

[e]Estimated. E Net exporter.
[1]One metric ton (1,000 kilograms) = 32,150.7 troy ounces.
[2]Refined bullion, doré, ores, concentrates, and precipitates.
Excludes:

a. Waste and scrap.
b. Official monetary gold.
c. Gold in fabricated items.
d. Gold in coins.
e. Net bullion flow (in tons) to market from foreign stocks at the New York Federal Reserve Bank: 220 (2008), 0 (2009), 0 (2010), -4 (2011), and 0 (2012, estimate).

[3]Includes gold in Exchange Stabilization Fund. Stocks were valued at the official price of $42.22 per troy ounce.
[4]Engelhard's average gold price quotation for the year. In 2012, the price was estimated by the USGS based on monthly data from January through October.
[5]Data from Mine Safety and Health Administration.
[6]Defined as imports – exports + adjustments for Government and industry stock changes.
[7]See Appendix C for resource/reserve definitions and information concerning data sources.
[8]U.S. Geological Survey National Mineral Resource Assessment Team, 2000, 1998 assessment of undiscovered deposits of gold, silver, copper, lead, and zinc in the United States: U.S. Geological Survey Circular 1178, 21 p.

*Corrections posted on July 3, 2013.

GRAPHITE (NATURAL)

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Although natural graphite was not produced in the United States in 2012, approximately 90 U.S. firms, primarily in the Northeastern and Great Lakes regions, used it for a wide variety of applications. The major uses of natural graphite in 2012, in decreasing order by tonnage, were refractory applications, steelmaking, brake linings, foundry operations, batteries, and lubricants. These uses consumed 70% of the total natural graphite used during 2012.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production, mine	—	—	—	—	—
Imports for consumption	58	33	65	72	56
Exports	8	11	6	6	6
Consumption, apparent[1]	50	22	60	66	50
Price, imports (average dollars per ton at foreign ports):					
Flake	753	694	720	1,180	1,530
Lump and chip (Sri Lankan)	2,550	1,410	1,700	1,820	1,990
Amorphous	203	249	257	301	329
Net import reliance[2] as a percentage of apparent consumption	100	100	100	100	100

Recycling: Refractory brick and linings, alumina-graphite refractories for continuous metal castings, magnesia-graphite refractory brick for basic oxygen and electric arc furnaces, and insulation brick led the way in recycling of graphite products. The market for recycled refractory graphite material is growing, with material being recycled into products such as brake linings and thermal insulation.

Recovering high-quality flake graphite from steelmaking kish is technically feasible, but not practiced at the present time. The abundance of graphite in the world market inhibits increased recycling efforts. Information on the quantity and value of recycled graphite is not available.

Import Sources (2008–11): China, 51%; Mexico, 22%; Canada, 17%; Brazil, 6%; and other, 4%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–12**
Crystalline flake (not including flake dust)	2504.10.1000	Free.
Powder	2504.10.5000	Free.
Other	2504.90.0000	Free.

Depletion Allowance: 22% (Domestic lump and amorphous), 14% (Domestic flake), and 14% (Foreign).

Government Stockpile: None.

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GRAPHITE (NATURAL)

Events, Trends, and Issues: Worldwide demand for graphite has steadily increased throughout 2011 and into 2012. This increase resulted from the improvement of global economic conditions and its impact on industries that use graphite. Principal import sources of natural graphite were, in descending order of tonnage, China, Mexico, Canada, Brazil, and Madagascar, which combined accounted for 97% of the tonnage and 90% of the value of total imports. Mexico provided all the amorphous graphite, and Sri Lanka provided all the lump and chippy dust variety. China, Canada, Madagascar, and Zimbabwe were, in descending order of tonnage, the major suppliers of crystalline flake and flake dust graphite.

During 2012, China produced the majority of the world's graphite. Chinese graphite production in 2012 decreased from that of 2011 because the Chinese government ordered the majority of graphite mines it controls in the Hunan province to be closed for environmental and resource protection.

Advances in thermal technology and acid-leaching techniques that enable the production of higher purity graphite powders are likely to lead to development of new applications for graphite in high-technology fields. Such innovative refining techniques have enabled the use of improved graphite in carbon-graphite composites, electronics, foils, friction materials, and special lubricant applications. Flexible graphite product lines, such as graphoil (a thin graphite cloth), are likely to be the fastest growing market. Large-scale fuel-cell applications are being developed that could consume as much graphite as all other uses combined.

World Mine Production and Reserves:

	Mine production		Reserves[3]
	2011	2012[e]	
United States	—	—	—
Brazil	73	75	360
Canada	25	26	([4])
China	800	750	55,000
India	150	150	11,000
Korea, North	30	30	([4])
Madagascar	4	5	940
Mexico	7	8	3,100
Norway	2	7	([4])
Romania	20	7	([4])
Russia	14	14	([4])
Sri Lanka	4	4	([4])
Turkey	10	10	([4])
Ukraine	6	6	([4])
Other countries	7	7	([4])
World total (rounded)	1,150	1,100	77,000

World Resources: Domestic resources of graphite are relatively small, but the rest of the world's inferred resources exceed 800 million tons of recoverable graphite.

Substitutes: Manufactured graphite powder, scrap from discarded machined shapes, and calcined petroleum coke compete for use in iron and steel production. Finely ground coke with olivine is a potential competitor in foundry facing applications. Molybdenum disulfide competes as a dry lubricant but is more sensitive to oxidizing conditions.

[e]Estimated. — Zero.
[1]Defined as imports – exports.
[2]Defined as imports – exports.
[3]See Appendix C for resource/reserve definitions and information concerning data sources.
[4]Included with "World total."

GYPSUM

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2012, domestic production of crude gypsum was estimated to be 9.9 million tons with a value of about $69.3 million. The leading crude gypsum-producing States were, in descending order, Oklahoma, Texas, Iowa, Nevada, and California, which together accounted for 58% of total output. Overall, 47 companies produced gypsum in the United States at 54 mines and plants in 34 States. Approximately 90% of domestic consumption, which totaled approximately 22 million tons, was accounted for by manufacturers of wallboard and plaster products. Approximately 1.5 million tons for cement production and agricultural applications and small amounts of high-purity gypsum for a wide range of industrial processes accounted for the remaining tonnage. At the beginning of 2012, the production capacity of operating wallboard plants in the United States was about 33 billion square feet[1] per year.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production:					
Crude	12,300	10,400	8,840	8,900	9,900
Synthetic[2]	9,660	8,120	10,700	11,800	11,800
Calcined[3]	17,900	13,800	12,100	11,900	12,100
Wallboard products sold (million square feet[1])	20,700	18,300	17,200	17,200	17,500
Imports, crude, including anhydrite	7,330	4,220	3,330	3,330	3,400
Exports, crude, not ground or calcined	149	156	360	316	500
Consumption, apparent[4]	29,100	22,600	22,500	23,700	24,600
Price:					
Average crude, f.o.b. mine, dollars per metric ton	8.70	8.50	6.90	7.00	7.00
Average calcined, f.o.b. plant, dollars per metric ton	42.60	35.00	29.70	30.00	30.00
Employment, mine and calcining plant, number[e]	5,400	4,500	4,500	4,500	4,500
Net import reliance[5] as a percentage of apparent consumption	25	18	13	13	12

Recycling: Some of the more than 4 million tons of gypsum scrap that was generated by wallboard manufacturing, wallboard installation, and building demolition was recycled. The recycled gypsum was used primarily for agricultural purposes and feedstock for the manufacture of new wallboard. Other potential markets for recycled gypsum include athletic field marking, cement production as a stucco additive, grease absorption, sludge drying, and water treatment.

Import Sources (2008–11): Canada, 60%; Mexico, 31%; Spain, 8%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Gypsum; anhydrite	2520.10.0000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: U.S. gypsum production increased 11% compared with that of 2011 as the housing and construction markets increased in activity. Apparent consumption increased by 4% compared with that of 2011. The world's leading gypsum producer, China, produced more than five times the amount produced in the United States, the world's fourth ranked producer. Iran is thought to rank second in world production and supplied much of the gypsum needed for construction in the Middle East. Spain, the leading European producer, ranked third in the world and supplied crude gypsum and gypsum products to much of Western Europe. An increased use of wallboard in Asia, coupled with new gypsum product plants, spurred increased production in that region. As more cultures recognize the economy and efficiency of wallboard use, worldwide production of gypsum is expected to increase.

Demand for gypsum depends principally on the strength of the construction industry, particularly in the United States, where about 95% of consumed gypsum is used for building plasters, the manufacture of portland cement, and wallboard products. If the construction of wallboard manufacturing plants designed to use synthetic gypsum from flue gas desulfurization (FGD) units as feedstock continues, this will result in less mining of natural gypsum. The availability of inexpensive natural gas, however, may limit the increase of future FGD units and, therefore, the production of synthetic gypsum. Gypsum imports increased slightly compared with those of 2011. Exports, although very low compared with imports and often subject to wide fluctuations, increased by 56%.

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GYPSUM

World Mine Production and Reserves: Reserves for Brazil, India, and Poland were revised based on information from those countries.

	Mine production		Reserves[6]
	2011	2012[e]	
United States	8,900	9,900	700,000
Algeria	1,650	1,650	NA
Argentina	1,340	1,200	NA
Australia	3,500	3,000	NA
Brazil	2,750	2,800	230,000
Canada	2,560	2,200	450,000
China	48,000	48,000	NA
France	2,300	2,300	NA
Germany	2,020	2,050	NA
India	2,700	2,750	69,000
Iran	13,000	14,000	NA
Italy	4,130	4,100	NA
Japan	5,600	5,700	NA
Mexico	3,840	3,850	NA
Poland	1,200	1,200	55,000
Russia	3,000	3,100	NA
Saudi Arabia	2,100	2,300	NA
Spain	11,500	11,500	NA
Thailand	9,900	10,000	NA
Turkey	3,200	3,000	NA
United Kingdom	1,700	1,700	NA
Other countries	14,500	14,900	NA
World total (rounded)	149,000	150,000	Large

World Resources: Reserves are large in major producing countries, but data for most are not available. Domestic gypsum resources are adequate but unevenly distributed. Large imports from Canada augment domestic supplies for wallboard manufacturing in the United States, particularly in the eastern and southern coastal regions. Imports from Mexico supplement domestic supplies for wallboard manufacturing along portions of the U.S. western seaboard. Large gypsum deposits occur in the Great Lakes region, the midcontinent region, and several Western States. Foreign resources are large and widely distributed; 87 countries produced gypsum in 2012.

Substitutes: In such applications as stucco and plaster, cement and lime may be substituted for gypsum; brick, glass, metallic or plastic panels, and wood may be substituted for wallboard. Gypsum has no practical substitute in the manufacturing of portland cement. Synthetic gypsum generated by various industrial processes, including flue gas desulfurization of smokestack emissions, is very important as a substitute for mined gypsum in wallboard manufacturing, cement production, and agricultural applications (in descending tonnage order). In 2012, synthetic gypsum accounted for approximately 54% of the total domestic gypsum supply.

[e]Estimated. NA Not available.
[1]The Gypsum Association; multiply square feet by 9.29×10^{-2} to convert to square meters.
[2]Data refer to the amount sold or used, not produced.
[3]From domestic crude and synthetic.
[4]Defined as crude production + total synthetic reported used + imports – exports.
[5]Defined as imports – exports.
[6]See Appendix C for resource/reserve definitions and information concerning data sources.

HELIUM

(Data in million cubic meters of contained helium gas[1] unless otherwise noted)

Domestic Production and Use: The estimated value of Grade-A helium (99.997% or better) extracted domestically during 2012 by private industry was about $830 million. Ten plants (five in Kansas, four in Texas, and one in Wyoming) extracted helium from natural gas and produced only a crude helium product that varied from 50% to 99% helium. Two plants (one in Colorado and one in Wyoming) extracted helium from natural gas and produced a Grade-A helium product. Six plants, (four in Kansas, one in Oklahoma, and one in Texas) accepted a crude helium product from other producers and the Bureau of Land Management (BLM) pipeline and purified it to a Grade-A helium product. Estimated 2012 domestic consumption of helium is 50 million cubic meters (1.8 billion cubic feet) and was used for cryogenic applications, 32%; for pressurizing and purging, 18%; for controlled atmospheres, 18%; for welding cover gas, 13%; leak detection, 4%; breathing mixtures, 2%; and other, 13%.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Helium extracted from natural gas[2]	80	78	75	71	75
Withdrawn from storage[3]	50	40	53	59	60
Grade-A helium sales	130	118	128	130	135
Imports for consumption	—	—	—	—	—
Exports[4]	70	71	77	82	85
Consumption, apparent[4]	60	47	51	48	50
Net import reliance[5] as a percentage of apparent consumption	E	E	E	E	E

Price: In fiscal year (FY) 2012, the price for crude helium to Government users was $2.36 per cubic meter ($65.50 per thousand cubic feet) and to nongovernment users was $2.73 per cubic meter ($75.75 per thousand cubic feet). The price for the Government-owned helium is mandated by the Helium Privatization Act of 1996 (Public Law 104–273). The estimated price range for private industry's Grade-A gaseous helium was about $6.13 per cubic meter ($170 per thousand cubic feet), with some producers posting surcharges to this price.

Recycling: In the United States, helium used in large-volume applications is seldom recycled. Some low-volume or liquid boiloff recovery systems are used. In Western Europe and Japan, helium recycling is practiced when economically feasible.

Import Sources (2008–11): None.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Helium	2804.29.0010	3.7% ad val.

Depletion Allowance: Allowances are applicable to natural gas from which helium is extracted, but no allowance is granted directly to helium.

Government Stockpile: Under Public Law 104–273, the BLM manages the Federal Helium Program, which includes all operations of the Cliffside Field helium storage reservoir, in Potter County, TX, and the Government's crude helium pipeline system. The BLM no longer supplies Federal agencies with Grade-A helium. Private firms that sell Grade-A helium to Federal agencies are required to purchase a like amount of (in-kind) crude helium from the BLM. The Helium Privatization Act of 1996 mandated that all Federal Conservation helium stored in Bush Dome at the Cliffside Field be offered for sale, except 16.6 million cubic meters (600 million cubic feet).

In FY 2012, privately owned companies purchased about 4.3 million cubic meters (154 million cubic feet) of in-kind crude helium. In addition to this, privately owned companies also purchased 58.2 million cubic meters (2,100 million cubic feet) of open market sales helium. During FY 2012, the BLM's Amarillo Field Office, Helium Operations (AMFO), accepted about 10.1 million cubic meters (363 million cubic feet) of private helium for storage and redelivered nearly 62.2 million cubic meters (2,494 million cubic feet). As of September 30, 2012, about 35.4 million cubic meters (1,277 million cubic feet) of privately owned helium remained in storage at Cliffside Field.

Stockpile Status—9–30–12[6]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2012	Disposals FY 2012
Helium	352.9	352.9	63.8	63.4

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HELIUM

Events, Trends, and Issues: In 2012, BLM continued to use a pricing mechanism based on the requirements of the Helium Privatization Act of 1996. During 2012, BLM helium prices to nongovernment buyers increased to $2.73 per cubic meter ($75.50 per thousand cubic feet) of gas delivered. In 2013, increased cost recovery measures are expected to be implemented at various natural gas fields throughout the United States, including the Hugoton and Riley Ridge Fields. The AMFO conducted four open market helium offerings in FY 2012, selling a total of 58.2 million cubic meters (2,100 million cubic feet) of helium. By the end of the decade, international helium extraction facilities are likely to become the main source of supply for world helium uses. Seven international helium plants are in operation and more are planned for the next 3 to 5 years. Expansions to facilities are planned in Algeria and Qatar. Additionally, a new extraction facility associated with LNG production in Qatar is expected to be online within the next 2 years. In 2012, demand exceeded the ability of the BLM's Crude Helium Enrichment Unit to supply its customers along the crude helium pipeline. As a result, the BLM allocated helium to the refiners along the pipeline. The shortage of helium and allocations are expected to continue in 2013 and may become greater as the storage reservoir production declines.

World Production and Reserves:

	Production		Reserves[8]
	2011	2012[e]	
United States (extracted from natural gas)	71	75	4,000
United States (from Cliffside Field)	59	60	([9])
Algeria	20	20	1,800
Canada	NA	NA	NA
China	NA	NA	NA
Poland	3	3	30
Qatar	13	15	NA
Russia	6	—	1,700
Other countries	NA	NA	NA
World total (rounded)	172	173	NA

World Resources: As of December 31, 2006, the total helium reserves and resources of the United States were estimated to be 20.6 billion cubic meters (744 billion cubic feet). This includes 4.25 billion cubic meters (153.2 billion cubic feet) of measured reserves, 5.33 billion cubic meters (192.2 billion cubic feet) of probable resources, 5.93 billion cubic meters (213.8 billion cubic feet) of possible resources, and 5.11 billion cubic meters (184.4 billion cubic feet) of speculative resources. Included in the measured reserves are 0.67 billion cubic meters (24.2 billion cubic feet) of helium stored in the Cliffside Field Government Reserve, and 0.065 billion cubic meters (2.3 billion cubic feet) of helium contained in Cliffside Field native gas. The Hugoton (Kansas, Oklahoma, and Texas), Panhandle West, Panoma, Riley Ridge in Wyoming, and Cliffside Fields are the depleting fields from which most U.S.-produced helium is extracted. These fields contained an estimated 3.9 billion cubic meters (140 billion cubic feet) of helium.

Helium resources of the world, exclusive of the United States, were estimated to be about 31.3 billion cubic meters (1.13 trillion cubic feet). The locations and volumes of the major deposits, in billion cubic meters, are Qatar, 10.1; Algeria, 8.2; Russia, 6.8; Canada, 2.0; and China, 1.1. As of December 31, 2010, the AMFO had analyzed about 22,000 gas samples from 26 countries and the United States, in a program to identify world helium resources.

Substitutes: There is no substitute for helium in cryogenic applications if temperatures below –429 °F are required. Argon can be substituted for helium in welding, and hydrogen can be substituted for helium in some lighter-than-air applications in which the flammable nature of hydrogen is not objectionable. Hydrogen is also being investigated as a substitute for helium in deep-sea diving applications below 1,000 feet.

[e]Estimated. E Net exporter. NA Not available. — Zero.

[1]Measured at 101.325 kilopascals absolute (14.696 psia) and 15 °C; 27.737 cubic meters of helium = 1 Mcf of helium at 70 °F and 14.7 psia.

[2]Both Grade-A and crude helium.

[3]Extracted from natural gas in prior years.

[4]Grade-A helium.

[5]Defined as imports – exports + adjustments for Government and industry stock changes.

[6]See Appendix B for definitions.

[7]Team Leader, Resources and Evaluation Group, Bureau of Land Management, Amarillo Field Office, Helium Operations, Amarillo, TX.

[8]See Appendix C for resource/reserve definitions and information concerning data sources.

[9]Included in United States (extracted from natural gas) reserves.

INDIUM

(Data in metric tons unless otherwise noted)

Domestic Production and Use: Indium was not recovered from ores in the United States in 2012. Two companies, one in New York and the other in Rhode Island, produced indium metal and indium products by upgrading lower grade imported indium metal. High-purity indium shapes, alloys, and compounds were also produced from imported indium by several additional firms. Production of indium tin oxide (ITO) continued to be the leading end use of indium and accounted for most global indium consumption. ITO thin-film coatings were primarily used for electrically conductive purposes in a variety of flat-panel devices—most commonly liquid crystal displays (LCDs). Other end uses included solders and alloys, compounds, electrical components and semiconductors, and research. The estimated value of primary indium metal consumed in 2012, based on the annual average New York dealer price, was about $49 million.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production, refinery	—	—	—	—	—
Imports for consumption[1]	144	105	117	146	110
Exports	NA	NA	NA	NA	NA
Consumption, estimated	125	130	110	120	90
Price, annual average, dollars per kilogram:					
U.S. producer[2]	685	500	565	720	650
New York dealer[3]	519	382	552	685	540
99.99% c.i.f. Japan[4]	479	348	546	680	510
Stocks, producer, yearend	NA	NA	NA	NA	NA
Net import reliance[5] as a percentage of estimated consumption	100	100	100	100	100

Recycling: Data on the quantity of secondary indium recovered from scrap were not available. Indium is most commonly recovered from ITO. Sputtering, the process in which ITO is deposited as a thin-film coating onto a substrate, is highly inefficient; approximately 30% of an ITO target material is deposited onto the substrate. The remaining 70% consists of the spent ITO target material, the grinding sludge, and the after-processing residue left on the walls of the sputtering chamber. ITO recycling is concentrated in China, Japan, and the Republic of Korea—the countries where ITO production and sputtering take place.

An LCD manufacturer has developed a process to reclaim indium directly from scrap LCD panels. Indium recovery from tailings was thought to have been insignificant, as these wastes contain low amounts of the metal and can be difficult to process. However, recent improvements to the process technology have made indium recovery from tailings viable when the price of indium is high.

Import Sources (2008–11):[1] China, 29%; Canada, 23%; Japan, 14%; Belgium, 11%; and other, 23%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Unwrought indium, including powders	8112.92.3000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: The annual average New York dealer price of indium decreased by approximately 21% in 2012 from that of 2011. The New York dealer price range for indium began the year at $630 to $670 per kilogram and decreased through late July, reaching a low of $485 to $520 per kilogram. The price range then increased beginning in September to $500 to $540 per kilogram, where it remained through early November. The U.S. producer price for indium began the year at $785 per kilogram. The price declined to $580 per kilogram in May and remained at that level through early November.

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INDIUM

Japanese imports of indium were 115 tons during the first 8 months of 2012, a decrease of almost 70% compared with those during the same period in 2011. Leading import sources included the Republic of Korea, Canada, and the United States, in descending order of quantity. During the time period, imports from China decreased by 94% year on year, while imports from the United States increased by 184%.

The Chinese indium export quota decreased slightly in 2012 from that of 2011 to 231 tons, of which the quota for the first half of the year was set at 139 tons, and the quota for the second half of the year totaled 92 tons. The number of companies that received export licenses remained at 18 in 2012.

World Refinery Production and Reserves:

	Refinery production		Reserves[6]
	2011	2012[e]	
United States	—	—	Quantitative estimates of reserves are not available.
Belgium	30	30	
Brazil	5	5	
Canada	75	70	
China	380	390	
Japan	70	70	
Korea, Republic of	70	70	
Russia	5	5	
Other countries	27	30	
World total (rounded)	662	670	

World Resources: Indium's abundance in the continental crust is estimated to be approximately 0.05 part per million. Trace amounts of indium occur in base metal sulfides—particularly chalcopyrite, sphalerite, and stannite—by ionic substitution. Indium is most commonly recovered from the zinc-sulfide ore mineral sphalerite. The average indium content of zinc deposits from which it is recovered ranges from less than 1 part per million to 100 parts per million. Although the geochemical properties of indium are such that it occurs with other base metals—copper, lead, and tin—and to a lesser extent with bismuth, cadmium, and silver, most deposits of these metals are subeconomic for indium.

Vein stockwork deposits of tin and tungsten host the highest known concentrations of indium. However, the indium from this type of deposit is usually difficult to recover economically. Other major geologic hosts for indium mineralization include volcanic-hosted massive sulfide deposits, sediment-hosted exhalative massive sulfide deposits, polymetallic vein-type deposits, epithermal deposits, active magmatic systems, porphyry copper deposits, and skarn deposits.

Substitutes: Indium's recent price volatility and various supply concerns associated with the metal have accelerated the development of ITO substitutes. Antimony tin oxide coatings, which are deposited by an ink-jetting process, have been developed as an alternative to ITO coatings in LCDs and have been successfully annealed to LCD glass. Carbon nanotube coatings, applied by wet-processing techniques, have been developed as an alternative to ITO coatings in flexible displays, solar cells, and touch screens. Poly(3,4-ethylene dioxythiophene) (PEDOT) has also been developed as a substitute for ITO in flexible displays and organic light-emitting diodes. PEDOT can be applied in a variety of ways, including spin coating, dip coating, and printing techniques. Graphene quantum dots have been developed to replace ITO electrodes in solar cells and also have been explored as a replacement for ITO in LCDs. Researchers have recently developed a more adhesive zinc oxide nanopowder to replace ITO in LCDs. Gallium arsenide can substitute for indium phosphide in solar cells and in many semiconductor applications. Hafnium can replace indium in nuclear reactor control rod alloys.

[e]Estimated. NA Not available. — Zero.
[1]Imports for consumption of unwrought indium and indium powders (Tariff no. 8112.92.3000).
[2]Indium Corp.'s price for 99.97%-purity metal; 1-kilogram bar in lots of 10,000 troy ounces. Source: Platts Metals Week.
[3]Price is based on 99.99%-minimum-purity indium at warehouse (Rotterdam); cost, insurance, and freight (in minimum lots of 50 kilograms). Source: Platts Metals Week.
[4]Price is based on 99.99%-purity indium, primary or secondary, shipped to Japan. Source: Platts Metals Week.
[5]Defined as imports – exports + adjustments for Government and industry stock changes; exports were assumed to be no greater than the difference between imports and consumption.
[6]See Appendix C for resource/reserve definitions and information concerning data sources.

IODINE

(Data in metric tons elemental iodine unless otherwise noted)

Domestic Production and Use: Iodine was produced in 2012 by two companies operating in Oklahoma, and one company in Montana. Production in 2012 was estimated to have slightly increased from that of 2011. To avoid disclosing company proprietary data, U.S. iodine production in 2012 was withheld. The operation at Woodward, OK, continued production of iodine from subterranean brines. Another company continued production at Vici, OK. Prices for iodine have increased in recent years owing to high demand, which has led to high utilization of capacity. The Japanese earthquake and tsunami in March 2011 tightened iodine supplies through disruptions in Japanese iodine production and panic buying of potassium iodide anti-radiation tablets. The average cost, insurance, and freight value of iodine imports in 2012 was estimated to be $41.00 per kilogram.

Domestic and imported iodine were used by downstream manufacturers to produce many intermediate iodine compounds, making it difficult to establish an accurate end-use pattern. Of the consumers that participate in an annual U.S. Geological Survey canvass, 17 plants reported consumption of iodine in 2011. Iodine and iodine compounds reported were unspecified organic and inorganic compounds, including ethyl and methyl iodide, 50%; ethylenediamine dihydroiodide, 5%; crude iodine, 4%; povidine-iodine, 9%; hydriodic acid, 3%; potassium iodide, 11%; resublimed iodine, 2%; sodium iodide, 3%; and other inorganic compounds, 13%.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production	W	W	W	W	W
Imports for consumption, crude content	6,300	5,190	5,710	6,590	5,200
Exports	950	1,160	1,070	900	1,000
Consumption:					
Apparent	W	W	W	W	W
Reported	4,580	4,550	4,640	4,740	4,700
Price, average c.i.f. value, dollars per kilogram, crude	21.52	25.55	24.39	38.13	41.00
Employment, number[e]	30	30	30	30	30
Net import reliance[1] as a percentage of reported consumption	100	89	100	100	88

Recycling: Small amounts of iodine were recycled, but no data were reported.

Import Sources (2008–11): Chile, 84%; Japan, 15%; and other, 1%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–12**
Iodine, crude	2801.20.0000	Free.
Iodide, calcium or copper	2827.60.1000	Free.
Iodide, potassium	2827.60.2000	2.8% ad val.
Iodides and iodide oxides, other	2827.60.5100	4.2% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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IODINE

Events, Trends, and Issues: In response to strong demand for iodine in recent years driven by the liquid crystal display (LCD) and x-ray contrast media industries, coupled with a supply shortfall resulting from the Japanese disaster in 2011, iodine prices were expected to remain at record high levels at the end of 2012 and into 2013. With a projected global economic recovery, demand for iodine used in biocides, iodine salts, LCDs, synthetic fabric treatments, and x-ray contrast media was expected to increase at a rate of between 3.5% and 4% per year during the next decade.

As in recent years, Chile was the world's leading producer of iodine, followed by Japan and the United States. Chile accounted for more than 59% of world production in 2011, having two of the leading iodine producers in the world. The Chilean producers were operating near capacity and were expected to expand production in response to changes in demand and to capitalize on price increases. The third largest Chilean producer initiated a new project at Algorta, Chile, which was expected to replace its current operation at Lagunas, Chile.

World Mine Production and Reserves: The reserve data for Chile were revised based on information reported by the Government of Chile.

	Mine production		Reserves[2]
	2011	2012[e]	
United States	W	W	250,000
Azerbaijan	300	300	170,000
Chile	16,000	17,000	1,800,000
China	590	600	4,000
Indonesia	75	75	100,000
Japan	9,300	9,400	5,000,000
Russia	300	300	120,000
Turkmenistan	270	270	170,000
Uzbekistan	2	2	NA
World total (rounded)	[3]26,800	[3]28,000	7,600,000

World Resources: In addition to the reserves shown above, seawater contains 0.06* parts per million iodine, or approximately 90 billion* tons. Seaweeds of the Laminaria family are able to extract and accumulate up to 0.45% iodine on a dry basis. Although not as economical as the production of iodine as a byproduct of gas, nitrate, and oil, the seaweed industry represented a major source of iodine prior to 1959 and remains a large resource.

Substitutes: There are no comparable substitutes for iodine in many of its principal applications, such as in animal feed, catalytic, nutritional, pharmaceutical, and photographic uses. Bromine and chlorine could be substituted for iodine in biocide, colorant, and ink, although they are usually considered less desirable than iodine. Antibiotics can be used as a substitute for iodine biocides.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Defined as imports – exports + adjustments for Government and industry stock changes.
[2]See Appendix C for resource/reserve definitions and information concerning data sources.
[3]Excludes U.S. production.

*Corrections posted on July 3, 2013.

IRON AND STEEL[1]

(Data in million metric tons of metal unless otherwise noted)

Domestic Production and Use: The iron and steel industry and ferrous foundries produced goods in 2012 that were estimated to be valued at $112 billion. Pig iron was produced by 5 companies operating integrated steel mills in 15 locations. About 48 companies produce raw steel at about 108 minimills. Combined production capability was about 118 million tons. Indiana accounted for 23% of total raw steel production, followed by Ohio, 14%; Michigan, 7%; and Pennsylvania, 6%. The distribution of steel shipments was estimated to be warehouses and steel service centers, 26%; construction, 16%; transportation (predominantly automotive), 15%; cans and containers, 3%; and other, 40%.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Pig iron production[2]	33.7	19.0	26.8	30.2	33
Steel production:	91.9	59.4	80.5	86.4	91
Basic oxygen furnaces, percent	42.6	38.2	38.7	39.7	41
Electric arc furnaces, percent	57.4	61.8	61.3	60.3	59
Continuously cast steel, percent	96.4	97.5	97.4	98.0	99
Shipments:					
Steel mill products	89.4	56.4	75.7	83.3	89
Steel castings[e, 3]	0.7	0.4	0.4	0.4	0.4
Iron castings[e, 3]	7.4	4.0	4.0	4.0	4.0
Imports of steel mill products	29.0	14.7	21.7	25.9	31
Exports of steel mill products	12.2	8.4	11.0	12.2	13
Apparent steel consumption[4]	102	63	80	90	101
Producer price index for steel mill products (1982=100)[5]	220.6	165.2	191.7	216.2	200
Steel mill product stocks at service centers, yearend[6]	7.8	5.6	7.0	7.6	7
Total employment, average, number:					
Blast furnaces and steel mills	99,000	85,000	87,000	94,000	90,000
Iron and steel foundries[e]	86,000	86,000	86,000	86,000	86,000
Net import reliance[7] as a percentage of apparent consumption	13	11	6	7	11

Recycling: See Iron and Steel Scrap and Iron and Steel Slag.

Import Sources (2008–11): Canada, 24%; European Union, 16%; Mexico, 11%; Republic of Korea, 8%; and other, 41%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Pig iron	7201.00.0000	Free.
Carbon steel:		
Semifinished	7207.00.0000	Free.
Sheets, hot-rolled	7208.10.0000	Free.
Hot-rolled, pickled	7208.10.1500	Free.
Cold-rolled	7209.00.0000	Free.
Galvanized	7210.00.0000	Free.
Bars, hot-rolled	7213.00.0000	Free.
Structural shapes	7216.00.0000	Free.
Stainless steel:		
Semifinished	7218.00.0000	Free.
Cold-rolled sheets	7219.31.0000	Free.
Bars, cold-finished	7222.20.0000	Free.

Depletion Allowance: Not applicable.

Government Stockpile: None.

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IRON AND STEEL

Events, Trends, and Issues: The expansion or contraction of gross domestic product (GDP) may be considered a predictor of the health of the steelmaking and steel manufacturing industries, worldwide and domestically. The World Bank's (WB) global GDP growth forecast for 2013 and 2014 was 3.0% and 3.3%, respectively, after 2.5% in 2012. The WB forecast that the U.S. economy would expand in 2013 and 2014 at rates of 2.4% and 2.8%, respectively.

According to the Institute of Supply Management (ISM), economic activity in the manufacturing sector expanded in October 2012 for the second consecutive month following 3 consecutive months of slight contraction, and the overall economy grew for the 41st consecutive month. The ISM manufacturing Purchasing Managers Index fluctuated between 49.6 and 54.8 during the 12 months ending October 2012 while averaging 52.2, which corresponds to a 3.2% increase in real GDP. An index in excess of 42.6 for a period of time generally indicates an expansion of the overall economy.

MEPS International Inc. forecast total world steel production in 2012 to be 5% more than that in 2011. MEPS also forecast changes in steel production in 2012 in Asia (excluding China), Africa/Middle East, China, the Commonwealth of Independent States/other Europe, European Union, North America, and South America, of 2.4%, 8.1%, 7.9%, 3.6%, 1.6%, 4.7%, and 5.4%, respectively. China accounted for about 47% of world steel production.

According to the World Steel Association, world apparent steel consumption (ASC) was expected to increase by 2.1% to 1.41 billion tons in 2012, and increase by 3.2% to 1.46 billion tons in 2013. ASC in China, the world's leading producer and consumer of steel, is expected to increase by 2.5% and by 3.1% in 2012 and 2013, to 640 million tons and 659 million tons, respectively. ASC for North America is expected to increase by 7.5% in 2012 to 130 million tons and by 3.6% in 2013 to135 million tons. ASC for India is expected to increase by 5.5% and 5.0% in 2012 and 2013, respectively. The global steel industry has been struggling from the impact of the debt crisis in Europe and slowing demand and oversupply in China. The global economy unexpectedly deteriorated during the second quarter of 2012 owing to continued uncertainty in the Euro area and a sharper than expected slowing of the China economy.

World Production:

	Pig iron		Raw steel	
	2011	2012[e]	2011	2012[e]
United States	30	33	86	91
Brazil	31	27	33	35
China	630	670	683	720
France	10	10	16	16
Germany	28	27	44	43
India	39	42	72	76
Japan	81	82	108	108
Korea, Republic of	42	42	69	70
Russia	50	51	68	72
Ukraine	29	29	35	34
United Kingdom	7	7	10	10
Other countries	113	80	296	225
World total (rounded)	1,090	1,100	1,520	1,500

World Resources: Not applicable. See Iron Ore.

Substitutes: Iron is the least expensive and most widely used metal. In most applications, iron and steel compete either with less expensive nonmetallic materials or with more expensive materials that have a performance advantage. Iron and steel compete with lighter materials, such as aluminum and plastics, in the motor vehicle industry; aluminum, concrete, and wood in construction; and aluminum, glass, paper, and plastics in containers.

[e]Estimated.

[1]Production and shipments data source is the American Iron and Steel Institute; see also Iron Ore and Iron and Steel Scrap.

[2]More than 95% of iron made is transported in molten form to steelmaking furnaces located at the same site.

[3]U.S. Census Bureau.

[4]Defined as steel shipments + imports - exports + adjustments for industry stock changes - semifinished steel product imports.

[5]U.S. Department of Labor, Bureau of Labor Statistics.

[6]Metals Service Center Institute.

[7]Defined as imports – exports + adjustments for Government and industry stock changes.

IRON AND STEEL SCRAP[1]

(Data in million metric tons of metal unless otherwise noted)

Domestic Production and Use: Total value of domestic purchases (receipts of ferrous scrap by all domestic consumers from brokers, dealers, and other outside sources) and exports was estimated to be $39.4 billion in 2012, 22% less than that of 2011. U.S. apparent steel consumption, an indicator of economic growth, increased to about 101 million tons in 2012. Manufacturers of pig iron, raw steel, and steel castings accounted for about 32% of scrap consumption by the domestic steel industry, using scrap together with pig iron and direct-reduced iron to produce steel products for the appliance, construction, container, machinery, oil and gas, transportation, and various other consumer industries. The ferrous castings industry consumed most of the remaining 68% to produce cast iron and steel products, such as motor blocks, pipe, and machinery parts. Relatively small quantities of scrap were used for producing ferroalloys, for the precipitation of copper, and by the chemical industry; these uses collectively totaled less than 1 million tons.

During 2012, raw steel production was about 91 million tons, up about 5.3% from that of 2011; annual steel mill capability utilization was about 78% compared with 74% for 2011. Net shipments of steel mill products were about 89 million tons compared with 83* million tons for 2011.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production:					
Home scrap	12	10	10	*10	*10
Purchased scrap[2]	73	70	66	*72	*72
Imports for consumption[3]	4	3	4	4	4
Exports[3]	22	22	21	24	23
Consumption, reported	68	54	60	*63	57
Price, average, dollars per metric ton delivered, No. 1 Heavy Melting composite price, Iron Age Average, Pittsburgh, Philadelphia, Chicago	349	208	319	392	375
Stocks, consumer, yearend	4.3	3.1	3.3	*4.1	4.0
Employment, dealers, brokers, processors, number[4]	30,000	30,000	30,000	30,000	30,000
Net import reliance[5] as a percentage of reported consumption	E	E	E	E	E

Recycling: Recycled iron and steel scrap is a vital raw material for the production of new steel and cast iron products. The steel and foundry industries in the United States have been structured to recycle scrap, and, as a result, are highly dependent upon scrap.

In the United States, the primary source of old steel scrap was the automobile. The recycling rate for automobiles in 2011, the latest year for which statistics were available, was about 95%. In 2011, the automotive recycling industry recycled more than 15.5 million tons of steel from end-of-life vehicles through more than 300 car shredders, the equivalent of nearly 11.9 million automobiles. More than 12,500 vehicle dismantlers throughout North America resell parts.

The recycling rates for appliances and steel cans in 2011 were 90% and nearly 71%, respectively; this is the latest year for which statistics were available. Recycling rates for construction materials in 2011 were, as in 2010, about 98% for plates and beams and 70% for rebar and other materials. The recycling rates for appliance, can, and construction steel are expected to increase not only in the United States, but also in emerging industrial countries at an even greater rate. Public interest in recycling continues, and recycling is becoming more profitable and convenient as environmental regulations for primary production increase.

Recycling of scrap plays an important role in the conservation of energy because the remelting of scrap requires much less energy than the production of iron or steel products from iron ore. Also, consumption of iron and steel scrap by remelting reduces the burden on landfill disposal facilities and prevents the accumulation of abandoned steel products in the environment. Recycled scrap consists of approximately 47% post-consumer (old, obsolete) scrap, 8% prompt scrap (produced in steel-product manufacturing plants), and 45% home scrap (recirculating scrap from current operations).

Import Sources (2008–11): Canada, 79%; Mexico, 10%; United Kingdom, 5%; Sweden, 3%; and other, 3%.

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IRON AND STEEL SCRAP

Tariff: Item	**Number**	**Normal Trade Relations 12–31–12**
Iron and steel waste and scrap:		
No. 1 Bundles	7204.41.0020	Free.
No. 1 Heavy Melting	7204.49.0020	Free.
No. 2 Heavy Melting	7204.49.0040	Free.
Shredded	7204.49.0070	Free.

Depletion Allowance: Not applicable.

Government Stockpile: None.

Events, Trends, and Issues: Hot-rolled steel prices decreased steadily during 2012 from a high in January of about $820 per ton to about $650 per ton in October 2012. During the first 11 months of 2012, prices of hot-rolled steel were lower than those in 2011. The producer price index for steel mill products increased to 222 in May 2011 from 153 in May 2009 and then decreased steadily to an estimated low of 199 in October 2012. Steel mill production capability utilization peaked at 80.9% in April 2012 from a low of 40.8% in April 2009.

Scrap prices fluctuated during the first 8 months of 2012, between about $311 and $421 per ton. Composite prices published by Scrap Price Bulletin for No. 1 Heavy Melting steel scrap delivered to purchasers in Chicago, IL, and Philadelphia and Pittsburgh, PA, averaged about $376 per ton during the first 8 months of 2012. As reported by Scrap Price Bulletin, the average price for nickel-bearing stainless steel scrap delivered to purchasers in Pittsburgh was about $1,762 per ton during the first 10 months of 2012, which was 19% lower than the 2011 average price of $2,182 per ton. Exports of ferrous scrap decreased in 2012 to an estimated 23 million tons from 24.3 million tons during 2011, mainly to Turkey, the Republic of Korea, Taiwan, Canada, and, China, in descending order of export tonnage. Export scrap value decreased* from $11.4 billion in 2011 to an estimated $10.1 billion in 2012.

Continuing and growing concern about the European Union sovereign-debt and banking crises* have adversely affected steel consumer confidence; depressed steel demand, production, and prices; and, thus, caused ferrous scrap prices to fluctuate considerably. World steel consumption was expected to increase by 2.1% in 2012 and 3.2% in 2013, following 15% annual growth in 2010 and 5.6% in 2011, according to the World Steel Association.

The 2008–12 global economic recession, which began in December 2007, adversely affected the entire world economy, including substantial slowing of the economic growth in developed and underdeveloped countries, including the United States, Europe, and Asia-Pacific countries. Purchases of new steel products by consumers have been delayed while recycling activity has declined, which has led to a steep decline in the global supply of scrap steel. The anticipated recovery of the global economy is expected to cause increased demand for, and the availability of, steel scrap. Global scrap steel consumption may reach 570 million tons by 2015.

World Mine Production and Reserves: Not applicable.

World Resources: Not applicable.

Substitutes: About 2.6 million tons of direct-reduced iron was used in the United States in 2012 as a substitute for iron and steel scrap, up from 1.6 million tons in 2011.

[e]Estimated. E Net exporter.
[1]See also Iron Ore and Iron and Steel.
[2]Receipts – shipments by consumers + exports – imports.
[3]Includes used rails for rerolling and other uses, and ships, boats, and other vessels for scrapping.
[4]Estimated, based on 2002 Census of Wholesale Trade for 2007 through 2011.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
*Corrections posted on April 2, 2013.

IRON AND STEEL SLAG

(Data in million metric tons unless otherwise noted)

Domestic Production and Use: Ferrous slags are coproducts of iron- and steelmaking and are sold primarily to the construction industry. Data on U.S. slag production are unavailable, but it is estimated to have been in the range of 17 to 22 million tons in 2012. Sales improved modestly but remained constrained by continued low levels of construction spending, particularly in the public sector. An estimated 16 million tons of iron and steel slag, valued at about $270 million[1] (f.o.b. plant), was sold in 2012. Iron (blast furnace) slag accounted for about 50% of the tonnage sold and had a value of about $250 million; nearly 85% of this value was granulated slag. Steel slag produced from basic oxygen and electric arc furnaces accounted for the remainder.[2] Slag was processed by nearly 30 companies servicing active iron and (or) steel facilities or reprocessing old slag piles at about 120 sites in 32 States; included in this tally are a number of facilities that grind and sell ground granulated blast furnace slag (GGBFS) based on imported unground feed.

The prices listed in the table below are weighted, rounded averages for iron and steel slags sold for a variety of applications. Actual prices per ton ranged widely in 2012 from a few cents for some steel slags at a few locations to about $100 for some GGBFS. Air-cooled iron slag and steel slag are mainly used as aggregates in concrete (air-cooled iron slag only), asphaltic paving, fill, and road bases; both slag types also are used as a feed for cement kilns. Almost all GGBFS is used as a partial substitute for portland cement in concrete mixes or in blended cements. Pelletized slag is generally used for lightweight aggregate but can be ground into material similar to GGBFS. Owing to their low unit values, most slag types can be shipped by truck only over short distances, but rail and waterborne transportation can be longer. The much higher unit value of GGBFS allows this slag to be shipped economically over longer distances.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production, marketed[1, 3]	18.8	12.5	15.8	15.4	16.0
Imports for consumption[4]	1.3	1.3	1.4	1.5	1.6
Exports	([5])	([5])	0.1	([5])	0.1
Consumption, apparent[4, 6]	18.8	12.5	15.8	15.4	16.0
Price average value, dollars per ton, f.o.b. plant	18.00	19.00	17.00	16.50	17.00
Stocks, yearend	NA	NA	NA	NA	NA
Employment, number[e]	2,100	2,000	2,100	2,000	1,800
Net import reliance[7] as a percentage of apparent consumption	7	10	8	9	9

Recycling: Slag is commonly returned to the blast and steel furnaces as ferrous and flux feed, but data on these returns are incomplete. Entrained metal, particularly in steel slag, is routinely recovered during slag processing for return to the furnaces, but data on metal returns are unavailable.

Import Sources (2008–11): Granulated blast furnace slag (mostly unground) is the dominant type of ferrous slag imported, but official import data include significant tonnages of nonslag materials (such as cenospheres, fly ash, and silica fume) and slags or other residues of various metallurgical industries (such as copper slag) whose unit values are outside the range expected for granulated slag. The official data appear to have underreported the granulated slag imports in some recent years, but likely not in 2011. Based on official data, the principal country sources for 2008–11 were Japan, 43%; Canada, 37%; Italy, 8%; South Africa, 7%; and other, 5%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Granulated slag	2618.00.0000	Free.
Slag, dross, scale, from manufacture of iron and steel	2619.00.3000	Free.

Depletion Allowance: Not applicable.

Government Stockpile: None.

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IRON AND STEEL SLAG

Events, Trends, and Issues: Blast furnace slag availability overall is becoming increasingly constrained by the general decline in recent years in the number of active U.S. blast furnaces (with three closing in 2012, perhaps permanently), the lack of construction of new furnaces, and the depletion of old slag piles. At yearend 2012, granulation cooling was installed at only three active blast furnaces but was being evaluated for installation at other sites, contingent on the sites remaining active. Pelletized blast furnace slag was in very limited supply, but it was uncertain if any additional pelletizing capacity was being planned. Production of basic oxygen furnace steel slag from integrated iron and steel works has increased recently as some previously idled steel furnaces were restarted, but slag availability for the construction market remained constrained by significant volumes of slag being returned to the furnaces and by the uncertain fate of the blast furnaces. Slag from electric arc steel furnaces (largely fed with steel scrap) remains relatively abundant. Where slag availability has not been a problem, slag (as aggregate) sales to the construction sector have sometimes been less volatile than those of natural aggregates or of cement. In contrast, sales of GGBFS have trended more in line with those of cement, but, for both environmental and performance reasons, this slag's share of the cementitious material market has increased in recent years, although it remains a very small share. Sales prices for GGBFS remain lower than those for portland cement; however, the differences have become small owing to significant declines in cement prices in recent years. Draft regulations released in 2009–11 to restrict emissions (especially of mercury) by U.S. cement plants and to reclassify fly ash as a hazardous waste for disposal purposes have the potential to reduce the supply of these cementitious materials to the U.S. market and could lead to an increase in demand for GGBFS. Long-term growth in the supply of GGBFS will mainly depend on imports, either of ground or unground material.

World Mine Production and Reserves: Slag is not a mined material and thus the concept of reserves does not apply to this mineral commodity. Slag production data for the world are unavailable, but it is estimated that annual world iron slag output in 2012 was on the order of 270 to 320 million tons, and steel slag about 150 to 230 million tons, based on typical ratios of slag to crude iron and steel output.

World Resources: Not applicable.

Substitutes: Slag competes with crushed stone and sand and gravel as aggregates in the construction sector. Fly ash, natural pozzolans, and silica fume are common alternatives to GGBFS as cementitious additives in blended cements and concrete. Slags (especially steel slag) can be used as a partial substitute for limestone and some other natural (rock) materials as raw material for clinker (cement) manufacture. Some other metallurgical slags, such as copper slag, can compete with ferrous slags in some specialty markets but are generally in much more restricted supply than ferrous slags.

[e]Estimated. NA Not available.
[1]The data (obtained from an annual survey of slag processors) pertain to the quantities of processed slag sold rather than that processed or produced during the year. The data exclude any entrained metal that may be recovered during slag processing and returned to iron and, especially, steel furnaces, and are incomplete regarding slag returns to the furnaces.
[2]There were very minor sales of open hearth furnace steel slag from stockpiles but no domestic production of this slag type in 2008–12.
[3]Data include sales of imported granulated blast furnace slag, either after domestic grinding or still unground, and exclude sales of pelletized slag (proprietary but very small). Overall, actual production of blast furnace slag may be estimated as equivalent to 25% to 30% of crude (pig) iron production and steel furnace slag as about 10% to 15% of crude steel output.
[4]Comparison of official (U.S. Census Bureau) with unofficial import data suggest that the official data may have understated the true imports of granulated slag, at least prior to 2010, by amounts up to about 1 million tons per year. The USGS canvass appears to capture only part of the imported slag.
[5]Less than 0.05 million metric tons.
[6]Although definable as total sales of slag (including those from imported feed) minus exports, apparent consumption of slag does not significantly differ from total sales owing to the very small export tonnages.
[7]Defined as total imports of slag minus exports of slag. Data are not available to allow adjustments for changes in stocks.

IRON ORE[1]

(Data in million metric tons of usable ore[2] unless otherwise noted)

Domestic Production and Use: In 2012, mines in Michigan and Minnesota shipped 97% of the usable ore produced in the United States, with an estimated value of $6.0 billion. Thirteen iron ore mines (11 open pits, 1 reclamation operation, and 1 dredging operation), 9 concentration plants, and 9 pelletizing plants operated during the year. Almost all ore was concentrated before shipment. Eight of the mines operated by three companies accounted for virtually all of the production. The United States was estimated to have produced and consumed 2% of the world's iron ore output.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production, usable	53.6	26.7	49.9	54.7	53.2
Shipments	53.6	27.6	50.6	55.6	54.1
Imports for consumption	9.2	3.9	6.4	5.3	5.2
Exports	11.1	3.9	10.0	11.1	11.8
Consumption:					
Reported (ore and total agglomerate)[3]	51.9	31.0	42.3	46.3	45.0
Apparent[e]	49.7	25.7	48.0	49.1	49.6
Price,[4] U.S. dollars per metric ton	70.43	92.76	98.79	99.45	101.00
Stocks, mine, dock, and consuming plant, yearend, excluding byproduct ore	4.07	5.06	3.47	3.26	3.50
Employment, mine, concentrating and pelletizing plant, quarterly average, number	4,770	3,530	4,780	5,270	5,290
Net import reliance[5] as a percentage of apparent consumption (iron in ore)	E	E	E	E	E

Recycling: None (see Iron and Steel Scrap section).

Import Sources (2008–11): Canada, 76%; Brazil, 7%; Russia, 5%; Chile, 4%; and other, 8%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Concentrates	2601.11.0030	Free.
Coarse ores	2601.11.0060	Free.
Fine ores	2601.11.0090	Free.
Pellets	2601.12.0030	Free.
Briquettes	2601.12.0060	Free.
Sinter	2601.12.0090	Free.
Roasted Iron Pyrites	2601.20.0000	Free.

Depletion Allowance: 15% (Domestic), 14% (Foreign).

Government Stockpile: None.

Events, Trends, and Issues: U.S. iron ore production was slightly less in 2012 owing to reduced steel consumption and destocking. In Cedar City, UT, the former Mountain Lion Mine returned to production and was renamed the Iron Mountain Project, selling crushed iron ore to China under contract. Construction of an iron nugget plant, planned for production in Michigan's Upper Peninsula, was determined to be not commercially viable. However, after closing down in June $60 million was invested in the Empire Mine, bringing it back into production in August. It was expected to remain in operation until at least 2015.

Following a 30% decrease in the worldwide price for iron ore fines sold in European and Asian markets in the first three quarters of 2012, owing to an increase in global iron ore production and project development, the price stabilized in the fourth quarter of 2012. Major iron-ore-mining companies continued to reinvest profits in mine development, but increases in production capacity outstripped expected consumption throughout early 2012, as economic growth that had been dominated by China slowed. Declining demand in China led to drops in spot prices for iron ore, and the delay, cancellation, or reorganization of major production improvement projects worldwide. Global prices declined steadily since 2011, and in September 2012, they reached the lowest benchmark prices since 2009.

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IRON ORE

Slight price rebounds in the fourth quarter were expected to be maintained through yearend of 2012 because of supply constraints from decreased exports; 1.6 million tons of output losses from worker strikes at Sishen Mine, South Africa; 1 million tons of shipment losses resulting from protests at Carajas Mine, Brazil: and 5 million tons per month of export losses owing to mining bans in Goa, India. This decline in supply led to prices increasing by approximately 30% in October 2012. It was estimated that in 2012, China imported more than 60% of the world's total iron ore trade, the Republic of Korea reported increases in imports of 15%, and Japan's imports fell by 4.4%. International iron ore imports are indicators of iron ore consumption, demonstrating that iron ore consumption in Asia is currently a key factor for the expansion of the international iron ore industry. Chinese companies are investing in all phases of mining and production, to include the takeover of a major iron ore producer in South Africa, for increased production of higher grade ore by Chinese mining groups. Despite overall weak iron ore prices, several major Australian producers planned to continue expansions of mines and shipping ports.

World Mine Production and Reserves: The mine production estimate for China is based on crude ore, rather than usable ore, which is reported for the other countries. Iron ore reserve estimates for Kazakhstan and Ukraine have been revised based on new information from those countries.

	Mine production		Reserves[6]	
	2011	2012[e]	Crude ore	Iron content
United States	55	53	6,900	2,100
Australia	488	525	35,000	17,000
Brazil	373	375	29,000	16,000
Canada	34	40	6,300	2,300
China	1,330	1,300	23,000	7,200
India	240	245	7,000	4,500
Iran	28	28	2,500	1,400
Kazakhstan	25	25	2,500	900
Mauritania	12	12	1,100	700
Mexico	15	13	700	400
Russia	100	100	25,000	14,000
South Africa	60	61	1,000	650
Sweden	25	25	3,500	2,200
Ukraine	81	81	[7]6,500	[7]2,300
Venezuela	17	20	4,000	2,400
Other countries	59	61	12,000	6,000
World total (rounded)	2,940	3,000	170,000	80,000

World Resources: U.S. resources are estimated to be about 27 billion tons of iron contained within 110 billion tons of ore. U.S. resources are mainly low-grade taconite-type ores from the Lake Superior district that require beneficiation and agglomeration prior to commercial use. World resources are estimated to exceed 230 billion tons of iron contained within greater than 800 billion tons of crude ore.

Substitutes: The only source of primary iron is iron ore, used directly as lump ore or converted to briquettes, concentrates, pellets, or sinter. At some blast furnace operations, ferrous scrap may constitute as much as 7% of the blast furnace feedstock. Scrap is extensively used in steelmaking in electric arc furnaces and in iron and steel foundries, but scrap availability can be an issue. Technological advancements were made, which allow hematite to be recovered from tailings basins and pelletized.

[e]Estimated. E Net exporter.
[1]See also Iron and Steel and Iron and Steel Scrap.
[2]Agglomerates, concentrates, direct-shipping ore, and byproduct ore for consumption.
[3]Includes weight of lime, flue dust, and other additives in sinter and pellets for blast furnaces.
[4]Estimated from reported value of ore at mines.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]See Appendix C for resource/reserve definitions and information concerning data sources.
[7]For Ukraine, reserves consist of the A+B categories of the former Soviet Union's reserves classification system.

IRON OXIDE PIGMENTS

(Data in metric tons unless otherwise noted)

Domestic Production and Use: Iron oxide pigments (IOPs) are mined by three companies in three States in the United States. Production data, which were withheld by the U.S. Geological Survey to protect company proprietary data, were virtually unchanged in 2012 from those of 2011. There were six companies, including the three producers of natural IOPs, that processed and sold finished natural and synthetic IOPs. Sales by those companies were virtually unchanged in 2012 from those of 2011, still remaining well below the sales peak of 88,100 tons in 2007. About 60% of natural and synthetic finished IOPs were used in concrete and other construction materials, 25% in coatings and paints, 5% in foundry uses, and more than 2% each in industrial chemicals, animal food, magnetic tape and ink, and other uses.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production, mine	W	W	W	W	W
Production, finished natural and synthetic IOP	83,300	50,800	54,700	48,000	48,000
Imports for consumption	155,000	106,000	151,000	158,000	150,000
Exports, pigment grade	4,740	5,640	8,750	8,650	8,000
Consumption, apparent[1]	234,000	151,000	197,000	197,000	190,000
Price, average value, dollars per kilogram[2]	1.39	1.46	1.48	1.54	1.54
Employment, mine and mill	65	58	60	58	58
Net import reliance[3] as a percentage of apparent consumption	>50%	>50%	>50%	>50%	>50%

Recycling: None.

Import Sources (2008–11): Natural: Cyprus, 61%; Spain, 14%; France, 11%; and other, 14%. Synthetic: China, 52%; Germany, 16%; Brazil, 7%; and other, 25%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–12**
Natural:		
Micaceous iron oxides	2530.90.2000	2.9% ad val.
Earth colors	2530.90.8015	Free.
Iron oxides and hydroxides containing more than 70% Fe_2O_3:		
Synthetic:		
Black	2821.10.0010	3.7% ad val.
Red	2821.10.0020	3.7% ad val.
Yellow	2821.10.0030	3.7% ad val.
Other	2821.10.0040	3.7% ad val.
Earth colors	2821.20.0000	5.5% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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IRON OXIDE PIGMENTS

Events, Trends, and Issues: In 2012, natural IOP production and sales increased slightly compared with those of 2010 and 2011, reflecting the continued slow recovery of the U.S. and European economies from the economic recession in 2008 and 2009; moderate to strong growth continued in Asia. Domestically, residential construction, in which IOPs are used to color concrete block and brick, ready-mixed concrete, and roofing tiles, increased slightly. Housing starts and completions were expected to continue to increase during 2012, based on increases in both statistics during the first 6 months of 2012. Spending on commercial construction, which had decreased in the first 8 months of 2010 and 2011 from each prior year, increased for the same period in 2012 by 20% from that of 2011. Exports of pigment-grade IOPs increased to some Asian markets, where economic recovery was taking place at a faster pace than in other regions. Exports also increased moderately to Mexico and some European and South American markets. Exports of other grades of IOPs and hydroxides also increased to markets in Asia, Germany, Mexico, and the United Arab Emirates. Total imports of natural and synthetic IOPs were trending slightly lower during the first 9 months of 2012 compared to the same period in 2011.

A major producer of finished natural and synthetic IOPs in the United States announced that it would build a new synthetic IOP production plant in Augusta, GA. The company planned to invest $115 million in the advanced technology facility, to be completed during the first half of 2013, which would be the first new IOP production plant built in the United States in nearly 35 years.

An increasing awareness of environmental issues, particularly in Europe and the United States, accompanied by an increasing demand for environmentally friendly products and industrial processes worldwide, presented challenges and opportunities for the pigments market. Efforts were underway to eliminate heavy metals and heavy-metal salts in the pigments for construction materials. Although losing some appeal because of toxicity, inorganic pigments with cadmium, chromium, or barium content were expected to continue to be the preferred types where heat, light, and chemical resistance properties were required.

World Mine Production and Reserves:

	Mine production		Reserves[4]
	2011	2012[e]	
United States	W	W	Moderate
Cyprus	12,000	12,000	Moderate
Germany[5]	220,000	230,000	Moderate
India	395,000	395,000	Large
Pakistan	6,100	6,000	Moderate
Spain	140,000	145,000	Large
Turkey	100,000	100,000	NA
United Kingdom	8,000	8,000	NA
Other countries	20,000	21,000	Moderate
World total (rounded)	[6]NA	[6]NA	Large

World Resources: Domestic and world resources for production of IOPs are adequate. Adequate resources are available worldwide for the manufacture of synthetic IOPs.

Substitutes: IOPs are probably the most important of the natural minerals suitable for use as pigments after milling. Because IOPs are low cost, color stable, and nontoxic, they can be economically used for imparting black, brown, yellow, and red coloring in large and relatively low-value applications. Other minerals may be used as colorants, but they generally cannot compete with IOPs because of the limited tonnages available. Synthetic IOPs are widely used as colorants and compete with natural IOPs in many color applications. Organic colorants are used for some colorant applications, but several of the organic compounds fade over time from exposure to sunlight.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Defined as production of finished natural and synthetic IOPs + imports – exports.
[2]Unit value for finished iron oxide pigments sold or used by U.S. producers.
[3]Defined as imports – exports.
[4]See Appendix C for resource/reserve definitions and information concerning data sources.
[5]Includes natural and synthetic iron oxide pigment.
[6]A significant number of other countries undoubtedly produce iron oxide pigments, but output is not reported and no basis is available to formulate estimates of output levels. Such countries include Azerbaijan, China, Honduras, Kazakhstan, Russia, and Ukraine. Unreported output likely is substantial.

KYANITE AND RELATED MATERIALS

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: One firm in Virginia with integrated mining and processing operations produced kyanite from two hard-rock open pit mines and mullite by calcining kyanite. Another company produced synthetic mullite in Georgia from materials mined from two domestic sites, one in Alabama the other in Georgia. Commercially produced mullite is synthetic, produced from sintering or fusing such feedstock materials as kyanite or bauxitic kaolin; natural mullite occurrences typically are rare and uneconomic to mine. Of the kyanite-mullite output, 90% was estimated to have been used in refractories and 10% in other uses. Of the refractory usage, an estimated 60% to 65% was used in ironmaking and steelmaking and the remainder in the manufacture of chemicals, glass, nonferrous metals, and other materials. The only source of commercially mined andalusite was produced in North Carolina as part of a mineral mixture of high-purity silica and alumina for use in a variety of refractory mineral products for the foundry and ceramics industries.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production:					
Mine[1]	97	71	93	98	95
Synthetic mullite[e]	40	40	40	40	40
Imports for consumption (andalusite)	6	5	2	5	2
Exports	36	26	38	38	36
Consumption, apparent[e]	107	90	97	105	101
Price, average, dollars per metric ton:[2]					
U.S. kyanite, raw	229	283	283	300	300
U.S. kyanite, calcined	357	383	422	448	450
Andalusite, Transvaal, South Africa	263	352	336	335	350
Employment, kyanite mine, office, and plant, number[e]	120	110	115	120	120
Employment, mullite plant, office, and plant, number[e]	190	170	180	190	190
Net import reliance[3] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (2008–11): South Africa, 86%; France, 7%; Peru, 4%; and other, 3%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12–31–12**
Andalusite, kyanite, and sillimanite	2508.50.0000	Free.
Mullite	2508.60.0000	Free.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: None.

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KYANITE AND RELATED MATERIALS

Events, Trends, and Issues: Crude steel production in the United States, which ranked third in the world in steel production, increased by 6% in the first 8 months of 2012 compared with that of the same period in 2011, indicating a similar increase in consumption for kyanite-mullite refractories. Total world steel production rose slightly during the first 8 months of 2012 compared with the same period in 2011. Of the total world refractories market, estimated to be approximately 24 million tons, crude steel manufacturing consumed around 70% of refractories production.

Increases in global demand for refractory products during 2010 and 2011 continued in 2012 although at a slower pace. Lower-than-expected growth in world steel production during 2012 was, in part, the result of a sluggish economy in Western Europe and slowing economic growth in China because of efforts by the Chinese Government to moderate growth, especially in its real estate sector. With steel production expanding, mullite received increasing consideration as an alternative aluminosilicate refractory mineral to less available refractory bauxite.

China is expected to continue to be the largest market for refractories, comprising the majority of global demand. The Asia Pacific region likely will continue to be the largest regional market. Above-average growth is expected in India. Eastern Europe, North America, and Western Europe had significant refractory demand because of their large industrial bases, but Eastern Europe is expected to have the highest growth of these regions, reflecting the area's continued industrialization. North America and Western Europe (to a lesser degree) are expected to have solid growth prospects in the near term, showing continued recovery in manufacturing and steel production, but in the longer term growth may lag behind the worldwide average, with steel production shifting to less-developed areas. Demand for refractories in iron and steel production is expected to have the strongest gain in the next several years, depending on the rate of increase in steel production. Growth also is anticipated for refractories needed to produce other metals and in the industrial mineral market because of increasing production of cement, ceramics, glass, and other mineral products.

World Mine Production and Reserves:

	Mine production		Reserves[4]
	2011	2012[e]	
United States[e]	98	95	Large
France	65	65	NA
India	25	25	1,400
South Africa	240	240	NA
Other countries	6	25	NA
World total (rounded)	434	450	NA

World Resources: Large resources of kyanite and related minerals are known to exist in the United States. The chief resources are in deposits of micaceous schist and gneiss, mostly in the Appalachian Mountains area and in Idaho. Other resources are in aluminous gneiss in southern California. These resources are not economical to mine at present. The characteristics of kyanite resources in the rest of the world are thought to be similar to those in the United States.

Substitutes: Two types of synthetic mullite (fused and sintered), superduty fire clays, and high-alumina materials are substitutes for kyanite in refractories. Principal raw materials for synthetic mullite are bauxite, kaolin and other clays, and silica sand.

[e]Estimated. E Net exporter. NA Not available.
[1]Source: Mining Engineering.
[2]Source: Industrial Minerals.
[3]Defined as imports – exports.
[4]See Appendix C for resource/reserve definitions and information concerning data sources.

LEAD

(Data in thousand metric tons of lead content unless otherwise noted)

Domestic Production and Use: The value of recoverable mined lead in 2012, based on the average North American producer price, was about $843 million. Six lead mines in Missouri, plus lead-producing mines in Alaska and Idaho, yielded all of the totals. Primary lead was processed at one smelter-refinery in Missouri. Of the plants that produced secondary lead, 14 had annual capacities of 30,000 tons or more and accounted for more than 99% of secondary production. Lead was consumed at about 76 manufacturing plants. The lead-acid battery industry continued to be the principal user of lead, accounting for about 86% of the reported U.S. lead consumption for 2012. Lead-acid batteries were primarily used as starting-lighting-ignition batteries for automobiles and trucks and as industrial-type batteries for uninterruptible power-supply equipment for computer and telecommunications networks and for motive power. During the first 8 months of 2012, 81.7 million lead-acid automotive batteries were shipped by North American producers, a 2% increase from those shipped in the same period of 2011.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production:					
Mine, lead in concentrates	410	406	369	342	345
Primary refinery	135	103	115	118	118
Secondary refinery, old scrap	1,140	1,110	1,140	1,130	1,140
Imports for consumption:					
Lead in concentrates	([1])	([1])	([1])	([1])	([1])
Refined metal, wrought and unwrought	314	253	272	315	300
Exports:					
Lead in concentrates	277	287	299	223	200
Refined metal, wrought and unwrought	75	82	83	47	50
Consumption:					
Reported	1,440	1,290	1,430	1,440	1,420
Apparent[2]	1,490	1,410	1,400	1,540	1,520
Price, average, cents per pound:					
North American Producer	120	86.9	109	122	114
London Metal Exchange	94.8	78.0	97.4	109	91.0
Stocks, metal, producers, consumers, yearend	73	63	65	47	66
Employment:					
Mine and mill (peak), number[3]	1,200	1,200	1,500	1,550	1,550
Primary smelter, refineries	340	310	290	290	290
Secondary smelters, refineries	1,600	1,600	1,600	1,600	1,700
Net import reliance[4] as a percentage of apparent consumption	E	E	E	4%	2%

Recycling: In 2012, about 1.14 million tons of secondary lead was produced, an amount equivalent to 80% of reported domestic lead consumption. Nearly all of it was recovered from old (post-consumer) scrap.

Import Sources (2008–11): Metal, wrought and unwrought: Canada, 79%; Mexico, 17%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations[5] 12–31–12
Unwrought (refined)	7801.10.0000	2.5% ad val.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: None.

Events, Trends, and Issues: The global lead market was in surplus during 2012 owing to the buildup of lead stocks held in London Metal Exchange (LME) and producer warehouses. North American producer prices were relatively stable throughout the first 9 months of the year. LME lead prices were more volatile, averaging $2,094 per metric ton in January, decreasing to $1,854 per metric ton in June, and rebounding to $2,169 per metric ton in September. Global stocks of lead held in LME warehouses decreased by 25% to 265,075 tons during the first 9 months of 2012. Domestic mine production in 2012 was expected to be relatively unchanged from that in the previous. In January, a silver-lead mine in Idaho that produced about 16,400 metric tons of lead in concentrate in 2011 was shut down for maintenance work and expected to be closed until 2013. A lead-producing mine in Alaska produced about 12% more lead in concentrate during the first 9 months of 2012 than it had in the corresponding period of 2011 owing to improved recovery rates.

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LEAD

In June, the operator of the only domestic primary lead smelter announced that it had decided not to proceed with plans to construct a new primary lead plant. The existing smelter will be closed by yearend 2013, according to an agreement with the U.S. Environmental Protection Agency (EPA).

The market for secondary lead was tight during the first half of 2012, partially owing to a mild winter in many regions that reduced the quantity of failed lead-acid batteries compared to previous years. Many lead producers, especially older plants, faced increased operating costs owing to recent regulatory changes. In 2012, a secondary lead producer announced plans to close a 65,000-ton-per-year smelter in Frisco, TX, by yearend 2012, and a 70,000-ton-per-year smelter in Reading, PA, by early 2013. The company operated three other secondary lead smelters. In September, a leading domestic lead-acid battery manufacturer opened a new $150 million 132,000-ton-per-year secondary lead smelter in Florence, SC. Another producer was completing an expansion project at its secondary smelter in Tampa, FL, to increase refined lead capacity by about fivefold to 120,000 tons per year.

Global mine production of lead was expected to increase by 11% in 2012 from that in 2011, to 5.20 million tons, mainly owing to production increases in China, and to a lesser extent in Mexico and Peru, offsetting declines in other regions. Global refined lead production was expected to increase by about 3% from that in 2011, to 10.9 million tons. Increased refined lead output was expected to be primarily driven by new production capacity in China (despite shutdowns of many smaller smelters) and increases in Italy, Kazakhstan, and Peru. Global lead consumption was expected to increase by about 3% in 2012 from that in 2011, to 10.8 million tons, partially owing to a 5% increase in Chinese lead consumption. The International Lead and Zinc Study Group forecast global refined lead production would exceed consumption by 180,000 tons by yearend 2012.

World Mine Production and Reserves: Reserve estimates for Australia and the United States were revised based on information from Government and industry sources.

	Mine production		Reserves[6]
	2011	2012[e]	
United States	342	345	5,000
Australia	621	630	36,000
Bolivia	100	110	1,600
Canada	59	53	450
China	2,350	2,600	14,000
India	115	118	2,600
Ireland	45	50	600
Mexico	220	245	5,600
Peru	230	235	7,900
Poland	60	60	1,700
Russia	105	105	9,200
South Africa	55	55	300
Sweden	62	60	1,100
Other countries	340	530	3,000
World total (rounded)	4,700	5,200	89,000

World Resources: In recent years, significant lead resources have been demonstrated in association with zinc and/or silver or copper deposits in Australia, China, Ireland, Mexico, Peru, Portugal, Russia, and the United States (Alaska). Identified lead resources of the world total more than 2 billion tons.

Substitutes: Substitution of plastics has reduced the use of lead in cable covering, cans, and containers. Aluminum, iron, plastics, and tin compete with lead in other packaging and coatings. Tin has replaced lead in solder for new or replacement potable water systems. In the electronics industry, there has been a move towards lead-free solders with compositions of bismuth, copper, silver, and tin. Steel and zinc were common substitutes for lead in wheel weights.

[e]Estimated. E Net exporter.
[1]Less than ½ unit.
[2]Apparent consumption defined as mine production + secondary refined + imports (concentrates and refined) – exports (concentrates and refined) + adjustments for Government and industry stock changes.
[3]Includes lead and zinc-lead mines for which lead was either a principal product or significant byproduct.
[4]Defined as imports – exports + adjustments for Government and industry stock changes; includes trade in both concentrates and refined lead.
[5]No tariff for Canada, Mexico, and Peru for item shown.
[6]See Appendix C for resource/reserve definitions and information concerning data sources.

LIME[1]

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2012, an estimated 19.5 million tons (21.5 million short tons) of quicklime and hydrate was produced (excluding commercial hydrators), valued at about $2.3 billion. At yearend, 31 companies were producing lime, which included 21 companies with commercial sales and 10 companies that produced lime strictly for internal use (for example, sugar companies). These companies had 76 primary lime plants (plants operating lime kilns) in 29 States and Puerto Rico. The 4 leading U.S. lime companies produced quicklime or hydrate in 24 States and accounted for about 75% of U.S. lime production. Principal producing States were, in descending order of production, Missouri, Kentucky, and Alabama (each with production of more than 2 million tons), and Ohio, Texas, Pennsylvania, and Nevada (each with production of more than 1 million tons). Major markets for lime were, in descending order of consumption, steelmaking, flue gas desulfurization, water treatment, construction, mining, paper and pulp, and precipitated calcium carbonate.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production[2]	19,900	15,800	18,300	19,100	19,500
Imports for consumption	307	422	445	512	484
Exports	174	108	215	231	194
Consumption, apparent	20,000	16,100	18,500	19,400	19,800
Quicklime average value, dollars per ton at plant	89.90	102.00	103.70	107.90	116.00
Hydrate average value, dollars per ton at plant	107.20	126.40	124.70	130.90	139.00
Employment, mine and plant, number	5,400	4,800	5,000	5,100	5,100
Net import reliance[3] as a percentage of apparent consumption	1	2	1	1	1

Recycling: Large quantities of lime are regenerated by paper mills. Some municipal water-treatment plants regenerate lime from softening sludge. Quicklime is regenerated from waste hydrated lime in the carbide industry. Data for these sources were not included as production in order to avoid duplication.

Import Sources (2008–11): Canada, 88%; Mexico, 11%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Calcined dolomite	2518.20.0000	3% ad. val.
Quicklime	2522.10.0000	Free.
Slaked lime	2522.20.0000	Free.
Hydraulic lime	2522.30.0000	Free.

Depletion Allowance: Limestone produced and used for lime production, 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: In 2012, domestic lime production was bolstered by increased steel production, which is the leading market for lime. U.S. steel production was projected to increase by more than 5% compared with that in 2011. This increase in U.S. steel production and the accompanying increase in lime consumption was expected to account for more than one-half of the 2012 lime production increase.

Lime prices increased in 2012, with quicklime prices increasing by more than 7% and hydrate prices increasing by about 6% compared with those in 2011. This continued a trend of substantial annual price increases that began in 2004 in which prices increased by about 5% to 7% per year (2009 being the exception when the price increase was much higher).

A leading North American lime company acquired a regional lime producer based in Wisconsin. The acquisition included two lime plants in Wisconsin (Eden and Green Bay) and one in Michigan (Port Inland) and strengthened the acquiring company's presence in the upper Midwest.

Two leading U.S. lime companies were taking advantage of the increased availability of low-priced natural gas by announcing plans to install gas-fired vertical shaft kilns. This type of kiln is more energy efficient than preheater rotary or straight rotary kilns. In Virginia, two vertical shaft kilns were being installed to replace rotary kilns at a plant that was idle during 2012. Plans were announced to install a vertical shaft kiln as a third kiln at Pennsylvania's leading lime plant, which would increase the plant's capacity by 25%.

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LIME

World Lime Production and Limestone Reserves:

	Production 2011	Production 2012[e]	Reserves[4]
United States	19,100	19,500	Adequate for all countries listed.
Australia	2,000	2,000	
Belgium	2,000	2,000	
Brazil	7,700	7,700	
Canada	1,960	2,000	
China	200,000	210,000	
France	3,900	3,900	
Germany	7,000	6,800	
India	15,000	15,000	
Iran	2,800	2,800	
Italy[5]	6,200	6,200	
Japan (quicklime only)	9,000	8,000	
Korea, Republic of	3,900	3,900	
Mexico	6,400	6,400	
Poland	1,800	2,000	
Romania	2,000	2,000	
Russia	8,200	8,200	
South Africa (sales)	1,400	1,400	
Spain	2,100	2,100	
Turkey (sales)	4,500	4,500	
Ukraine	4,250	3,900	
United Kingdom	1,500	1,600	
Vietnam	1,600	1,600	
Other countries	16,700	17,000	
World total (rounded)	331,000	340,000	

World Resources: Domestic and world resources of limestone and dolomite suitable for lime manufacture are adequate.

Substitutes: Limestone is a substitute for lime in many applications, such as agriculture, fluxing, and sulfur removal. Limestone, which contains less reactive material, is slower to react and may have other disadvantages compared with lime, depending on the application; however, limestone is considerably less expensive than lime. Calcined gypsum is an alternative material in industrial plasters and mortars. Cement, cement kiln dust, fly ash, and lime kiln dust are potential substitutes for some construction uses of lime. Magnesium hydroxide is a substitute for lime in pH control, and magnesium oxide is a substitute for dolomitic lime as a flux in steelmaking.

[e]Estimated.
[1]Data are for quicklime, hydrated lime, and refractory dead-burned dolomite. Includes Puerto Rico.
[2]Sold or used by producers.
[3]Defined as imports – exports.
[4]See Appendix C for resource/reserve definitions and information concerning data sources.
[5]Includes hydraulic lime.

LITHIUM

(Data in metric tons of lithium content unless otherwise noted)

Domestic Production and Use: The only commercially active lithium mine in the United States was a brine operation in Nevada. The mine's production capacity was expanded in 2012, and a new lithium hydroxide plant opened in North Carolina. Two companies produced a large array of downstream lithium compounds in the United States from domestic or South American lithium carbonate, lithium chloride, and lithium hydroxide. A U.S. recycling company produced a small quantity of lithium carbonate from solutions recovered during the recycling of lithium-ion batteries.

Although lithium markets vary by location, global end-use markets are estimated as follows: ceramics and glass, 30%; batteries, 22%; lubricating greases, 11%; air treatment, 4%; metallurgical, 4%; polymers, 3%; pharmaceuticals, 2%; primary aluminum production, 1%; and other uses, 23%. Lithium use in batteries expanded significantly in recent years because rechargeable lithium batteries were being used increasingly in portable electronic devices and electrical tools.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production	W	W	W	W	W
Imports for consumption	3,160	1,890	1,960	2,850	2,700
Exports	1,450	919	1,410	1,310	1,300
Consumption:					
Apparent	W	W	W	W	W
Estimated	2,300	1,300	1,100	[1]2,000	[1]2,000
Employment, mine and mill, number	68	68	68	68	68
Net import reliance[2] as a percentage of apparent consumption	>50%	>50%	>50%	>80%	>70%

Recycling: Recycled lithium content has been historically insignificant, but has increased steadily owing to the growth in consumption of lithium batteries. One U.S. company has recycled lithium metal and lithium-ion batteries since 1992 at its Canadian facility in British Columbia. In 2009, the U.S. Department of Energy awarded the company $9.5 million to construct the first U.S. recycling facility for lithium-ion batteries.

Import Sources (2008–11): Argentina, 52%; Chile, 44%; China, 3%; and other, 1%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–12**
Other alkali metals	2805.19.9000	5.5% ad val.
Lithium oxide and hydroxide	2825.20.0000	3.7% ad val.
Lithium carbonate:		
U.S.P. grade	2836.91.0010	3.7% ad val.
Other	2836.91.0050	3.7% ad val.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: None.

Events, Trends, and Issues: Worldwide lithium production increased in 2012. Production volumes of two major lithium producers in Australia and Chile increased moderately through the third quarter of 2012. Argentina's major lithium producer experienced weather-related complications during the year, which reduced production and delayed efforts to increase production capacity. Industry analysts and the major lithium producers expected worldwide consumption of lithium in 2012 to be between 25,900 and 28,200 tons, increasing by 7.5% to 10% from that of 2011. All of the major brine and mineral-based lithium producers increased their lithium prices in 2012. Many emerging companies continued exploring for lithium on claims worldwide. Numerous claims in Nevada, as well as in Argentina, Australia, Bolivia, and Canada, have been leased or staked.

Subsurface brines have become the leading raw material for lithium carbonate production worldwide because of lower production costs compared with the mining and processing costs for hard-rock ores. Owing to growing spodumene demand from China in the last several years, however, mineral-sourced lithium has gained market share on brine-sourced lithium. Two brine operations in Chile dominate the world market, and a facility at a brine deposit in Argentina produced lithium carbonate and lithium chloride. One new brine operation in Argentina began limited commercial production in 2012, and several additional brine operations were under development. Brine operations in China produced lithium carbonate, lithium chloride, and lithium hydroxide. Lithium minerals were used directly as ore

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LITHIUM

concentrates in ceramics and glass applications worldwide and, increasingly, as feedstock for lithium carbonate and other lithium compounds in China.

Owing to China's growing demand for high-quality spodumene by its chemical companies, Australia's leading lithium ore miner doubled its production capacity, raising its total lithium carbonate equivalent production capacity to 110,000 tons per year. A major lithium brine producer agreed to acquire the Australian lithium ore miner in 2012 to diversify its supply of lithium. An emerging Australian lithium ore producer continued lithium concentrate production in Western Australia and opened a lithium carbonate plant in China, where the lithium concentrate was to be converted to battery-grade lithium carbonate and supplied to the Asian market. Utilizing a unique reverse-osmosis process, a California company began producing high-purity lithium carbonate from geothermal brines. The reverse-osmosis process eliminates the need for solar evaporation, a crucial and lengthy procedure in common brine operations. Initial lithium carbonate production capacity was 500 tons per year.

Batteries, especially rechargeable batteries, are the uses for lithium compounds with the largest growth potential. Demand for rechargeable lithium batteries exceeds that of rechargeable nonlithium batteries for use in cellular telephones, cordless tools, MP3 players, and portable computers and tablets. Major automobile companies were developing lithium batteries for electric vehicles and hybrid electric vehicles—vehicles with an internal combustion engine and a battery-powered electric motor. Nonrechargeable lithium batteries were used in calculators, cameras, computers, electronic games, watches, and other devices.

Lithium supply security has become a top priority for Asian technology companies. Strategic alliances and joint ventures have been, and are continuing to be, established with lithium exploration companies worldwide to ensure a reliable, diversified supply of lithium for Asia's battery suppliers and vehicle manufacturers.

World Mine Production and Reserves: The reserve estimates for Australia and Brazil have been revised based on new information from Government and industry sources.

	Mine production		Reserves[3]
	2011	2012[e]	
United States	W	W	38,000
Argentina	2,950	2,700	850,000
Australia	12,500	13,000	1,000,000
Brazil	320	490	46,000
Chile	12,900	13,000	7,500,000
China[4]	4,140	6,000	3,500,000
Portugal	820	820	10,000
Zimbabwe	470	500	23,000
World total (rounded)	[5]34,100	[5]37,000	13,000,000

World Resources: The identified lithium resources total 5.5 million tons in the United States and approximately 34 million tons in other countries. Among the other countries, identified lithium resources for Bolivia and Chile total 9 million tons and in excess of 7.5 million tons, respectively. Identified lithium resources for Argentina, China, and Australia are 6.5 million tons, 5.4 million tons, and 1.7 million tons, respectively; while Canada, Congo (Kinshasa), Russia, and Serbia contain approximately 1 million tons each. Identified lithium resources for Brazil total 180,000 tons.

Substitutes: Substitution for lithium compounds is possible in batteries, ceramics, greases, and manufactured glass. Examples are calcium and aluminum soaps as substitutes for stearates in greases; calcium, magnesium, mercury, and zinc as anode material in primary batteries; and sodic and potassic fluxes in ceramics and glass manufacture. Lithium carbonate is not considered to be an essential ingredient in aluminum potlines. Substitutes for aluminum-lithium alloys in structural materials are composite materials consisting of boron, glass, or polymer fibers in resins.

[e]Estimated. W Withheld to avoid disclosing company proprietary data.
[1]Rounded to one significant figure to avoid disclosing company proprietary data.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix C for resource/reserve definitions and information concerning data sources.
[4]Official sources for China's lithium production in 2011 and 2012 reported higher figures than industry sources, which reported, on average, 2,600 metric tons of contained lithium for each year.
[5]Excludes U.S. production.

MAGNESIUM COMPOUNDS[1]

(Data in thousand metric tons of magnesium content unless otherwise noted)

Domestic Production and Use: Seawater and natural brines accounted for about 55% of U.S. magnesium compounds production in 2012. Magnesium oxide and other compounds were recovered from seawater by two companies in California and Delaware; from well brines by one company in Michigan; and from lake brines by two companies in Utah. Magnesite was mined by one company in Nevada, and olivine was mined by one company in Washington. About 55% of the magnesium compounds consumed in the United States was used for refractories. The remaining 45% was used in agricultural, chemical, construction, environmental, and industrial applications.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production	274	239	261	306	300
Imports for consumption	342	173	279	316	270
Exports	25	13	16	20	17
Consumption, apparent	591	399	524	602	553
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant, number[e]	370	300	300	300	275
Net import reliance[2] as a percentage of apparent consumption	54	40	50	49	46

Recycling: Some magnesia-based refractories are recycled, either for reuse as refractory material or for use as construction aggregate.

Import Sources (2008–11): China, 64%; Canada, 7%; Brazil, 7%; Australia, 6%; and other, 16%.

Tariff:[3] Item	Number	Normal Trade Relations 12–31–12
Crude magnesite	2519.10.0000	Free.
Dead-burned and fused magnesia	2519.90.1000	Free.
Caustic-calcined magnesia	2519.90.2000	Free.
Kieserite	2530.20.1000	Free.
Epsom salts	2530.20.2000	Free.
Magnesium hydroxide	2816.10.0000	3.1% ad val.
Magnesium chloride	2827.31.0000	1.5% ad val.
Magnesium sulfate (synthetic)	2833.21.0000	3.7% ad val.

Depletion Allowance: Brucite, 10% (Domestic and foreign); dolomite, magnesite, and magnesium carbonate, 14% (Domestic and foreign); magnesium chloride (from brine wells), 5% (Domestic and foreign); and olivine, 22% (Domestic) and 14% (Foreign).

Government Stockpile: None.

Events, Trends, and Issues: The sole U.S. magnesite producer, which also owned a seawater magnesia plant in Florida, closed the Florida operation in 2011 leaving only two magnesia-from-seawater plants in the United States—one in California and one in Delaware. The Norwegian olivine producer that owned the olivine operation in North Carolina decided to close the mine and plant in North Carolina and a processing plant in Indiana and supply the United States market with olivine from its Norway operations.

A class-action lawsuit that a group of U.S. farmers filed in 2010 against a U.S. magnesia producer and two other firms alleging that the three companies agreed to control the price of magnesia used in animal feed and fertilizers was voluntarily dismissed by the plaintiffs in September.

An Austrian-based magnesia and refractories producer purchased the magnesia producer in Serbia to add to its worldwide operations. The Serbian firm restarted production of dead-burned magnesia in March 2011 after completing a 4-year modernization project and owns magnesite mines in Cacak and Zlatibor. The Austrian firm had purchased magnesia operations in Ireland and Norway in 2011 and installed a new 76,000-ton-per-year rotary kiln at its Turkey operations to increase dead-burned magnesia production capacity there to 216,000 tons per year.

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MAGNESIUM COMPOUNDS

In the Netherlands, the magnesium chloride brine producer planned to increase its production capacity for dead-burned magnesia at Veendam by 40,000 tons per year to 200,000 tons per year by 2013. The company also was drilling a new well to provide additional magnesium chloride salt raw material for its expansion.

Russia's leading magnesite producer completed construction of a crushing plant in Siberia as part of development of magnesite mines in the area. The company also began furnace construction for the 100,000-ton-per-year magnesia plant. When completed, the plant will have the capacity to produce 200,000 tons per year of calcined magnesia and 150,000 tons per year of fused magnesia. In January, a Greek magnesia producer completed installation of a new rotary kiln at its subsidiary in Turkey, which would double the caustic-calcined magnesia production capacity to 32,000 tons per year there.

Several firms were installing fused magnesia production capacity because dead-burned magnesia was being replaced with fused magnesia in some steel furnaces. Fused magnesia has superior properties to dead-burned magnesia in some refractory applications, including a higher magnesia content, a higher density, and a larger crystal size. New production capacity also provides consumers with an alternative to fused magnesia produced in China. In Norway, one of the leading refractory manufacturers was installing 80,000 tons per year of fused magnesia capacity at its brine magnesia plant, which was scheduled to be operational by yearend 2012. The leading magnesia producer in Turkey added 35,000 tons per year of fused magnesia capacity for a total of 52,000 tons per year; this also was expected to be operational by yearend 2012. In Russia, the leading magnesia producer doubled its fused magnesia capacity to 100,000 tons per year by yearend. The leading magnesia producer in Iran announced that it would complete a 5,000-ton-per-year fused magnesia plant by early 2013.

World Magnesite Mine Production and Reserves: Reserve data for Brazil, China, Greece, and India were revised based on new information from these Governments.

	Mine production		Reserves[4]
	2011	2012[e]	
United States	W	W	10,000
Australia	86	90	95,000
Austria	219	220	15,000
Brazil	140	140	86,000
China	4,180	4,300	500,000
Greece	86	90	80,000
India	101	100	20,000
Korea, North	43	45	450,000
Russia	346	350	650,000
Slovakia	172	180	35,000
Spain	133	130	10,000
Turkey	288	300	49,000
Other countries	135	150	390,000
World total (rounded)	[5]5,930	[5]6,100	2,400,000

In addition to magnesite, there are vast reserves of well and lake brines and seawater from which magnesium compounds can be recovered.

World Resources: Resources from which magnesium compounds can be recovered range from large to virtually unlimited and are globally widespread. Identified world resources of magnesite total 12 billion tons, and of brucite, several million tons. Resources of dolomite, forsterite, magnesium-bearing evaporite minerals, and magnesia-bearing brines are estimated to constitute a resource in billions of tons. Magnesium hydroxide can be recovered from seawater.

Substitutes: Alumina, chromite, and silica substitute for magnesia in some refractory applications.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]See also Magnesium Metal.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]Tariffs are based on gross weight.
[4]See Appendix C for resource/reserve definitions and information concerning data sources.
[5]Excludes U.S. production.

MAGNESIUM METAL[1]

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2012, magnesium was produced by one company at a 63,500-ton-per-year plant in Utah by an electrolytic process that recovered magnesium from brines from the Great Salt Lake. Magnesium used as a constituent of aluminum-based alloys that were used for packaging, transportation, and other applications was the leading use for primary magnesium, accounting for 43% of primary metal use. Structural uses of magnesium (castings and wrought products) accounted for 40% of primary metal consumption. Desulfurization of iron and steel accounted for 11% of U.S. consumption of primary metal, and other uses were 6%.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production:					
Primary	W	W	W	W	W
Secondary (new and old scrap)	88	69	72	75	75
Imports for consumption	83	47	53	48	53
Exports	14	20	15	12	18
Consumption:					
Reported, primary	65	51	56	59	60
Apparent	[2]130	[3]80	[2]100	[2]110	[2]110
Price, yearend:					
U.S. spot Western, dollars per pound, average	3.15	2.30	2.43	2.13	2.20
China free market, dollars per metric ton, average	2,665	2,950	2,925	3,025	3,250
Stocks, producer and consumer, yearend	W	W	W	W	W
Employment, number[e]	400	400	400	400	400
Net import reliance[4] as a percentage of apparent consumption	50	33	38	33	31

Recycling: In 2012, about 24,000 tons of secondary production was recovered from old scrap.

Import Sources (2008–11): Israel, 32%; Canada, 25%; China, 13%; and other, 30%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Unwrought metal	8104.11.0000	8.0% ad val.
Unwrought alloys	8104.19.0000	6.5% ad val.
Wrought metal	8104.90.0000	14.8¢/kg on Mg content + 3.5% ad val.

Depletion Allowance: Dolomite, 14% (Domestic and foreign); magnesium chloride (from brine wells), 5% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: The U.S. Department of Commerce, International Trade Administration (ITA), revised the final results of its decision regarding imports of pure magnesium from a specific Chinese firm into the United States from May 1, 2006, through April 30, 2007, because the review was "tainted by fraud." The ITA had originally calculated a dumping margin of 0.63% ad valorem, but amended the duty to 111.73% ad valorem. The U.S. Court of International Trade (CIT) denied an appeal from the U.S. magnesium producer that contested a 2011 decision by the U.S. International Trade Commission (ITC) to revoke antidumping duties on pure magnesium from Russia. In a 5-year sunset review of imports of magnesium from China and Russia, the ITC had determined that the duties on magnesium from China should be maintained, but the duties on magnesium from Russia should be discontinued. The U.S. producer challenged the ITC's decision not to cumulate imports from China and Russia. The CIT determined that although there was some overlap in uses for the two different types of imports, the interchangeability was limited.

A U.S.-based aluminum and magnesium diecasting firm planned to add two new production lines at its Mexico, MO, facility by 2017 at a cost of $12.5 million. One of the production lines would be to manufacture oil sumps and head covers for a German automobile manufacturer, and the other to make battery cases for a U.S. auto manufacturer's electric vehicles. The firm also expected to increase production of parts for a Japanese auto manufacturer.

Production resumed at the primary magnesium plant in Perak, Malaysia, in mid-February after the plant had been shut down for maintenance in mid-2011. The plant was expected to produce at its full capacity of 15,000 tons per year by mid-2013.

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MAGNESIUM METAL

Construction of a new 10,000-ton-per-year primary magnesium plant in Gangneung, Gangwon Province, Republic of Korea, was completed in July, and, after trial production, the plant shipped its first magnesium ingot at the beginning of October. Magnesium produced at the new plant was projected to be supplied to a magnesium plate operation in Suncheon, Jeonnam Province, and to South Korean diecasting companies.

In Australia, the company that planned to construct a magnesium-from-coal-fly-ash plant would reduce the size of its proposed plant to 5,000 tons per year from 10,000 tons per year. This reduction in capacity would also reduce the capital cost to $37 to $42 million from $106 million. Construction of the plant was scheduled to begin in Victoria in July 2013, with production to begin a year later.

According to the China Non-Ferrous Metals Industry Association, China’s reported magnesium production was 322,000 tons in the first half of 2012, 8.5% lower than that in the first half of 2011. Forty-nine percent of the output was from Shaanxi Province, 33% from Shanxi Province, and 5% from Ningxia Province. Production has shifted from Shanxi Province to Shaanxi Province because of lower energy costs; in Shaanxi Province, magnesium production plants use residual gas from coking operations as a fuel source. Analysts estimated that the cost of magnesium production in Shaanxi Province was $1,970 per ton compared with $2,610 per ton in Shanxi Province.

Considerable research and development work is taking place to adapt magnesium and its alloys for new applications, including a new family of alloys that shows potential as a bioabsorbable material. Because they have properties close to those of bone, magnesium alloys show promise as medical orthopedic implants, and they could be used as vascular stents. A consortium from academia and private industry received $2.7 million from the U.S. Department of Energy to develop a diecasting process to produce thin-walled magnesium alloy vehicle doors. This project was expected to develop an integrated supervacuum diecasting process using a new magnesium alloy to achieve a 50% energy savings compared to the multipiece, multistep, stamping and joining process currently used to manufacture car doors. By substituting magnesium for steel inner panels, car doors could weigh 60% less, resulting in fuel economy improvements and carbon emission savings. A U.S. auto manufacturer began testing a thermal forming process and a proprietary corrosion-resistance treatment that would enable magnesium alloy sheet to be used as a substitute for steel and aluminum in some automotive applications. The company planned to use the magnesium alloy sheet as a rear-deck inner-lid panel to reduce vehicle weight.

World Primary Production and Reserves:

	Primary production	
	2011	**2012[e]**
United States	W	W
Brazil	16	16
China	661	640
Israel	30	30
Kazakhstan	21	21
Malaysia	2	5
Russia	37	37
Serbia	2	2
Ukraine	2	2
World total[6] (rounded)	771	750

Reserves[5]

Magnesium metal is derived from seawater, natural brines, dolomite, and other minerals. The reserves for this metal are sufficient to supply current and future requirements. To a limited degree, the existing natural brines may be considered to be a renewable resource wherein any magnesium removed by humans may be renewed by nature in a short span of time.

World Resources: Resources from which magnesium may be recovered range from large to virtually unlimited and are globally widespread. Resources of dolomite and magnesium-bearing evaporite minerals are enormous. Magnesium-bearing brines are estimated to constitute a resource in the billions of tons, and magnesium can be recovered from seawater at places along world coastlines.

Substitutes: Aluminum and zinc may substitute for magnesium in castings and wrought products. For iron and steel desulfurization, calcium carbide may be used instead of magnesium.

[e]Estimated. W Withheld to avoid disclosing company proprietary data.
[1]See also Magnesium Compounds.
[2]Rounded to two significant digits to protect proprietary data.
[3]Rounded to one significant digit to protect proprietary data.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]See Appendix C for resource/reserve definitions and information concerning data sources.
[6]Excludes U.S. production.

MANGANESE

(Data in thousand metric tons gross weight unless otherwise specified)

Domestic Production and Use: Manganese ore containing 35% or more manganese has not been produced domestically since 1970. Manganese ore was consumed mainly by eight firms with plants principally in the East and Midwest. Most ore consumption was related to steel production, directly in pig iron manufacture and indirectly through upgrading ore to ferroalloys. Additional quantities of ore were used for such nonmetallurgical purposes as production of dry cell batteries, in plant fertilizers and animal feed, and as a brick colorant. Manganese ferroalloys were produced at two smelters. Construction, machinery, and transportation end uses accounted for about 29%, 10%, and 10%, respectively, of manganese consumption. Most of the rest went to a variety of other iron and steel applications. The value of domestic consumption, estimated from foreign trade data, was about $1.4 billion.

Salient Statistics—United States:[1]	2008	2009	2010	2011	2012[e]
Production, mine[2]	—	—	—	—	—
Imports for consumption:					
Manganese ore	571	269	489	552	450
Ferromanganese	448	153	326	348	420
Silicomanganese[3]	365	130	297	348	370
Exports:					
Manganese ore	48	15	14	1	2
Ferromanganese	23	24	19	5	4
Silicomanganese	7	19	9	8	6
Shipments from Government stockpile excesses:[4]					
Manganese ore	9	3	—	–75	—
Ferromanganese	18	25	26	10	7
Consumption, reported:[5]					
Manganese ore[6]	464	422	450	532	530
Ferromanganese	304	242	292	303	310
Silicomanganese	113	94	97	106	110
Consumption, apparent, manganese[7]	844	451	721	699	870
Price, average, 46% to 48% Mn metallurgical ore, dollars per metric ton unit, contained Mn:					
Cost, insurance, and freight (c.i.f.), U.S. ports[e]	12.15	7.95	9.64	7.88	7.40
CNF[8] China, Ryan's Notes	14.70	5.61	7.23	5.72	[9]5.00
Stocks, producer and consumer, yearend:					
Manganese ore[6]	255	115	168	250	214
Ferromanganese	27	31	32	25	26
Silicomanganese	24	26	26	22	23
Net import reliance[10] as a percentage of apparent consumption	100	100	100	100	100

Recycling: Manganese was recycled incidentally as a constituent of ferrous and nonferrous scrap; however, scrap recovery specifically for manganese was negligible. Manganese is recovered along with iron from steel slag.

Import Sources (2008–11): Manganese ore: Gabon, 61%; Australia, 21%; South Africa, 7%; Brazil, 5%; and other, 6%. Ferromanganese: South Africa, 51%; China, 13%; Ukraine, 8%; Republic of Korea, 7%; and other, 21%. Manganese contained in all manganese imports: South Africa, 25%; Gabon, 22%; Australia, 12%; China, 9%; and other, 32%.

Tariff:

Item	Number	Normal Trade Relations 12–31–12
Ore and concentrate	2602.00.0040/60	Free.
Manganese dioxide	2820.10.0000	4.7% ad val.
High-carbon ferromanganese	7202.11.5000	1.5% ad val.
Silicomanganese	7202.30.0000	3.9% ad val.
Metal, unwrought	8111.00.4700/4900	14% ad val.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

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MANGANESE

Government Stockpile:

Stockpile Status—9–30–12[11]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2012	Disposals FY 2012
Manganese ore[12]	292	292	91	—
Ferromanganese, high-carbon	345	345	91	8

Events, Trends, and Issues: U.S. steel production in 2012 was projected to be 4% more than that in 2011. Imports of manganese ferroalloys were expected to be substantially more in 2012 than in 2011—21% and 6% more for ferromanganese and silicomanganese, respectively. As a result, U.S. manganese apparent consumption increased by an estimated 24% to 870,000 tons in 2012. The annual average domestic manganese ore contract price followed the decrease in the average international price for metallurgical-grade ore set between Japanese consumers and major suppliers in 2012. More than 6 million metric tons per year of additional manganese ore production capacity was planned worldwide in 2012 through mine expansions and startups, the bulk (72%) of which was in South Africa.

World Mine Production and Reserves (metal content): Reserve estimates have been revised from those previously published for Australia, Gabon, India, and Mexico, based on reports by the Governments of Australia and India and the major manganese producers in Gabon and Mexico.

	Mine production		Reserves[13]
	2011	2012[e]	
United States	—	—	—
Australia	3,200	3,400	97,000
Brazil	1,210	1,100	110,000
Burma	234	230	NA
China	2,800	3,000	44,000
Gabon	1,860	2,000	27,000
India	895	810	49,000
Kazakhstan	390	390	5,000
Malaysia	225	230	NA
Mexico	171	170	5,000
South Africa	3,400	3,500	150,000
Ukraine	330	310	140,000
Other countries	1,740	1,700	Small
World total (rounded)	16,000	16,000	630,000

World Resources: Land-based manganese resources are large but irregularly distributed; those of the United States are very low grade and have potentially high extraction costs. South Africa accounts for about 75% of the world's identified manganese resources, and Ukraine accounts for 10%.

Substitutes: Manganese has no satisfactory substitute in its major applications.

[e]Estimated. NA Not available. — Zero.
[1]Manganese content typically ranges from 35% to 54% for manganese ore and from 74% to 95% for ferromanganese.
[2]Excludes insignificant quantities of low-grade manganiferous ore.
[3]Imports more nearly represent amount consumed than does reported consumption.
[4]Net quantity, in manganese content, defined as stockpile shipments – receipts.
[5]Manganese consumption cannot be estimated as the sum of manganese ore and ferromanganese consumption because so doing would count manganese in ore used to produce ferromanganese twice.
[6]Consumers only, exclusive of ore consumed at iron and steel plants.
[7]Thousand metric tons, manganese content; based on estimated average content for all components except imports, for which content is reported.
[8]Cost and freight (CNF) represents the costs paid by a seller to ship manganese ore by sea to a Chinese port; excludes insurance.
[9]Average weekly price through October 2012.
[10]Defined as imports – exports + adjustments for Government and industry stock changes.
[11]See Appendix B for definitions.
[12]Metallurgical grade.
[13]See Appendix C for resource/reserve definitions and information concerning data sources.

MERCURY

(Data in metric tons of mercury content unless otherwise noted)[1]

Domestic Production and Use: Mercury has not been produced as a principal mineral commodity in the United States since 1992, when the McDermitt Mine, in Humboldt County, NV, closed. In 2012, mercury was recovered as a byproduct from processing gold-silver ore at several mines in Nevada; however, these production data were not reported. Secondary, or recycled, mercury was recovered by retorting end-of-use mercury-containing products that mainly included batteries, compact and traditional fluorescent lamps, dental amalgam, medical devices, and thermostats, as well as mercury-contaminated soils. The mercury was processed and refined for resale or exported. Secondary mercury production data were not reported. Mercury use is not carefully tracked in the United States; however, less than 50 metric tons per year of mercury was consumed domestically. The leading domestic end user of mercury was the chlorine-caustic soda industry. Owing to mercury toxicity and concerns for the environment and human health, overall mercury use has declined in the United States. Mercury has been released to the environment from mercury-containing car switches when the automobile is scrapped for recycling, from coal-fired powerplant emissions, and from incinerated mercury-containing medical devices. Mercury is no longer used in batteries and paints manufactured in the United States. Mercury was imported, refined, and then exported for global use in chlorine-caustic soda production, compact and traditional fluorescent lights, dental amalgam, and neon lights; however, its primary use is for small-scale gold mining in many parts of the world. Some button-type batteries, cleansers, fireworks, folk medicines, grandfather clocks, pesticides, and some skin-lightening creams and soaps may contain mercury.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production:					
Mine (byproduct)	NA	NA	NA	NA	NA
Secondary	NA	NA	NA	NA	NA
Imports for consumption (gross weight), metal	155	206	294	110	280
Exports (gross weight), metal	732	753	459	132	110
Price, average value, dollars per flask, free market[2]	600	610	1,076	1,850	1,850
Net import reliance[3] as a percentage of apparent consumption	E	E	E	E	NA

Recycling: In 2012, six companies in the United States accounted for the majority of secondary mercury recycling and production. Mercury-containing automobile convenience switches, barometers, compact and traditional fluorescent lamps, computers, dental amalgam, medical devices, thermostats, and some mercury-containing toys were collected by as many as 50 smaller companies and then the mercury-containing materials were shipped to larger companies for retorting and reclamation of the mercury. In addition, many recycling companies recovered mercury from waste themselves when retorting was not required. The increased use of nonmercury substitutes has resulted in a shrinking reservoir of mercury-containing products for recycling.

Import Sources (2008–11): Chile, 46%; Peru, 43%; Germany, 6%; Canada, 3%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Mercury	2805.40.0000	1.7% ad val.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: An inventory of 4,436 tons of mercury was held in storage at the Hawthorne Army Depot, Hawthorne, NV. About 1,200 tons of mercury also was held by the U.S. Department of Energy, Oak Ridge, TN. Sales of mercury from the National Defense Stockpile remained suspended.

Stockpile Status—9–30–12[4]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2012	Disposals FY 2012
Mercury	4,436	4,436	—	—

Events, Trends, and Issues: The United States was one of the five leading mercury-exporting countries in 2012; the principal export destinations were Indonesia, Nigeria, and Peru. The average monthly price of one flask of domestic mercury and free market mercury was unchanged at $1,850 throughout the year. Imports increased significantly in 2012; this is the result of foreign companies storing mercury for 2 to 3 years before exporting it to the United States. Imports have fluctuated since 2000 on a 2- or 3-year cycle.

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MERCURY

Global consumption of mercury was estimated to be 2,000 tons per year, and approximately 50% of this consumption came from the use of mercury compounds as a catalyst in the coal-based manufacture of vinyl chloride monomer in China. Use of nonmercury technology for chloralkali production and the ultimate closure of the world's mercury-cell chloralkali plants may put a large quantity of mercury on the global market for recycling, sale, or, owing to export bans in Europe and the United States, storage. A major chlorine producer continued the conversion of one mercury cell plant in Tennessee to membrane technology and planned to discontinue chlorine manufacture at a plant in Georgia that used mercury cell technology. These changes were scheduled to be completed by yearend 2012, leaving only 2 mercury cell chlorine-caustic soda plants in use in the United States, compared with 5 in 2008, and 14 in 1996.

Byproduct mercury production is expected to continue from large-scale domestic and foreign gold-silver mining and processing, as is secondary production of mercury from an ever-diminishing supply of mercury-containing products, such as automobile convenience switches and thermostats. However, the volume of byproduct mercury that enters the global supply from foreign gold-silver processing may fluctuate dramatically from year to year; for example, mercury in Chile and Peru is typically stockpiled until there is sufficient material for export. Domestic mercury consumption will continue to decline as nonmercury-containing products, such as digital thermometers, are substituted for those containing mercury.

World Mine Production and Reserves:

	Mine production		Reserves[5]
	2011	2012[e]	
United States	NA	NA	—
Chile (byproduct)	100	90	NA
China	1,500	1,200	21,000
Kyrgyzstan	250	150	7,500
Mexico (reclaimed)	21	21	27,000
Peru (byproduct)	35	35	NA
Other countries	103	100	38,000
World total (rounded)	2,010	1,600	94,000

World Resources: China, Kyrgyzstan, Mexico, Peru, Russia, Slovenia, Spain, and Ukraine have most of the world's estimated 600,000 tons of mercury resources. Mexico reclaims mercury from Spanish Colonial silver mining waste. In Peru, mercury production from the Santa Barbara Mine (Huancavelica) stopped in the 1990s; however, Peru continues to be an important source of byproduct mercury imported into the United States. Spain, once a leading producer of mercury from its centuries-old Almaden Mine, stopped mining in 2003. In the United States, there are mercury occurrences in Alaska, Arkansas, California, Nevada, and Texas; however, mercury has not been mined as a principal mineral commodity since 1992. The declining consumption of mercury, except for small-scale gold mining, indicates that these resources are sufficient for another century or more of use.

Substitutes: For aesthetic or human health concerns, natural-appearing ceramic composites substitute for the dark-gray mercury-containing dental amalgam. "Galistan," an alloy of gallium, indium, and tin, or alternatively, digital thermometers, now replaces the mercury used in traditional mercury thermometers. At chloralkali plants around the world, mercury-cell technology is being replaced by newer diaphragm and membrane cell technology. Light-emitting diodes that contain indium substitute for mercury-containing fluorescent lamps. Lithium, nickel-cadmium, and zinc-air batteries replace mercury-zinc batteries in the United States; indium compounds substitute for mercury in alkaline batteries; and organic compounds have been substituted for mercury fungicides in latex paint.

[e]Estimated. E Net exporter. NA Not available. — Zero.

[1]Some international data and dealer prices are reported in flasks. One metric ton (1,000 kilograms) = 29.0082 flasks, and 1 flask = 76 pounds, or 34.5 kilograms, or 0.035 ton.

[2]Platts Metals Week average mercury price quotation for the year. Actual prices may vary significantly from quoted prices.

[3]Defined as imports – exports + adjustments for Government and industry stock changes.

[4]See Appendix B for definitions.

[5]See Appendix C for resource/reserve definitions and information concerning data sources.

MICA (NATURAL)

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Scrap and flake mica production, excluding low-quality sericite, was estimated to be 44,000 tons in 2012. Mica was mined in Alabama, Georgia, North Carolina, and South Dakota. Scrap mica was recovered principally from mica and sericite schist and as a byproduct from feldspar, kaolin, and industrial sand beneficiation. The majority of domestic production was processed into small particle-size mica by either wet or dry grinding. Primary uses were joint compound, oil-well-drilling additives, paint, roofing, and rubber products. The value of 2012 scrap mica production was estimated to be $5.0 million.

A minor amount of sheet mica was produced in 2012 as a byproduct at a gemstone mine in Amelia, VA, and as incidental production from feldspar mining in the Spruce Pine area of North Carolina. The domestic consuming industry was dependent upon imports to meet demand for sheet mica. Most sheet mica was fabricated into parts for electronic and electrical equipment.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Scrap and flake:					
Production:[1, 2]					
Mine	85	51	53	50	44
Ground	98	77	76	80	86
Imports, mica powder and mica waste	25	20	26	27	26
Exports, mica powder and mica waste	9	8	6	6	6
Consumption, apparent[3]	101	63	73	72	64
Price, average, dollars per metric ton, reported:					
Scrap and flake	120	128	137	122	125
Ground:					
Dry	251	284	285	281	285
Wet	651	651	651	651	700
Employment, mine, number	NA	NA	NA	NA	NA
Net import reliance[4] as a percentage of apparent consumption	16	19	27	30	31
Sheet:					
Production, mine[e]	([5])	([5])	([5])	([5])	([5])
Imports, plates, sheets, strips; worked mica; split block; splittings; other >$1.00/kg	1.90	1.50	1.98	2.19	2.32
Exports, plates, sheets, strips; worked mica; crude and rifted into sheet or splittings >$1.00/kg	2.06	1.11	0.93	1.04	1.59
Shipments from Government stockpile excesses	([5])	—	—	—	—
Consumption, apparent	([6, 7])	[6]0.39	1.05	1.15	0.74
Price, average value, dollars per kilogram, muscovite and phlogopite mica, reported:					
Block	122	121	130	152	156
Splittings	1.53	1.66	1.53	1.63	1.68
Stocks, fabricator and trader, yearend	NA	NA	NA	NA	NA
Net import reliance[4] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2008–11): Scrap and flake: Canada, 34%; China, 34%; India, 22%; Finland, 7%; and other, 3%. Sheet: China, 25%; Brazil, 21%; Belgium, 18%; India, 17%; and other, 19%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Split block mica	2525.10.0010	Free.
Mica splittings	2525.10.0020	Free.
Unworked—other	2525.10.0050	Free.
Mica powder	2525.20.0000	Free.
Mica waste	2525.30.0000	Free.
Plates, sheets, and strips of agglomerated or reconstructed mica	6814.10.0000	2.7% ad val.
Worked mica and articles of mica—other	6814.90.0000	2.6% ad val.

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MICA (NATURAL)

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: None.

Events, Trends, and Issues: Domestic production and consumption of scrap and flake mica were estimated to decrease in 2012, for the third consecutive year. The decrease primarily resulted from decreased production of minerals from which mica is a byproduct, and it seemed that the slight recovery in construction materials markets had not resulted in increased mica consumption. Apparent consumption of sheet mica decreased in 2012. No environmental concerns are associated with the manufacture and use of mica products.

Significant stocks of sheet mica previously sold from the National Defense Stockpile (NDS) to domestic and foreign mica traders, brokers, and processors were exported, possibly resulting in understating apparent consumption in 2006 through 2009. The NDS has not held mica since 2008, when the last stocks of muscovite block were sold. Future supplies for U.S. consumption were expected to come increasingly from imports, primarily from Brazil, China, India, and Russia.

World Mine Production and Reserves:

	Scrap and flake			Sheet		
	Mine production[e]		Reserves[8]	Mine production[e]		Reserves[8]
	2011	2012		2011	2012	
All types:						
United States[1]	50	44	Large	([5])	([5])	Very small
Argentina	9	9	Large	—	—	NA
Canada	14	14	Large	—	—	NA
China	760	760	Large	—	—	NA
Finland:	70	70	Large			NA
France	20	20	Large	—	—	NA
India	7	7	Large	3.5	4.0	Very large
Korea, Republic of	35	36	Large	—	—	NA
Russia	100	100	Large	1.5	1.5	Moderate
Other countries	25	26	Large	0.2	0.2	Moderate
World total (rounded)	1,090	1,100	Large	5.2	5.7	Very large

World Resources: Resources of scrap and flake mica are available in clay deposits, granite, pegmatite, and schist, and are considered more than adequate to meet anticipated world demand in the foreseeable future. World resources of sheet mica have not been formally evaluated because of the sporadic occurrence of this material. Large deposits of mica-bearing rock are known to exist in countries such as Brazil, India, and Madagascar. Limited resources of sheet mica are available in the United States. Domestic resources are uneconomic because of the high cost of hand labor required to mine and process sheet mica from pegmatites.

Substitutes: Some lightweight aggregates, such as diatomite, perlite, and vermiculite, may be substituted for ground mica when used as filler. Ground synthetic fluorophlogopite, a fluorine-rich mica, may replace natural ground mica for uses that require thermal and electrical properties of mica. Many materials can be substituted for mica in numerous electrical, electronic, and insulation uses. Substitutes include acrylic, cellulose acetate, fiberglass, fishpaper, nylatron, nylon, phenolics, polycarbonate, polyester, styrene, vinyl-PVC, and vulcanized fiber. Mica paper made from scrap mica can be substituted for sheet mica in electrical and insulation applications.

[e]Estimated. NA Not available.
[1]Sold or used by producing companies.
[2]Excludes low-quality sericite used primarily for brick manufacturing.
[3]Based on scrap and flake mica mine production.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]Less than ½ unit.
[6]See explanation in the Events, Trends, and Issues section.
[7]Apparent consumption calculation in 2008 resulted in a negative number.
[8]See Appendix C for resource/reserve definitions and information concerning data sources.

MOLYBDENUM

(Data in metric tons of molybdenum content unless otherwise noted)

Domestic Production and Use: In 2012, molybdenum, valued at about $1.7 billion (based on an average oxide price), was produced at 12 mines. Molybdenum ore was produced as a primary product at four mines—one each in Colorado, Idaho, Nevada, and New Mexico—whereas eight copper mines (four in Arizona, one each in Montana, Nevada, New Mexico, and Utah) recovered molybdenum as a byproduct. Three roasting plants converted molybdenite concentrate to molybdic oxide, from which intermediate products, such as ferromolybdenum, metal powder, and various chemicals, were produced. Iron and steel and superalloy producers accounted for about 76% of the molybdenum consumed.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production, mine	55,900	47,800	59,400	63,700	57,000
Imports for consumption	14,500	11,400	19,700	21,100	21,000
Exports	34,700	27,900	31,600	35,400	34,000
Consumption:					
Reported[1]	21,100	17,700	19,200	19,300	18,000
Apparent[2]	36,400	30,500	46,500	48,300	45,000
Price, average value, dollars per kilogram[3]	62.99	25.84	34.93	34.13	29.20
Stocks, mine and plant concentrates, product, and consumer materials	7,000	7,700	8,800	9,800	8,800
Employment, mine and plant, number	940	920	940	940	940
Net import reliance[4] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Molybdenum in the form of molybdenum metal or superalloys was recovered, but the amount was small. Although molybdenum is not recovered from scrap steel, recycling of steel alloys is significant, and some molybdenum content is reutilized. The amount of molybdenum recycled as part of new and old steel and other scrap may be as much as 30% of the apparent supply of molybdenum.

Import Sources (2008–11): Ferromolybdenum: Chile, 74%; Canada, 8%; United Kingdom, 6%; China, 3%; and other, 9%. Molybdenum ores and concentrates: Mexico, 32%; Chile, 24%; Peru, 24%; Canada, 16%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Molybdenum ore and concentrates, roasted	2613.10.0000	12.8¢/kg + 1.8% ad val.
Molybdenum ore and concentrates, other	2613.90.0000	17.8¢/kg.
Molybdenum chemicals:		
Molybdenum oxides and hydroxides	2825.70.0000	3.2% ad val.
Molybdates of ammonium	2841.70.1000	4.3% ad val.
Molybdates, all others	2841.70.5000	3.7% ad val.
Molybdenum pigments, molybdenum orange	3206.20.0020	3.7% ad val.
Ferroalloys, ferromolybdenum	7202.70.0000	4.5% ad val.
Molybdenum metals:		
Powders	8102.10.0000	9.1¢/kg + 1.2% ad val.
Unwrought	8102.94.0000	13.9¢/kg + 1.9% ad val.
Wrought bars and rods	8102.95.3000	6.6% ad val.
Wrought plates, sheets, strips, etc.	8102.95.6000	6.6% ad val.
Wire	8102.96.0000	4.4% ad val.
Waste and scrap	8102.97.0000	Free.
Other	8102.99.0000	3.7% ad val.

Depletion Allowance: 22% (Domestic); 14% (Foreign).

Government Stockpile: None.

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MOLYBDENUM

Events, Trends, and Issues: U.S. mine output of molybdenum in concentrate in 2012 decreased by 11% from that of 2011. U.S. imports for consumption slightly increased from those of 2011, while U.S. exports decreased by 4% from those of 2011. Domestic roasters operated close to full production levels in both 2011 and 2012. Reported U.S. consumption of primary molybdenum products decreased by 4% from that of 2011. Apparent consumption of roasted molybdenum concentrates decreased by 7% from that of 2011. Mine capacity utilization in 2011 was about 75%.

Molybdenum prices slowly increased in the first 2 months of 2012 but decreased for the remainder of the year; the average price for 2012 was lower than that of 2011. However, molybdenum demand remained strong. Both byproduct and primary molybdenum production levels in the United States remained stable in 2012 compared with their relatively low levels in 2009. Byproduct molybdenum production commenced at the Chino Mine in Grant County, NM, and the Morenci Mine in Greenlee County, AZ. Byproduct molybdenum production at the Mission Mine in Pima County, AZ, continued to be suspended.

World Mine Production and Reserves: Reserves for Armenia and Chile were revised based on new information from those countries.

	Mine production		Reserves[5]
	2011	2012[e]	(thousand metric tons)
United States	63,700	57,000	2,700
Armenia	4,500	4,600	150
Canada	8,400	9,400	220
Chile	40,900	35,300	2,300
China	106,000	105,000	4,300
Iran	3,700	4,000	50
Kazakhstan	—	—	130
Kyrgyzstan	250	250	100
Mexico	10,900	10,900	130
Mongolia	1,960	1,950	160
Peru	19,100	19,500	450
Russia[e]	3,900	3,900	250
Uzbekistan[e]	550	550	60
World total (rounded)	264,000	250,000	11,000

World Resources: Identified resources of molybdenum in the United States are about 5.4 million tons, and in the rest of the world, about 14 million tons. Molybdenum occurs as the principal metal sulfide in large low-grade porphyry molybdenum deposits and as an associated metal sulfide in low-grade porphyry copper deposits. Resources of molybdenum are adequate to supply world needs for the foreseeable future.

Substitutes: There is little substitution for molybdenum in its major application as an alloying element in steels and cast irons. In fact, because of the availability and versatility of molybdenum, industry has sought to develop new materials that benefit from the alloying properties of the metal. Potential substitutes for molybdenum include chromium, vanadium, niobium (columbium), and boron in alloy steels; tungsten in tool steels; graphite, tungsten, and tantalum for refractory materials in high-temperature electric furnaces; and chrome-orange, cadmium-red, and organic-orange pigments for molybdenum orange.

[e]Estimated. E Net exporter. —Zero.
[1]Reported consumption of primary molybdenum products.
[2]Apparent consumption of molybdenum concentrates roasted to make molybdenum oxide.
[3]Time-weighted average price per kilogram of molybdenum contained in technical-grade molybdic oxide, as reported by Ryan's Notes.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]See Appendix C for resource/reserve definitions and information concerning data sources.

NICKEL

(Data in metric tons of nickel content unless otherwise noted)

Domestic Production and Use: The United States did not have any active nickel mines in 2011. An underground chalcopyrite-pentlandite mine, however, was being developed in Michigan and was scheduled to be in full production by 2014. Three mining projects were also in various stages of development in northeastern Minnesota. On a monthly or annual basis, 122 facilities reported nickel consumption. The principal consuming State was Pennsylvania, followed by Kentucky, North Carolina, and New York. Approximately 48% of the primary nickel consumed went into stainless and alloy steel production, 39% into nonferrous alloys and superalloys, 10% into electroplating, and 3% into other uses. End uses were as follows: transportation, 30%; fabricated metal products, 14%; electrical equipment, 12%; petroleum industry, 10%; chemical industry, construction, household appliances, and industrial machinery, 8% each; and other, 2%. The estimated value of apparent primary consumption was $2.85 billion.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production, refinery byproduct	W	W	W	W	W
Shipments of purchased scrap[1]	161,000	152,000	139,000	142,000	130,000
Imports:					
Primary	129,000	99,900	129,000	138,000	137,000
Secondary	20,100	17,700	23,800	21,300	22,200
Exports:					
Primary	11,600	7,030	12,600	12,400	7,970
Secondary	94,600	90,000	80,300	64,800	57,200
Consumption:					
Reported, primary	102,000	83,200	97,600	103,000	106,000
Reported, secondary	86,700	79,900	81,900	89,300	95,100
Apparent, primary	115,000	94,100	113,000	124,000	128,000
Total[2]	202,000	174,000	195,000	214,000	223,000
Price, average annual, London Metal Exchange:					
Cash, dollars per metric ton	21,104	14,649	21,804	22,890	17,600
Cash, dollars per pound	9.572	6.645	9.890	10.383	7.990
Stocks:					
Consumer, yearend	15,200	13,600	16,800	18,100	18,600
Producer, yearend[3]	5,860	5,490	6,240	6,620	6,570
Net import reliance[4] as a percentage of apparent consumption	32	22	41	47	49

Recycling: About 95,000 tons of nickel was recovered from purchased scrap in 2012. This represented about 43% of reported secondary plus apparent primary consumption for the year.

Import Sources (2008–11): Canada, 36%; Russia, 17%; Australia, 11%; Norway, 10%; and other, 26%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Nickel oxides, chemical grade	2825.40.0000	Free.
Ferronickel	7202.60.0000	Free.
Unwrought nickel, not alloyed	7502.10.0000	Free.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: The U.S. Government sold the last of the nickel in the National Defense Stockpile in 1999. The U.S. Department of Energy is holding 8,800 tons of nickel ingot contaminated by low-level radioactivity plus 5,080 tons of contaminated shredded nickel scrap. Ongoing decommissioning activities at former nuclear defense sites are expected to generate an additional 20,000 tons of nickel in shredded scrap.

Events, Trends, and Issues: The U.S. economy continued to recover from the global recession of 2008–09, but the recovery was slow. In 2012, U.S. production of austenitic (nickel-bearing) stainless steel decreased to 1.41 million tons—slightly less than production in 2011 but 22% greater than the reduced output of 1.16 million tons in 2009. Stainless steel has traditionally accounted for two-thirds of primary nickel use worldwide, with more than one-half of the steel going into the construction, food processing, and transportation sectors. China, the world's leading producer, cast a record-high 11.5 million tons of austenitic stainless steel in 2012.

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NICKEL

Nickel prices deteriorated during the spring and summer of 2011. In February 2012, the London Metal Exchange (LME) cash mean for 99.8%-pure nickel peaked briefly at $20,462 per metric ton after partially recovering from the 12-month decline. The cash price, however, started contracting again as the European debt situation worsened and the Chinese economy began to slow. Economic problems in Japan created by the March 2011 earthquake and tsunami reinforced the global slowdown. By August, the cash price had fallen to $15,654 per metric ton and was accompanied by the gradual buildup of stocks in LME warehouses to early 2011 levels. The average monthly LME cash price for October 2012 was $17,242 per ton. Global demand for austenitic stainless steel was projected to grow despite the depressed economic climate. Stainless steel producers in Finland, India, and the United States were constructing new meltshops and expanding operations in anticipation of growing demand, particularly in developing countries. Demand for superalloys is expected to be especially strong in the aerospace and power-generation sectors. Increased extraction of natural gas from shale and the discovery of gas fields in the Mozambique Channel are expected to accelerate orders for new turbines manufactured from nickel-bearing stainless steel and superalloys. New nickel mines were being developed in Brazil, Canada, East Africa, Oceania, and Southeast Asia to meet the projected long-term growth in demand. The $5.5 billion Ambatovy pressure-acid-leach project in Madagascar began shipping nickel metal briquettes in November 2012, and the Koniambo open pit mining and smelting complex in New Caledonia was scheduled to begin producing ferronickel in early 2013. Companies mining lateritic ore in the Philippines continued to ramp up production to meet increased demand from Chinese producers of nickel pig iron.

World Mine Production and Reserves: Estimates of reserves for Brazil, Colombia, the Dominican Republic, Russia, and the United States were revised based on new information from company reports.

	Mine production		Reserves[5]
	2011	2012[e]	
United States	—	—	7,100
Australia	215,000	230,000	[6]20,000,000
Botswana	26,000	26,000	490,000
Brazil	109,000	140,000	7,500,000
Canada	220,000	220,000	3,300,000
China	89,800	91,000	3,000,000
Colombia	76,000	80,000	1,100,000
Cuba	71,000	72,000	5,500,000
Dominican Republic	21,700	24,000	970,000
Indonesia	290,000	320,000	3,900,000
Madagascar	5,900	22,000	1,600,000
New Caledonia[7]	131,000	140,000	12,000,000
Philippines	270,000	330,000	1,100,000
Russia	267,000	270,000	6,100,000
South Africa	44,000	42,000	3,700,000
Other countries	103,000	120,000	4,600,000
World total (rounded)	1,940,000	2,100,000	75,000,000

World Resources: Identified land-based resources averaging 1% nickel or greater contain at least 130 million tons of nickel. About 60% is in laterites and 40% is in sulfide deposits. Extensive resources of nickel are also found in manganese crusts and nodules covering large areas of the ocean floor. The long-term decline in discovery of new sulfide deposits in traditional mining districts has forced exploration teams to shift to more challenging locations like east-central Africa and the Subarctic. Development of awaruite deposits in Canada may help alleviate projected shortages of nickel concentrate. Awaruite, a natural iron-nickel alloy, is easier to concentrate than pentlandite.

Substitutes: Low-nickel, duplex, or ultrahigh-chromium stainless steels are being substituted for austenitic grades in construction. Nickel-free specialty steels are sometimes used in place of stainless steel in the power-generating and petrochemical industries. Titanium alloys can substitute for nickel metal or nickel-based alloys in corrosive chemical environments. Lithium-ion batteries instead of nickel-metal hydride may be used in certain applications.

[e]Estimated. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Scrap receipts – shipments by consumers + exports – imports + adjustments for consumer stock changes.
[2]Apparent primary consumption + reported secondary consumption.
[3]Stocks of producers, agents, and dealers held only in the United States.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]See Appendix C for resource/reserve definitions and information concerning data sources.
[6]For Australia, Joint Ore Reserves Committee (JORC)-compliant reserves were about 7.0 million tons.
[7]Overseas territory of France.

NIOBIUM (COLUMBIUM)

(Data in metric tons of niobium content unless otherwise noted)

Domestic Production and Use: Significant U.S. niobium mine production has not been reported since 1959. Domestic niobium resources are of low grade, some are mineralogically complex, and most are not commercially recoverable. Companies in the United States produced ferroniobium and niobium compounds, metal, and other alloys from imported niobium minerals, oxides, and ferroniobium. Niobium was consumed mostly in the form of ferroniobium by the steel industry and as niobium alloys and metal by the aerospace industry. Major end-use distribution of reported niobium consumption was as follows: steels, 58%; and superalloys, 42%. In 2011, the estimated value of niobium consumption was $424 million and was expected to be about $500 million in 2012, as measured by the value of imports.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production:					
Mine	—	—	—	—	—
Secondary	NA	NA	NA	NA	NA
Imports for consumption[e, 1]	9,230	4,400	8,500	9,500	9,200
Exports[e, 1]	781	195	281	363	430
Government stockpile releases[e, 2]	—	—	—	—	—
Consumption:[e]					
Apparent	8,450	4,210	8,210	9,156	8,800
Reported[3]	5,380	4,350	5,590	7,210	5,900
Unit value, ferroniobium, dollars per metric ton[4]	34,398	37,298	37,781	41,000	47,000
Net import reliance[5] as a percentage of apparent consumption	100	100	100	100	100

Recycling: Niobium was recycled when niobium-bearing steels and superalloys were recycled; scrap recovery specifically for niobium content was negligible. The amount of niobium recycled is not available, but it may be as much as 20% of apparent consumption.

Import Sources (2008–11): Niobium contained in niobium and tantalum ore and concentrate; ferroniobium; and niobium metal and oxide: Brazil, 85%; Canada, 10%; Germany, 2%; and other, 3%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–12**
Synthetic tantalum-niobium concentrates	2615.90.3000	Free.
Niobium ores and concentrates	2615.90.6030	Free.
Niobium oxide	2825.90.1500	3.7% ad val.
Ferroniobium:		
Less than 0.02% of P or S, or less than 0.4% of Si	7202.93.4000	5.0% ad val.
Other	7202.93.8000	5.0% ad val.
Niobium, unwrought:		
Waste and scrap[6]	8112.92.0600	Free.
Alloys, metal, powders	8112.92.4000	4.9% ad val.
Niobium, other[6]	8112.99.9000	4.0% ad val.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: For fiscal year (FY) 2012, which ended on September 30, 2012, the Defense Logistics Agency, DLA Strategic Materials disposed of no niobium materials. The DLA Strategic Materials has not yet announced maximum disposal limits for niobium metal in FY 2013. The DLA Strategic Materials' niobium mineral concentrate inventory was exhausted in FY 2007; niobium carbide powder, in FY 2002; and ferroniobium, in FY 2001.

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NIOBIUM (COLUMBIUM)

Stockpile Status—9–30–12[7]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2012	Disposals FY 2012
Niobium metal	10.0	—	—	—

Inventory in FY2012 is less than that of FY2011 owing to revised inventory in 2012, not to material purchase.

Events, Trends, and Issues: Niobium principally was imported in the form of ferroniobium and niobium unwrought metal, alloy, and powder. U.S. niobium import dependence was expected to be the same in 2012 as in 2011, when Brazil was the leading niobium supplier. By weight in 2011, Brazil supplied 85% of total U.S. niobium imports, 85% of ferroniobium, 85% of niobium metal, and 84% of niobium oxide. The leading suppliers of niobium in ore and concentrate were Australia (54%), Mozambique (13%), and Canada and Brazil (10%, each).

World Mine Production and Reserves:

	Mine production 2011	Mine production 2012[e]	Reserves[8]
United States	—	—	—
Brazil	58,000	63,000	4,100,000
Canada	4,630	5,000	200,000
Other countries	732	700	NA
World total (rounded)	63,400	69,000	>4,000,000

World Resources: World resources of niobium are more than adequate to supply projected needs. Most of the world's identified resources of niobium occur mainly as pyrochlore in carbonatite [igneous rocks that contain more than 50% by volume carbonate (CO_3) minerals] deposits and are outside the United States. The United States has approximately 150,000 tons of niobium resources in identified deposits, all of which were considered uneconomic at 2012 prices for niobium.

Substitutes: The following materials can be substituted for niobium, but a performance or cost penalty may ensue: molybdenum and vanadium, as alloying elements in high-strength low-alloy steels; tantalum and titanium, as alloying elements in stainless and high-strength steels; and ceramics, molybdenum, tantalum, and tungsten in high-temperature applications.

[e]Estimated. NA Not available. — Zero.
[1]Imports and exports include the estimated niobium content of niobium and tantalum ores and concentrates, niobium oxide, ferroniobium, niobium unwrought alloys, metal, and powder.
[2]Government stockpile inventory reported by DLA Strategic Materials is the basis for estimating Government stockpile releases.
[3]Includes ferroniobium and nickel niobium.
[4]Unit value is mass-weighted average U.S. import value of ferroniobium assuming 65% niobium content. To convert dollars per metric ton to dollars per pound, divide by 2,205.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]This category includes other than niobium-containing material.
[7]See Appendix B for definitions.
[8]See Appendix C for resource/reserve definitions and information concerning data sources.

NITROGEN (FIXED)—AMMONIA

(Data in thousand metric tons of nitrogen unless otherwise noted)

Domestic Production and Use: Ammonia was produced by 13 companies at 25 plants in 16 States in the United States during 2012; 3 additional plants were idle for the entire year. Sixty-one percent of total U.S. ammonia production capacity was centered in Louisiana, Oklahoma, and Texas because of their large reserves of natural gas, the dominant domestic feedstock. In 2012, U.S. producers operated at about 85% of their rated capacity. The United States was one of the world's leading producers and consumers of ammonia. Urea, ammonium nitrate, ammonium phosphates, nitric acid, and ammonium sulfate were the major derivatives of ammonia in the United States, in descending order of importance.

Approximately 87% of apparent domestic ammonia consumption was for fertilizer use, including anhydrous ammonia for direct application, urea, ammonium nitrates, ammonium phosphates, and other nitrogen compounds. Ammonia also was used to produce plastics, synthetic fibers and resins, explosives, and numerous other chemical compounds.

Salient Statistics—United States:[1]	**2008**	**2009**	**2010**	**2011**	**2012**[e]
Production	[2]7,870	[2]7,700	[2]8,290	[3]9,350	[4]9,470
Imports for consumption	6,020	4,530	5,540	5,600	5,090
Exports	192	16	35	26	42
Consumption, apparent	13,500	12,300	13,800	14,900	14,400
Stocks, producer, yearend	302	167	165	178	180
Price, dollars per ton, average, f.o.b. Gulf Coast[5]	590	251	396	531	575
Employment, plant, number[e]	1,100	1,050	1,050	1,050	1,100
Net import reliance[6] as a percentage of apparent consumption	42	38	40	37	35

Recycling: None.

Import Sources (2008–11): Trinidad and Tobago, 60%; Russia, 15%; Canada, 10%; Ukraine, 6%; and other, 9%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Ammonia, anhydrous	2814.10.0000	Free.
Urea	3102.10.0000	Free.
Ammonium sulfate	3102.21.0000	Free.
Ammonium nitrate	3102.30.0000	Free.

Depletion Allowance: Not applicable.

Government Stockpile: None.

Events, Trends, and Issues: The Henry Hub spot natural gas price ranged between $1.80 and $3.20 per million British thermal units for most of the year, with an average of about $2.70 per million British thermal units. Natural gas prices in 2012 were relatively stable; slightly higher prices were a result of increased demand for natural gas owing to hot temperatures and associated increases in demand for power generation. The average Gulf Coast ammonia price gradually increased from $612 per short ton at the beginning of 2012 to a high of around $655 per short ton in September. The average ammonia price for the year was estimated to be about $575 per short ton. The U.S. Department of Energy, Energy Information Administration, projected that Henry Hub natural gas spot prices would average $3.34 per million British thermal units in 2013.

A long period of stable and low natural gas prices in the United States has made it economical for companies to upgrade existing plants and plan for the construction of new nitrogen projects.

Several companies have announced plans to build new ammonia plants in Azerbaijan, Canada, Egypt, Iraq, Nigeria, Peru, and Trinidad and Tobago, which would add about 6.4 million tons of annual production capacity within the next 2 to 4 years. The largest growth in ammonia production is in Canada because of the low natural gas prices.

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NITROGEN (FIXED)—AMMONIA

According to the U.S. Department of Agriculture, U.S. corn growers planted 39 million hectares of corn in the 2012 crop year (July 1, 2011, through June 30, 2012), which was 5% higher than the area planted in 2011. Expectations of corn acreage utilization increased in many States because of higher selling prices and expectations of better net returns from corn compared to other commodities. Corn plantings for the 2013 crop year were expected to decrease slightly to 37.2 million hectares. Overall corn acreage was expected to remain high owing in part to continued U.S. ethanol production and U.S. corn exports in response to a strong global demand for feed grains.

Nitrogen compounds also were an environmental concern. Overfertilization and the subsequent runoff of excess fertilizer may contribute to nitrogen accumulation in watersheds. Nitrogen in excess fertilizer runoff was suspected to be a cause of the hypoxic zone that arises in the Gulf of Mexico during the summer. Scientists continued to study the effects of fertilization on the Nation's environmental health.

World Ammonia Production and Reserves:

	Plant production 2011	Plant production 2012[e]	Reserves[7]
United States	9,350	9,470	Available atmospheric nitrogen and sources of natural gas for production of ammonia are considered adequate for all listed countries.
Australia	1,200	1,200	
Bangladesh	1,300	1,300	
Canada	3,900	3,900	
China	41,700	44,000	
Egypt	3,000	3,000	
Germany	2,820	2,800	
India	11,800	12,000	
Indonesia	5,000	5,100	
Iran	2,500	2,500	
Japan	1,200	1,200	
Netherlands	1,800	1,800	
Oman	1,700	1,700	
Pakistan	2,450	2,500	
Poland	1,700	1,700	
Qatar	1,900	1,900	
Romania	1,100	1,100	
Russia	10,500	10,000	
Saudi Arabia	2,600	2,600	
Trinidad and Tobago	5,500	5,500	
Ukraine	4,300	4,300	
United Kingdom	1,100	1,100	
Uzbekistan	1,000	1,000	
Venezuela	1,160	1,200	
Other countries	14,000	14,000	
World total (rounded)	135,000	137,000	

World Resources: The availability of nitrogen from the atmosphere for fixed nitrogen production is unlimited. Mineralized occurrences of sodium and potassium nitrates, found in the Atacama Desert of Chile, contribute minimally to global nitrogen supply.

Substitutes: Nitrogen is an essential plant nutrient that has no substitute. Also, there are no known practical substitutes for nitrogen explosives and blasting agents.

[e]Estimated.
[1]U.S. Department of Commerce (DOC) data unless otherwise noted.
[2]Annual and preliminary data as reported in Current Industrial Reports MQ325B (DOC).
[3]Source: U.S. Census Bureau and The Fertilizer Institute; data adjusted by the U.S. Geological Survey.
[4]Source: The Fertilizer Institute as adjusted by the U.S. Geological Survey.
[5]Source: Green Markets.
[6]Defined as imports – exports + adjustments for Government and industry stock changes.
[7]See Appendix C for resource/reserve definitions and information concerning data sources.

PEAT

(Data in thousand metric tons unless otherwise noted)[1]

Domestic Production and Use: The estimated f.o.b. plant value of marketable peat production in the conterminous United States was $13.0 million in 2012. Peat was harvested and processed by about 35 companies in 12 of the conterminous States. The Alaska Department of Natural Resources, which conducted its own canvass of producers, reported 61,500 cubic meters of peat was produced in 2011; output was reported only by volume.[2] A production estimate was unavailable for Alaska for 2012. Florida and Minnesota were the leading producing States, in order of quantity harvested. Reed-sedge peat accounted for approximately 85% of the total volume produced, followed by sphagnum moss, 10%, hypnum moss, 4%, and humus, 1%. About 80% of domestic peat was sold for horticultural use, including general soil improvement, golf course construction, nurseries, and potting soils. Other applications included earthworm culture medium, mixed fertilizers, mushroom culture, packing for flowers and plants, seed inoculants, and vegetable cultivation. In the industrial sector, peat was used as an oil absorbent and as an efficient filtration medium for the removal of waterborne contaminants in mine waste streams, municipal storm drainage, and septic systems.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production	615	609	628	568	560
Commercial sales	647	644	605	595	570
Imports for consumption	936	906	947	982	940
Exports	[3]57	77	69	49	75
Consumption, apparent[4]	1,440	1,440	1,560	1,500	1,500
Price, average value, f.o.b. mine, dollars per ton	26.42	23.24	24.39	22.73	23.00
Stocks, producer, yearend	152	149	100	133	100
Employment, mine and plant, number[e]	620	610	610	600	580
Net import reliance[5] as a percentage of apparent consumption	57	58	60	61	62

Recycling: None.

Import Sources (2008–11): Canada, 96%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Peat	2703.00.0000	Free.

Depletion Allowance: 5% (Domestic).

Government Stockpile: None.

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PEAT

Events, Trends, and Issues: Peat is an important component of growing media, and the demand for peat generally follows that of horticultural applications. In the United States, the short-term outlook is for production to average about 560,000 tons per year and imported peat from Canada to account for more than 60% of domestic consumption.

Canada's peat harvest showed improvement over the 2011 season. Eastern Canada had higher than expected volumes of peat being harvested, while central Canada was slightly above expectations. An early start of the season and favorable weather conditions contributed to the increase in peat production in eastern and central Canada.

World Mine Production and Reserves: Countries that reported by volume only and had insufficient data for conversion to tons were combined and included with "Other countries."

	Mine production		Reserves[6]
	2011	2012[e]	
United States	568	560	150,000
Belarus	2,730	3,300	400,000
Canada	1,120	1,200	720,000
Estonia	960	970	60,000
Finland	6,460	6,400	6,000,000
Germany	2,930	2,900	([7])
Ireland	3,300	3,700	([7])
Latvia	1,120	1,000	76,000
Lithuania	326	330	190,000
Moldova	475	475	([7])
Norway	425	300	([7])
Poland	670	750	([7])
Russia	1,650	1,300	1,000,000
Sweden	2,550	2,500	([7])
Ukraine	454	600	([7])
Other countries	540	510	1,400,000
World total (rounded)	26,300	26,800	10,000,000

World Resources: Peat is a renewable resource, continuing to accumulate on 60% of global peatlands. However, the volume of global peatlands has been decreasing at a rate of 0.05% annually owing to harvesting and land development. Many countries evaluate peat resources based on volume or area because the variations in densities and thickness of peat deposits make it difficult to estimate tonnage. Volume data have been converted using the average bulk density of peat produced in that country. Reserve data were estimated based on data from International Peat Society publications and the percentage of peat resources available for peat extraction. More than 50% of the U.S. peatlands are located in undisturbed areas of Alaska. Total world resources of peat were estimated to be between 5 trillion and 6 trillion tons, covering about 400 million hectares.[8]

Substitutes: Natural organic materials such as composted yard waste and coir (coconut fiber) compete with peat in horticultural applications. Shredded paper and straw are used to hold moisture for some grass-seeding applications. The superior water-holding capacity and physiochemical properties of peat limit substitution alternatives.

[e]Estimated.
[1]See Appendix A for conversion to short tons.
[2]Harbo. L.A., Mineral Specialist, Alaska Office of Economic Development, oral commun., September 5, 2012.
[3]Source: U.S. Census Bureau; adjusted by the U.S. Geological Survey.
[4]Defined as production + imports – exports + adjustments for industry stock changes.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]See Appendix C for resource/reserve definitions and information concerning data sources.
[7]Included with "Other countries."
[8]Lappalainen, Eino, 1996, Global peat resources: Jyvaskyla, Finland, International Peat Society, p. 55.

PERLITE

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: The estimated value (f.o.b. mine) of processed crude perlite produced in 2012 was $24.5 million. Crude ore production came from eight mines operated by six companies in five Western States. New Mexico continued to be the major producing State. Processed crude perlite was expanded at 50 plants in 27 States. The principal end uses were building construction products, 54%; fillers, 15%; horticultural aggregate, 14%; and filter aid, 10%. The remaining 7% includes miscellaneous uses and estimated expanded perlite consumption whose use is unknown.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production[1]	434	348	414	420	424
Imports for consumption[e]	187	153	174	193	168
Exports[e]	37	33	42	36	35
Consumption, apparent	584	468	546	577	557
Price, average value, dollars per ton, f.o.b. mine	48	49	52	56	58
Employment, mine and mill	103	97	102	95	95
Net import reliance[2] as a percentage of apparent consumption	26	26	24	27	24

Recycling: Not available.

Import Sources (2008–11): Greece, 100%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–12**
Vermiculite, perlite and chlorites, unexpanded	2530.10.0000	Free.

Depletion Allowance: 10% (Domestic and foreign).

Government Stockpile: None.

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PERLITE

Events, Trends, and Issues: The amount of processed crude perlite sold or used from U.S. mines increased slightly in 2012 compared with that reported for 2011. Imports decreased about 13% as demand for perlite-based construction products, fillers, and filter aid failed to sustain a modest recovery started in 2010.

The quantities of processed crude perlite sold or used each year from 2009 through 2012 had not recovered to levels seen prior to 2006, and in 2012 were still lower than they had been since the early 1980s. Imports declined for the first time since 2009 as decreased demand affected imports, even as domestic miners maintained production and sales levels near those attained in 2011.

Perlite mining generally takes place in remote areas, and its environmental impact is not severe. The mineral fines, overburden, and reject ore produced during ore mining and processing are used to reclaim the mined-out areas, and, therefore, little waste remains. Airborne dust is captured by baghouses, and there is practically no runoff that contributes to water pollution.

World Processed Perlite Production and Reserves: Greece surpassed the United States in processed perlite production starting in 2003. Estimates for 2012, however, indicate the United States may have once again overtaken Greece. Information for China and several other countries is unavailable, making it unclear whether or not Greece and the United States are the world's leading producers. Reserve data previously reported for some countries have been removed because they were based on information that was judged to be no longer reliable. Updated reserve data for these countries were not available.

	Production		Reserves[3]
	2011	2012[e]	
United States	420	424	50,000
Greece	500	400	50,000
Hungary	65	70	NA
Italy	60	60	NA
Japan	300	200	NA
Mexico	30	30	NA
Turkey	250	400	NA
Other countries	150	150	NA
World total (rounded)	1,770	1,700	NA

World Resources: Insufficient information is available to make reliable estimates of resources in perlite-producing countries.

Substitutes: Alternative materials can be substituted for all uses of perlite, if necessary. Long-established competitive commodities include diatomite, expanded clay and shale, pumice, slag, and vermiculite.

[e]Estimated. NA Not available.
[1]Processed perlite sold and used by producers.
[2]Defined as imports - exports + adjustments for Government and industry stock changes; changes in stocks were not available and assumed to be zero for apparent consumption and net import reliance calculations.
[3]See Appendix C for resource/reserve definitions and information concerning data sources.

PHOSPHATE ROCK

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Phosphate rock ore was mined by 6 firms at 11 mines in 4 States and upgraded to an estimated 29.2 million tons of marketable product valued at $2.9 billion, f.o.b. mine. Florida and North Carolina accounted for more than 85% of total domestic output; the remainder was produced in Idaho and Utah. Marketable product refers to beneficiated phosphate rock with phosphorus pentoxide (P_2O_5) content suitable for phosphoric acid or elemental phosphorus production. More than 95% of the U.S. phosphate rock mined was used to manufacture wet-process phosphoric acid and superphosphoric acid, which were used as intermediate feedstocks in the manufacture of granular and liquid ammonium phosphate fertilizers and animal feed supplements. Approximately 45% of the wet-process phosphoric acid produced was exported in the form of upgraded granular diammonium and monoammonium phosphate (DAP and MAP, respectively) fertilizer, and merchant-grade phosphoric acid. The balance of the phosphate rock mined was for the manufacture of elemental phosphorus, which was used to produce phosphorus compounds for a variety of food-additive and industrial applications.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production, marketable	30,200	26,400	25,800	28,100	29,200
Sold or used by producers	28,900	25,500	28,100	28,600	26,600
Imports for consumption	2,750	2,000	2,400	3,350	2,850
Consumption[1]	31,600	27,500	30,500	32,000	29,500
Price, average value, dollars per ton, f.o.b. mine[2]	76.76	127.19	76.69	96.64	96.90
Stocks, producer, yearend	6,340	8,120	5,620	4,580	5,800
Employment, mine and beneficiation plant, number[e]	2,550	2,500	2,300	2,270	2,260
Net import reliance[3] as a percentage of apparent consumption	4	1	16	13	5

Recycling: None.

Import Sources (2008–11): Morocco, 88%; and Peru, 12%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–12**
Natural calcium phosphates:		
Unground	2510.10.0000	Free.
Ground	2510.20.0000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: Domestic consumption and imports of phosphate rock were estimated to have been lower in 2012 compared with 2011, owing to the lower seasonal demand in the first quarter of the year, which resulted in the temporary closure of some fertilizer plants. World production of phosphate rock was estimated to have increased in 2012 primarily because of higher production in China and a new mine in Saudi Arabia, which opened late in 2010.

A Canadian company continued with development of a new underground phosphate rock mine in southeastern Idaho. The mine encompasses the site of three abandoned mines that operated intermittently from 1917 to 1975. The company planned to begin production in 2014 and produce 10 million metric tons of phosphate concentrate over the life of the mine. The company planned to sell the phosphate rock for domestic use and export.

The sole North American producer of elemental phosphorus was expected to open a new phosphate rock mine in 2013 to replace its current mine in Idaho that was nearing depletion. The company's phosphate and phosphorus production capacity will remain the same after the new mine is operational. U.S. mine production capacity at the end of 2012 was 34.7 million tons per year.

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PHOSPHATE ROCK

World phosphate rock production capacity was projected to increase from 220 million tons per year in 2012 to 256 million tons per year, with more than 50% of the growth in North Africa. The largest expansion project was in progress in Morocco, where phosphate rock production capacity was being increased from 30 million tons per year to 50 million tons per year by 2018. Elsewhere in Africa, phosphate rock mines and expansions were under development in Angola, Congo (Brazzaville), Egypt, Ethiopia, Guinea-Bissau, Namibia, Mali, Mauritania, Mozambique, Senegal, South Africa, Togo, Tunisia, Uganda, and Zambia. Outside of Africa, phosphate rock mines were in various stages of development in Australia, Brazil, Canada, China, Kazakhstan, and New Zealand.

The projected increases in annual production capacity for phosphate rock will supply the associated projected increase in phosphoric acid and fertilizer production. World population growth ensures the need for phosphate fertilizer to grow crops for food and biofuels. World consumption of P_2O_5 in fertilizer was projected to increase from 41.9 million tons in 2012 to 45.3 million tons in 2016.

World Mine Production and Reserves: Reserves for Brazil and Peru were updated with information from Government agencies in each country. Reserve data for Iraq were updated based on a report prepared jointly by the U.S. Geological Survey (USGS) and the Iraqi Ministry of Industry and Minerals in 2012.

	Mine production		Reserves[4]
	2011	2012[e]	
United States	28,100	29,200	1,400,000
Algeria	1,500	1,500	2,200,000
Australia	2,650	2,600	490,000
Brazil	6,200	6,300	270,000
Canada	900	900	2,000
China[5]	81,000	89,000	3,700,000
Egypt	3,500	3,000	100,000
India	1,250	1,260	6,100
Iraq	30	150	460,000
Israel	3,100	3,000	180,000
Jordan	6,500	6,500	1,500,000
Mexico	1,510	1,700	30,000
Morocco and Western Sahara	28,000	28,000	50,000,000
Peru	2,540	2,560	820,000
Russia	11,200	11,300	1,300,000
Saudi Arabia	1,000	1,700	750,000
Senegal	980	980	180,000
South Africa	2,500	2,500	1,500,000
Syria	3,100	2,500	1,800,000
Togo	730	865	60,000
Tunisia	5,000	6,000	100,000
Other countries	6,790	6,000	390,000
World total (rounded)	198,000	210,000	67,000,000

World Resources: Domestic reserve data were based on USGS and individual company information. Phosphate rock resources occur principally as sedimentary marine phosphorites. The largest sedimentary deposits are found in northern Africa, China, the Middle East, and the United States. Significant igneous occurrences are found in Brazil, Canada, Finland, Russia, and South Africa. Large phosphate resources have been identified on the continental shelves and on seamounts in the Atlantic Ocean and the Pacific Ocean. World resources of phosphate rock are more than 300 billion tons.

Substitutes: There are no substitutes for phosphorus in agriculture.

[e]Estimated.
[1]Defined as phosphate rock sold or used + imports.
[2]Marketable phosphate rock, weighted value, all grades.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix C for resource/reserve definitions and information concerning data sources.
[5]Production data for large mines only.

PLATINUM-GROUP METALS

(Platinum, palladium, rhodium, ruthenium, iridium, osmium)
(Data in kilograms unless otherwise noted)

Domestic Production and Use: The Stillwater and East Boulder Mines in south-central Montana were the only primary platinum-group metals (PGMs) mines in the United States and were owned by one company. Small quantities of PGMs were also recovered as byproducts of copper refining. The leading demand sector for PGMs continued to be catalysts to decrease harmful emissions in both light- and heavy-duty vehicles. PGMs are also used in the chemical sector as catalysts for manufacturing bulk chemicals such as nitric acid and in the production of specialty silicones; in the petroleum refining sector; and in laboratory equipment, including crucibles for growing high-purity single crystals for use in the electronics sector. Also in the electronics sector, PGMs are used in computer hard disks to increase storage capacity, in multilayer ceramic capacitors, and in hybridized integrated circuits. PGMs are used by the glass manufacturing sector in the production of fiberglass, liquid crystal displays, and flat-panel displays. Platinum alloys, in cast or wrought form, are commonly used for jewelry. Platinum, palladium, and a variety of complex gold-silver-copper alloys are used as dental restorative materials. Platinum, palladium, and rhodium are used as investment tools in the form of exchange-traded notes and exchange-traded funds.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Mine production:[1]					
Platinum	3,580	3,830	3,450	3,700	3,700
Palladium	11,900	12,700	11,600	12,400	12,200
Imports for consumption:					
Platinum	150,000	183,000	152,000	129,000	164,000
Palladium	120,000	69,700	70,700	98,900	81,500
Rhodium	12,600	11,200	12,800	13,100	13,000
Ruthenium	49,800	21,200	14,100	13,200	12,500
Iridium	2,550	1,520	3,530	2,880	1,300
Osmium	11	68	76	48	75
Exports:					
Platinum	15,600	15,600	16,900	11,300	10,000
Palladium	26,400	30,300	38,100	32,000	36,000
Rhodium	1,980	1,220	2,320	1,370	1,600
Other PGMs	6,450	4,020	3,720	1,150	800
Price,[2] dollars per troy ounce:					
Platinum	1,578.26	1,207.55	1,615.56	1,724.51	1,580.00
Palladium	355.12	265.65	530.61	738.51	650.00
Rhodium	6,533.57	1,591.32	2,459.07	2,204.35	1,300.00
Ruthenium	324.60	97.28	198.45	165.85	115.00
Iridium	448.34	420.40	642.15	1,035.87	1,070.00
Employment, mine, number[1]	1,360	1,270	1,350	1,570	1,500
Net import reliance as a percentage of apparent consumption[e]					
Platinum	89	95	91	89	91
Palladium	79	62	49	64	54

Recycling: An estimated 150,000 kilograms of PGMs was recovered globally from new and old scrap in 2012.

Import Sources (2008–11): Platinum: Germany, 17%; South Africa, 14%; United Kingdom, 9%; Canada, 7%; and other, 53%. Palladium: Russia, 39%; South Africa, 24%; United Kingdom, 11%; Norway, 5%; and other, 21%.

Tariff: All unwrought and semimanufactured forms of PGMs can be imported duty free.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: Sales of iridium and platinum from the National Defense Stockpile remained suspended through FY 2012.

Stockpile Status—9–30–12[3]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2012	Disposals FY 2012
Platinum	261	261	[4]778	—
Iridium	18	18	[4]186	—

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PLATINUM-GROUP METALS

Events, Trends, and Issues: The global economy continued to struggle, and average annual prices for palladium, platinum, rhodium, and ruthenium were lower in 2012 than those of 2011 owing to economic concerns. Prices for platinum, palladium, rhodium, and ruthenium increased from the beginning of the year until late February in response to supply disruptions caused by a 6-week workers' strike at a major PGM producer in South Africa that began in January. Prices decreased after resolution of the strike. In August, prices again spiked in response to workers' strike actions that erupted into violence at another major PGM producer in South Africa. Strikes spread to several other South African PGM mining companies resulting in supply disruptions, and prices remained elevated through September in response. The iridium price decreased in July and August owing to decreased buying. The platinum price was above that for rhodium for the first time since 2004, and continued to be below that for gold throughout the year.

The single domestic mining company continued progress on expansion projects adjacent to its two existing mines. The projects were expected to increase production, and one of the projects was expected to be completed in 2015 and the other in 2017. Test work continued on precious metals refinery technology.

A new palladium trading service was launched in China, which allowed private individuals to trade palladium via account, to let investors amass quantities of palladium through regular small investments in order to spread cost and diversify risks. In Canada, a new platinum and palladium exchange-traded fund (ETF) was scheduled to be launched and would be backed by physical metal held at the Royal Canadian Mint. The ETF was intended for long-term investment rather than short-term investment on price fluctuations. Unlike traditional ETFs, investors could redeem the physical metal.

World Mine Production and Reserves:

	Mine production				PGMs
	Platinum		Palladium		Reserves[5]
	2011	2012[e]	2011	2012[e]	
United States	3,700	3,700	12,400	12,200	900,000
Canada	7,000	6,500	14,000	13,000	310,000
Colombia	1,230	660	NA	NA	([6])
Russia	25,000	26,000	86,000	82,000	1,100,000
South Africa	145,000	128,000	82,000	72,000	63,000,000
Zimbabwe	10,600	11,500	8,200	8,900	([6])
Other countries	2,500	2,500	12,200	12,000	800,000
World total (rounded)	195,000	179,000	215,000	200,000	66,000,000

World Resources: World resources of PGMs in mineral concentrations that can be mined economically are estimated to total more than 100 million kilograms. The largest reserves are in the Bushveld Complex in South Africa.

Substitutes: Most motor vehicle manufacturers have substituted palladium for the more expensive platinum in gasoline-engine catalytic converters. As much as 25% palladium can routinely be substituted for platinum in diesel catalytic converters; new technologies have increased that proportion to around 50% in some applications. For other end uses, some PGMs can be substituted for other PGMs, with some losses in efficiency.

[e]Estimated. NA Not available. — Zero.
[1]Estimates from published sources.
[2]Engelhard Corporation unfabricated metal.
[3]See Appendix B for definitions.
[4]Actual quantity limited to remaining inventory.
[5]See Appendix C for resource/reserve definitions and information concerning data sources.
[6]Included with "Other countries."

POTASH

(Data in thousand metric tons of K_2O equivalent unless otherwise noted)

Domestic Production and Use: In 2012, the production value of marketable potash, f.o.b. mine, was about $675 million. Potash was produced in Michigan, New Mexico, and Utah. Most of the production was from southeastern New Mexico, where two companies operated three mines. New Mexico sylvinite and langbeinite ores were beneficiated by flotation, dissolution-recrystallization, heavy-media separation, or combinations of these processes, and provided more than 75% of total U.S. producer sales. In Utah, which has three operations, one company extracted underground sylvinite ore by deep-well solution mining. Solar evaporation crystallized the sylvinite ore from the brine solution, and a flotation process separated the potassium chloride (muriate of potash or MOP) from byproduct sodium chloride. Two companies processed surface and subsurface brines by solar evaporation and flotation to produce MOP, potassium sulfate (sulfate of potash or SOP), and byproducts. In Michigan, one company used deep-well solution mining and mechanical evaporation for crystallization of MOP and byproduct sodium chloride.

The fertilizer industry used about 85% of U.S. potash sales, and the chemical industry used the remainder. More than 60% of the potash produced was MOP. Potassium magnesium sulfate (sulfate of potash-magnesia or SOPM) and SOP, which are required by certain crops and soils, also were produced.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production, marketable[1]	1,100	720	930	1,000	900
Sales by producers, marketable[1]	1,100	630	1,000	1,000	950
Imports for consumption	5,800	2,220	4,760	4,980	4,000
Exports	222	303	297	202	195
Consumption:[1]					
Apparent[2]	6,700	2,600	5,500	5,800	4,700
Reported[3]	6,700	2,500	5,500	5,800	4,800
Price, dollars per metric ton of K_2O, average, muriate, f.o.b. mine[4]	675	800	630	745	750
Employment, number:					
Mine	525	510	540	550	550
Mill	615	640	650	650	650
Net import reliance[5] as a percentage of apparent consumption	84	73	83	83	81

Recycling: None.

Import Sources (2008–11): Canada, 84%; Russia, 11%; and other, 5%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Potassium nitrate	2834.21.0000	Free.
Potassium chloride	3104.20.0000	Free.
Potassium sulfate	3104.30.0000	Free.
Potassic fertilizers, other	3104.90.0100	Free.
Potassium-sodium nitrate mixtures	3105.90.0010	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: U.S. production in 2012 was estimated to have been lower than that in 2011 owing to some companies reducing stocks and weaker demand. World consumption was estimated to have been lower in 2012 compared with that of 2011 because of weak demand for potash in China and India.

Development of several new potash mines in the Western United States continued in 2012. The leading U.S. producer reported significant progress in the conversion of an underground mine in New Mexico to a solution mine. The new mine was scheduled to begin production in late 2013 and gradually ramp up production through 2015 to nearly full capacity of 200,000 tons per year.

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POTASH

A Canadian company began a feasibility study for the development of a new potash mine in Lea County, NM, 97 kilometers from Carlsbad, NM. The mine was expected to produce SOP and SOPM only and would have an annual production capacity of 700,000 tons per year of SOP and SOPM combined. The company expected to begin production by 2016.

A Colorado-based company began development of an underground potash mine near Holbrook, AZ. The company plans to mine 2 million tons per year of potash for about 40 years. This would be the first potash mine to be developed in the vast Holbrook Basin Deposit. Late in 2012, a Chinese company agreed to purchase 25% of the annual output from the mine for export to China. The mine was expected to begin production in late 2015 or early 2016.

World consumption of potash was projected to grow at a rate of about 3% per year through 2016, owing to world population growth and the associated need for food and biofuels. To meet this growth in consumption, almost 40 new mines or capacity expansions are planned to be completed worldwide by 2017. The majority of the projects were located in Argentina, Belarus, Brazil, Canada, Chile, China, Congo (Brazzaville), Eritrea, Ethiopia, Laos, Mexico, Peru, Kazakhstan, Russia, Turkmenistan, the United Kingdom, and Uzbekistan.

World Mine Production and Reserves: Reserve data for China and Russia were obtained from official Government sources and may not be comparable to the reserve definition in Appendix C. Reserves for Chile and Germany were revised based on information reported by the leading producer in those countries.

	Mine production		Reserves[6]
	2011	2012[e]	
United States	[1]1,000	[1]900	130,000
Belarus	5,500	5,650	750,000
Brazil	454	460	300,000
Canada	11,000	9,000	4,400,000
Chile	980	900	150,000
China	3,700	3,900	210,000
Germany	3,010	3,000	140,000
Israel	1,960	1,900	[7]40,000
Jordan	1,380	1,400	[7]40,000
Russia	6,500	6,500	3,300,000
Spain	420	425	20,000
United Kingdom	427	430	22,000
Other countries	—	—	50,000
World total (rounded)	36,400	34,000	9,500,000

World Resources: Estimated domestic potash resources total about 7 billion tons. Most of these lie at depths between 1,800 and 3,100 meters in a 3,110-square-kilometer area of Montana and North Dakota as an extension of the Williston Basin deposits in Manitoba and Saskatchewan, Canada. The Paradox Basin in Utah contains resources of about 2 billion tons, mostly at depths of more than 1,200 meters. The Holbrook Basin of Arizona contains resources of about 0.7 to 2.5 billion tons. A large potash resource lies about 2,100 meters under central Michigan and contains approximately 40 million tons. Estimated world resources total about 250 billion tons.

Substitutes: There are no substitutes for potassium as an essential plant nutrient and an essential nutritional requirement for animals and humans. Manure and glauconite (greensand) are low-potassium-content sources that can be profitably transported only short distances to the crop fields.

[e]Estimated. — Zero.
[1]Data are rounded to no more than two significant digits to avoid disclosing company proprietary data.
[2]Defined as production + imports – exports.
[3]Defined as sales + imports – exports.
[4]Average prices based on actual sales; excludes soluble and chemical muriates.
[5]Defined as imports – exports.
[6]See Appendix C for resource/reserve definitions and information concerning data sources.
[7]Total reserves in the Dead Sea are arbitrarily divided equally between Israel and Jordan for inclusion in this tabulation.

PUMICE AND PUMICITE

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2012, domestic production of pumice and pumicite was estimated to be 515,000 tons with an estimated processed value of about $12.4 million, f.o.b. plant. Production took place at 11 operations in 7 States. Pumice and pumicite were mined in Oregon, Nevada, Idaho, Arizona, California, New Mexico, and Kansas, in descending order of production. Approximately 54% of all production came from Oregon and Nevada. About 50% of mined pumice was used in the production of construction building block; horticulture consumed 33%; concrete admixture and aggregate, 8%; abrasives, 5%; and the remaining 4% was used for absorbent, filtration, laundry stone washing, and other applications.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production, mine[1]	791	410	390	489	515
Imports for consumption	65	26	34	23	100
Exports[e]	15	11	13	14	11
Consumption, apparent	841	425	411	498	604
Price, average value, dollars per ton, f.o.b. mine or mill	20.13	29.97	20.00	22.89	24.00
Employment, mine and mill, number	220	150	145	140	140
Net import reliance[2] as a percentage of apparent consumption	6	4	5	2	15

Recycling: Not available.

Import Sources (2008–11): Greece, 81%; Iceland, 4%; Mexico, 3%; Montserrat, 2%; and other, 10%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Pumice, crude or in irregular pieces, including crushed	2513.10.0010	Free.
Pumice, other	2513.10.0080	Free.

Depletion Allowance: 5% (Domestic and foreign).

Government Stockpile: None.

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PUMICE AND PUMICITE

Events, Trends, and Issues: The amount of domestically produced pumice and pumicite sold or used in 2012 increased to 515,000 tons, compared with 489,000 tons in 2011. Exports decreased and imports increased compared with those of 2011. Approximately 98% of pumice imports originated from Greece, Iceland, and Mexico in 2012, and primarily supplied markets in the eastern and gulf coast regions of the United States.

Although pumice and pumicite are plentiful in the Western United States, legal challenges and public land designations could limit access to known deposits. Pumice and pumicite production is sensitive to mining and transportation costs. An increase in fuel prices would likely lead to increases in production expenditures; imports and competing materials could become more attractive than domestic products.

All known domestic pumice and pumicite mining in 2012 was accomplished through open pit methods, generally in remote areas where land-use conflicts were not severe. Although the generation and disposal of reject fines in mining and milling resulted in local dust issues at some operations, the environmental impact was restricted to a relatively small geographic area.

World Mine Production and Reserves:

	Mine production		Reserves[3]
	2011	2012[e]	
United States[1]	489	515	Large in the United States. Quantitative estimates of reserves for most countries are not available.
Cameroon	600	600	
Chile	850	850	
Ecuador	800	800	
Greece	1,230	400	
Iran	1,500	1,500	
Italy	3,020	3,000	
Saudi Arabia	950	1,000	
Spain	600	600	
Syria	900	700	
Turkey	4,500	4,500	
Other countries	2,600	2,700	
World total (rounded)	18,000	17,000	

World Resources: The identified U.S. resources of pumice and pumicite are concentrated in the Western States and estimated to be more than 25 million tons. The estimated total resources (identified and undiscovered) in the Western and Great Plains States are at least 250 million tons and may total more than 1 billion tons. Turkey and Italy are the leading producers of pumice and pumicite, followed by Iran, Greece, Saudi Arabia, and Chile. Large resources of pumice and pumicite have been identified on all continents.

Substitutes: The costs of transportation determine the maximum economic distance pumice and pumicite can be shipped and still remain competitive with alternative materials. Competitive resources that may be substituted for pumice and pumicite include crushed aggregates, diatomite, expanded shale and clay, and vermiculite.

[e]Estimated.
[1]Quantity sold and used by producers.
[2]Defined as imports – exports.
[3]See Appendix C for resource/reserve definitions and information concerning data sources.

QUARTZ CRYSTAL (INDUSTRIAL)

(Data in metric tons unless otherwise noted)

Domestic Production and Use: Cultured quartz crystal production capacity exists in the United States, but after years of inactivity, facilities would require considerable refurbishment to be brought online. In the past several years, cultured quartz crystal was increasingly produced overseas, primarily in Asia. Electronic applications accounted for most industrial uses of quartz crystal; other uses included special optical applications. Lascas[1] mining and processing in Arkansas ended in 1997 and, in 2012, no U.S. firms reported the production of cultured quartz crystals.

Virtually all quartz crystal used for electronics was cultured rather than natural crystal. Electronic-grade quartz crystal was essential for making filters, frequency controls, and timers in electronic circuits employed for a wide range of products, such as communications equipment, computers, and many consumer goods, such as electronic games and television receivers.

Salient Statistics—United States: The U.S. Census Bureau, which is the primary Government source of U.S. trade data, does not provide specific import or export statistics on lascas. The U.S. Census Bureau collects import and export statistics on electronic and optical-grade quartz crystal; however, the quartz crystal import and export quantities and values reported in previous years included zirconia that was inadvertently reported to be quartz crystal. The price of as-grown cultured quartz was estimated to be $170 per kilogram in 2012. The price of lumbered quartz, which is as-grown quartz that has been processed by sawing and grinding, was estimated to be $400 per kilogram in 2012; however prices ranged from $20 per kilogram to more than $900 per kilogram, depending on the application. Other salient statistics were not available.

Recycling: None.

Import Sources (2008–11): The United States is 100% import reliant on cultured quartz crystal. Although no definitive data exist listing import sources for cultured quartz crystal, imported material is thought to be mostly from China, Japan, and Russia.

Tariff:

Item	Number	Normal Trade Relations 12–31–12
Sands:		
95% or greater silica	2505.10.10.00	Free.
Less than 95% silica	2505.10.50.00	Free.
Quartz (including lascas)	2506.10.00.50	Free.
Piezoelectric quartz	7104.10.00.00	3% ad val.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: As of September 30, 2012, the Defense Logistics Agency, DLA Strategic Materials contained 7,134 kilograms of natural quartz crystal. The stockpile has 11 weight classes for natural quartz crystal that range from 0.2 kilogram to more than 10 kilograms. The stockpiled crystals, however, are primarily in the larger weight classes. The larger pieces are suitable as seed crystals, which are very thin crystals cut to exact dimensions, to produce cultured quartz crystal. In addition, many of the stockpiled crystals could be of interest to the specimen and gemstone industry. Little, if any, of the stockpiled material is likely to be used in the same applications as cultured quartz crystal. No natural quartz crystal was sold from the DLA Strategic Materials stockpile in 2012, and the Federal Government does not intend to dispose of or sell any of the remaining material. Previously, only individual crystals in the DLA Strategic Materials stockpile inventory that weighed 10 kilograms or more and could be used as seed material were sold.

Stockpile Status—9–30–12[2]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2012	Disposals FY 2012
Quartz crystal	7	([3])	—	—

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QUARTZ CRYSTAL (INDUSTRIAL)

Events, Trends, and Issues: Reports indicate that demand for quartz crystal devices will continue to increase, and consequently, worldwide quartz crystal production is expected to remain strong well into the future. Growth of the consumer electronics market (for products such as personal computers, electronic games, and cellular telephones) will continue to drive global production. The growing global electronics market may require additional quartz crystal production capacity worldwide.

World Mine Production and Reserves:[4] This information is unavailable, but the global reserves for lascas are thought to be large.

World Resources: Limited resources of natural quartz crystal suitable for direct electronic or optical use are available throughout the world. World dependence on these resources will continue to decline because of the increased acceptance of cultured quartz crystal as an alternative material; however, use of cultured quartz crystal will mean an increased dependence on lascas for growing cultured quartz.

Substitutes: Quartz crystal is the best material for frequency-control oscillators and frequency filters in electronic circuits. Other materials, such as aluminum orthophosphate (the very rare mineral berlinite), langasite, lithium niobate, and lithium tantalate, which have larger piezoelectric coupling constants, have been studied and used. The cost competitiveness of these materials, as opposed to cultured quartz crystal, is dependent on the type of application the material is used for and the processing required.

— Zero.
[1]Lascas is a nonelectronic-grade quartz used as a feedstock for growing cultured quartz crystal and for production of fused quartz.
[2]See Appendix B for definitions.
[3]Less than ½ unit.
[4]See Appendix C for resource/reserve definitions and information concerning data sources.

RARE EARTHS[1]

[Data in metric tons of rare-earth oxide (REO) content unless otherwise noted]

Domestic Production and Use: Rare earths were mined by one company in 2012. Bastnäsite, a rare-earth fluocarbonate mineral, was mined as a primary product in California. Rare-earth concentrates produced at Mountain Pass, CA, were further processed into rare-earth compounds and metal products. The United States continued to be a major consumer, exporter, and importer of rare-earth products in 2012. The estimated value of refined rare earths imported by the United States in 2012 was $615 million, a decrease from $802 million imported in 2011. Based on reported data through August 2012, the estimated 2012 distribution of rare earths by end use, in decreasing order, was as follows: catalysts, 62%; metallurgical applications and alloys, 13%; glass polishing and ceramics, 9%; permanent magnets, 7%; phosphors, 3%; and other, 6%.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production, bastnäsite concentrates	—	—	—	—	7,000
Exports:[2]					
Cerium compounds	1,380	840	1,350	1,640	1,100
Rare-earth metals, alloys	1,390	4,930	1,380	3,030	1,700
Other rare-earth compounds	663	455	1,690	3,620	1,900
Ferrocerium, alloys	4,490	2,970	3,460	2,010	860
Thorium ore (monazite or various thorium materials)	—	18	1	—	—
Imports:[2]					
Cerium compounds	2,080	1,500	1,770	1,120	1,200
Ferrocerium, alloys	125	102	131	186	430
Mixed rare-earth chlorides	1,310	411	956	382	540
Mixed REOs	2,400	4,750	5,480	1,830	480
Rare-earth oxides, compounds	8,820	5,080	3,980	3,770	2,700
Rare-earth metals, alloy	679	226	525	468	280
Thorium ore (monazite or various thorium materials)	—	—	26	17	24
Consumption, apparent (excludes thorium ore)[3]	7,410	W	W	W	NA
Price, dollars per kilogram, yearend:					
Bastnäsite concentrate, REO basis	8.82	5.73	6.87	NA	15.00
Monazite concentrate, REO basis	0.48	0.87	0.87	2.70	NA
Mischmetal, metal basis, metric ton quantity[4]	8–9	8–9	45–55	47–50	17–18
Stocks, producer and processor, yearend	W	W	W	W	NA
Employment, mine and mill, number at yearend	100	110	220	230	370
Net import reliance[5] as a percentage of apparent consumption	100	100	100	100	NA

Recycling: Small quantities, mostly permanent magnet scrap.

Import Sources (2008–11): Rare-earth metals, compounds, etc.: China, 86%; France, 4%; Japan, 3%; and other, 7%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Thorium ores and concentrates (monazite)	2612.20.0000	Free.
Rare-earth metals, scandium and yttrium whether or not intermixed or interalloyed	2805.30.0000	5.0% ad val.
Cerium compounds	2846.10.0000	5.5% ad val.
Mixtures of REOs (except cerium oxide)	2846.90.2010	Free.
Mixtures of rare-earth chlorides (except cerium chloride)	2846.90.2050	Free.
Rare-earth compounds, individual REOs (excludes cerium compounds)	2846.90.8000	3.7% ad val.
Ferrocerium and other pyrophoric alloys	3606.90.3000	5.9% ad val.

Depletion Allowance: Monazite, 22% on thorium content and 14% on rare-earth content (Domestic), 14% (Foreign); bastnäsite and xenotime, 14% (Domestic and foreign).

Government Stockpile: None.

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RARE EARTHS

Events, Trends, and Issues: The rare-earth separation plant at Mountain Pass, CA, continued to operate throughout 2012. The company resumed mining operations and neared completion of new processing facilities. Bastnäsite concentrates and other rare-earth intermediates and refined products were produced from newly mined ore at Mountain Pass. Based on 8 months of trade data, domestic consumption of rare-earth imports in 2012 declined to 5,700 tons compared with 7,790 tons in 2011. Sluggish economic conditions and improved material efficiencies resulted in decreased consumption of REO. In the wake of significant price increases in 2011, prices for most rare-earth products declined in 2012. For example, prices for neodymium oxide used to produce magnets began the year at $195 per kilogram, but fell to $80 per kilogram by yearend. The increased use of light emitting diodes, in lieu of other more rare-earth intensive technologies, reduced consumption of europium and yttrium.

Claiming domestic needs and environmental concerns, China continued efforts to restrict the supply of REO. Rare-earth producers were required to submit to environmental inspections and their feed material was to come from licensed rare-earth mines. Rare-earth traders were required to have registered capital of at least ¥50 million ($8 million). Following requests by the European Union, Japan, and the United States, the World Trade Organization set up an investigation into China's restrictive rare-earth trade policies. In India, a 10,000-ton-per-year monazite processing plant to produce REO was expected to be commissioned by yearend. In Malaysia, the commissioning of a rare-earth-oxide processing plant was delayed by appeals from environmental activists, but was expected to start operating by yearend.

Exploration efforts to develop rare-earth projects continued in 2012. Exploration and development assessments in the United States included Bear Lodge, WY, Bokan, AK, Diamond Creek, ID, Elk Creek, NE, La Paz, AZ, Lemhi Pass, ID-MT, Pea Ridge, MO, Round Top, TX, and Thor, NV. Additional assessments were underway in Australia, Brazil, Canada, China, Finland, Greenland, India, Kyrgyzstan, Madagascar, Malawi, Mozambique, South Africa, Sweden, Tanzania, Turkey, and Vietnam.

World Mine Production and Reserves: Brazilian reserves were updated based on data published by the Departamento Nacional de Produção Mineral. Other countries were revised to include the Commonwealth of Independent States.

	Mine production[e]		Reserves[6]
	2011	2012	
United States	—	7,000	13,000,000
Australia	2,200	4,000	1,600,000
Brazil	250	300	36,000
China	105,000	95,000	55,000,000
India	2,800	2,800	3,100,000
Malaysia	280	350	30,000
Other countries	NA	NA	41,000,000
World total (rounded)	111,000	110,000	110,000,000

World Resources: Rare earths are relatively abundant in the Earth's crust, but discovered minable concentrations are less common than for most other ores. U.S. and world resources are contained primarily in bastnäsite and monazite. Bastnäsite deposits in China and the United States constitute the largest percentage of the world's rare-earth economic resources, while monazite deposits constitute the second largest segment. Apatite, cheralite, eudialyte, loparite, phosphorites, rare-earth-bearing (ion adsorption) clays, secondary monazite, spent uranium solutions, and xenotime make up most of the remaining resources. Undiscovered resources are thought to be very large relative to expected demand.

Substitutes: Substitutes are available for many applications but generally are less effective.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.

[1]Data include lanthanides and yttrium but exclude most scandium. See also Scandium and Yttrium.

[2]REO equivalent or contents of various materials were estimated. Data from U.S. Census Bureau.

[3]Defined as production + imports – exports + adjustments for industry stock changes. In 2012, insufficient data were available to determine stocks changes used to calculate apparent consumption.

[4]Price range from Elements—Rare Earths, Specialty Metals and Applied Technology and Web-based High Tech Materials, Longmont, CO, and Hefa Rare Earth Canada Co. Ltd., Richmond, British Columbia, Canada.

[5]Defined as imports – exports + adjustments for industry stock changes. In 2012, insufficient data were available to determine stocks changes used to calculate net import reliance.

[6]See Appendix C for resource/reserve definitions and information concerning data sources.

RHENIUM

(Data in kilograms of rhenium content unless otherwise noted)

Domestic Production and Use: During 2012, ores containing rhenium were mined at seven operations (four in Arizona, and one each in Montana, New Mexico, and Utah). Rhenium compounds are included in molybdenum concentrates derived from porphyry copper deposits, and rhenium is recovered as a byproduct from roasting such molybdenum concentrates. Rhenium-containing products included ammonium perrhenate (APR), metal powder, and perrhenic acid. The major uses of rhenium were in petroleum-reforming catalysts and in superalloys used in high-temperature turbine engine components, representing an estimated 20% and 70%, respectively, of end use. Bimetallic platinum-rhenium catalysts were used in petroleum-reforming for the production of high-octane hydrocarbons, which are used in the production of lead-free gasoline. Rhenium improves the high-temperature (1,000° C) strength properties of some nickel-based superalloys. Rhenium alloys were used in crucibles, electrical contacts, electromagnets, electron tubes and targets, heating elements, ionization gauges, mass spectrographs, metallic coatings, semiconductors, temperature controls, thermocouples, vacuum tubes, and other applications. The estimated value of rhenium consumed in 2012 was about $82 million.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production[1]	7,910	5,580	6,100	8,610	9,400
Imports for consumption	43,700	31,500	33,600	33,500	34,000
Exports	NA	NA	NA	NA	NA
Consumption, apparent	51,600	37,100	39,700	42,100	44,000
Price,[2] average value, dollars per kilogram, gross weight:					
Metal pellets, 99.99% pure	10,400	7,500	4,720	4,670	4,000
Ammonium perrhenate	10,300	7,580	4,630	4,360	4,000
Stocks, yearend, consumer, producer, dealer	NA	NA	NA	NA	NA
Employment, number	Small	Small	Small	Small	Small
Net import reliance[3] as a percentage of apparent consumption	85	85	85	80	78

Recycling: Molybdenum-rhenium and tungsten-rhenium scrap continued to be processed by a growing number of companies, mainly in the United States and Germany. All spent platinum-rhenium catalysts were recycled.

Import Sources (2008–11): Rhenium metal powder: Chile, 89%; Netherlands, 5%; Germany, 3%; and other, 3%. Ammonium perrhenate: Kazakhstan, 29%; United Kingdom, 16%; Poland, 11%; Republic of Korea, 11%; and other, 33%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Salts of peroxometallic acids, other— ammonium perrhenate	2841.90.2000	3.1% ad val.
Rhenium, etc., (metals) waste and scrap	8112.92.0600	Free.
Rhenium, (metals) unwrought; powders	8112.92.5000	3% ad val.
Rhenium, etc., (metals) wrought; etc.	8112.99.9000	4% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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RHENIUM

Events, Trends, and Issues: During 2012, the United States continued to rely on imports for much of its supply of rhenium, and Chile and Kazakhstan supplied most of the imported rhenium. Rhenium imports for consumption increased slightly from that of 2011. Rhenium production in the United States increased by 9% owing to increased production of byproduct molybdenum concentrates in the United States. Six of the seven copper-molybdenum mines increased byproduct molybdenum production levels in 2012. Owing to the scarcity and minor output of rhenium, its production and processing pose no known threat to the environment. In areas where it is recovered, pollution-control equipment for sulfur dioxide removal also prevents most of the rhenium from escaping into the atmosphere.

In 2012, the catalytic-grade APR price remained at $4,250 per kilogram until March, when the price decreased to $3,950 per kilogram. In November, the price decreased further to $3,800 per kilogram. Rhenium metal pellet price started out the year at $4,630 per kilogram until the end of February, when it decreased to $4,190 per kilogram. In early March, the price increased to $4,300 per kilogram until August, when the price decreased to $3,640 per kilogram. In early November, the price decreased again to $3,400 per kilogram.

Consumption of catalyst-grade APR by the petroleum industry was expected to remain at high levels. Demand for rhenium in the aerospace industry, although more unpredictable, was expected to continue to increase. However, the major aerospace companies were expected to continue testing superalloys that contain half the rhenium used in currently designed engine blades, as well as testing rhenium-free alloys for other engine components. New technology continued to be developed to allow recycling of superalloy scrap. Secondary rhenium recycling rates continued to increase worldwide.

World Mine Production and Reserves: Production data for Canada and Peru were revised based on new information from industry sources.

	Mine production[4]		Reserves[5]
	2011	2012[e]	
United States	8,610	9,400	390,000
Armenia	600	600	95,000
Canada	—	—	32,000
Chile[6]	27,000	27,000	1,300,000
Kazakhstan	3,000	3,000	190,000
Korea, Republic of	500	500	NA
Peru	—	—	45,000
Poland	6,000	6,200	NA
Russia	500	500	310,000
Uzbekistan	3,000	3,000	NA
Other countries	1,500	1,500	91,000
World total (rounded)	50,700	52,000	2,500,000

World Resources: Most rhenium occurs with molybdenum in porphyry copper deposits. Identified U.S. resources are estimated to be about 5 million kilograms, and the identified resources of the rest of the world are approximately 6 million kilograms. Rhenium is also associated with copper minerals in sedimentary deposits in Armenia, Kazakhstan, Poland, Russia, and Uzbekistan, where ore is processed for copper recovery, and the rhenium-bearing residues are recovered at the copper smelter.

Substitutes: Substitutes for rhenium in platinum-rhenium catalysts are being evaluated continually. Iridium and tin have achieved commercial success in one such application. Other metals being evaluated for catalytic use include gallium, germanium, indium, selenium, silicon, tungsten, and vanadium. The use of these and other metals in bimetallic catalysts might decrease rhenium's share of the existing catalyst market; however, this would likely be offset by rhenium-bearing catalysts being considered for use in several proposed gas-to-liquid projects. Materials that can substitute for rhenium in various end uses are as follows: cobalt and tungsten for coatings on copper x-ray targets, rhodium and rhodium-iridium for high-temperature thermocouples, tungsten and platinum-ruthenium for coatings on electrical contacts, and tungsten and tantalum for electron emitters.

[e]Estimated. NA Not available. — Zero.
[1]Based on 80% recovery of estimated rhenium contained in MoS_2 concentrates.
[2]Average price per kilogram of rhenium in pellets or catalytic-grade ammonium perrhenate, from Metal Bulletin.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]Estimated amount of rhenium recovered in association with copper and molybdenum production.
[5]See Appendix C for resource/reserve definitions and information concerning data sources.
[6]Estimated rhenium recovered from roaster residues from Belgium, Chile, and Mexico.

RUBIDIUM

(Data in kilograms of rubidium content unless otherwise noted)

Domestic Production and Use: Rubidium is not mined in the United States; however, occurrences are known in Maine and South Dakota, and rubidium is associated with some evaporite mineral occurrences in other States. Rubidium concentrate is imported from Canada for processing in the United States. Applications for rubidium and its compounds include biomedical research, electronics, specialty glass, and pyrotechnics. Biomedical applications include rubidium salts used in the treatment of epilepsy and rubidium-82 used as a blood-flow tracer. Rubidium is used to generate electricity in some photoelectric cells, commonly referred to as solar panels, or as an electrical signal generator in motion sensor devices. Rubidium is used in gas cell oscillators, which are required as an atomic resonance frequency standard in some atomic clocks, playing a vital role in global positioning systems (GPS). Rubidium-rich feldspars are used in ceramic applications for spark plugs and electrical insulators because of their high dielectric capacity.

Salient Statistics—United States: U.S. salient statistics, such as consumption, exports, and imports, are not available. U.S rubidium consumption was small and may amount to only a few thousand kilograms per year. One mine in Canada produced rubidium ore as a byproduct, which was processed as concentrate; however, production data for that mine are not available. Part of that concentrate was exported to the United States for further processing. No market price for rubidium is published because the metal is not traded in commercial quantities. In 2012, one company offered 1-gram ampoules of 99.75%-grade rubidium (metal basis) for $74.60 each, a 3.5% increase from that of 2011. The price for 100 grams of the same material was $1,367.00, also a 3.5% increase from that of 2011.

Recycling: None.

Import Sources (2008–11): The United States is 100% import reliant on byproduct rubidium concentrate imported from Canada.

Tariff:

Item	Number	Normal Trade Relations 12–31–12
Alkali metals, other	2805.19.9000	5.5% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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RUBIDIUM

Events, Trends, and Issues: Rubidium has been commercially available as a byproduct of lithium chemicals production for 40 years. The use of rubidium was primarily in chemical, medical and electronics research. The use of rubidium in atomic clocks continued to increase, with emphasis on new ultra-accuracy atomic clocks. Rubidium-82 was being used to create quantum gates that transfer information within atomic circuit technology for quantum computing. Research into the use of rubidium in superconductors was increasing.

The use of rubidium-82 positron emission tomography (PET) combined with computed tomography angiography (CTA) in the evaluation and care of patients with suspected coronary artery disease continues to increase. Recent improvements in PET/CT scanning machines have led to licensing, which could allow for the replacement of technetium-99 with rubidium-82 as a safer, efficient, and stable component.

Cold atom traps, which will utilize supercooled rubidium atoms to detect gravitational changes with great sensitivity, were under development and were expected to be marketable within 5 years. Applications could include the subsurface detection of oil wells, tracking geologic faults and continental plate movement, climate change research, and higher gravitational sensitivity for satellites and space research vessels.

World Mine Production and Reserves:[1] No minerals exist in which rubidium is the predominant metallic element; however, rubidium may be taken up in trace amounts in the lattices of potassium feldspars and micas during the crystallization of pegmatites. The rubidium-bearing minerals lepidolite and pollucite may be found in zoned pegmatites, which are exceptionally coarse-grained plutonic rocks that formed late in the crystallization of a silicic magma. Lepidolite, the principal source of rubidium, can contain up to 3.5% rubidium oxide, and pollucite contains up to 1.5% rubidium oxide. Mines reported to produce rubidium as a by-product are in Canada, China, and Zimbabwe. Canadian reserves were estimated from data collected by Natural Resources Canada.

	Reserves[1]
Canada	113,000,000
Other countries	NA
World total	NA

World Resources: World resources of rubidium are unknown. In addition to several significant rubidium-bearing zoned pegmatites in Canada, pegmatite occurrences have been identified in Afghanistan, Namibia, Peru, Russia, and Zambia. Minor amounts of rubidium are reported in brines in northern Chile and China and in evaporites in France, Germany, and the United States (New Mexico and Utah).

Substitutes: Rubidium and cesium have similar physical properties and may be used interchangeably in many applications; however, cesium is a preferred material in many applications because it is more electropositive than rubidium.

NA Not available.
[1]See Appendix C for resource/reserve definitions and information concerning data sources.

SALT

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Domestic production of salt decreased by 11% in 2012. The total value was estimated to be more than $1.6 billion. Twenty-eight companies operated 67 plants in 16 States. The estimated percentage of salt sold or used, by type, was salt in brine, 47%; rock salt, 36%; vacuum pan, 9%; and solar salt, 8%.

Salt for highway deicing consumed about 41% of total salt sales. The chemical industry accounted for about 39% with salt in brine representing about 94% of the type of salt used for feedstock. The chlorine and caustic soda manufacturing sector was the main consumer within the chemical industry. The remaining markets for salt, in declining order, were distributors, 8%; food processing, 4%, agricultural, 3%; general industrial and other uses combined with exports, 2% each; and primary water treatment, 1%.

Salient Statistics—United States:[1]	**2008**	**2009**	**2010**	**2011**	**2012**[e]
Production	48,000	46,000	43,300	45,000	40,200
Sold or used by producers[2]	47,400	43,100	43,500	45,500	40,200
Imports for consumption	13,800	14,700	12,900	13,800	10,500
Exports	1,030	1,450	595	846	1,000
Consumption:					
Reported	53,100	45,000	48,600	47,600	49,700
Apparent[2]	60,200	56,400	55,800	58,500	49,700
Price, average value of bulk, pellets and packaged salt, dollars per ton, f.o.b. mine and plant:					
Vacuum and open pan salt	158.59	178.67	180.08	174.00	175.00
Solar salt	64.33	72.09	57.41	51.11	50.00
Rock salt	31.39	36.08	35.67	38.29	36.00
Salt in brine	7.99	7.85	7.49	8.15	8.00
Employment, mine and plant, number[e]	4,100	4,100	4,100	4,100	4,100
Net import reliance[3] as a percentage of apparent consumption	21	24	22	22	19

Recycling: None.

Import Sources (2008–11): Canada, 37%; Chile, 36%; Mexico, 9%; The Bahamas, 5%; and other, 13%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Salt (sodium chloride)	2501.00.0000	Free.

Depletion Allowance: 10% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: The 2011–12 winter was relatively mild nationwide. Many municipalities and local and State transportation departments reported an overabundance of rock salt inventories. As a result, rock salt production and imports in 2012 were substantially less than the previous year. Many contracts between the salt supplier and the consumer require that the customer must take delivery of at least 80 percent of its order, thereby adding additional salt to overfilled storage facilities. Because of the low demand for deicing salt, a few salt companies were forced to temporarily lay off many of their mine workers.

A Japanese company developed a lamp for camping or emergency uses that is powered by saltwater. The light-emitting-diode lantern uses salt dissolved in water as an electrolyte with a set of magnesium and carbon rods that serve as the positive and negative electrodes. The lantern produces enough illumination for 8 hours. The magnesium rod is good for about 120 hours of use but replacement rods can be purchased separately.

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SALT

The National Aeronautics and Space Administration (NASA) launched its Aquarius instrument on a satellite in June 2011. Since then, NASA produced the first global map of the salinity of the Earth's ocean surface to measure salinity variations and their connections between global rainfall, ocean currents, and climate variations. The data showed higher salinity in the subtropics and lower salinity in the equatorial rain belts. The salinity changes are linked to the influence of freshwater around the planet on ocean circulation. Many scientists have been studying global weather changes using a network of 3,000 floating sensors, called Argo. The Argo Ocean Profiling Network collects data from different depths including changes in salinity by measuring the electrical conductance of the seawater. The researchers have reported a 4 percent increase in the overall salinity of the oceans over the last half of the 20th century, and global ocean surface temperatures rising 0.5 degrees Celsius (0.9 degrees Farenheit).

The majority of local and State governments reportedly have ample supplies of rock salt for the winter of 2012–13. However, many weather forecasters indicate that it may be very severe in many parts of the United States, and that could reduce the deicing salt inventories substantially. It is anticipated that the domestic salt industry will be able to provide adequate salt supplies from domestic and foreign sources for emergency use in the event of adverse winter weather.

World Production and Reserves:

	Production		Reserves[4]
	2011	2012[e]	
United States[1]	45,000	40,200	Large. Economic and subeconomic deposits of salt are substantial in principal salt-producing countries. The oceans contain a virtually inexhaustible supply of salt.
Australia	11,700	11,700	
Bahamas, The	10,000	10,000	
Brazil	7,020	7,100	
Canada	12,600	11,000	
Chile	9,970	9,500	
China	72,000	73,000	
France	6,100	6,100	
Germany	18,800	18,500	
India	17,000	17,000	
Mexico	8,810	8,800	
Netherlands	5,000	5,000	
Poland	3,740	3,900	
Spain	4,350	4,400	
Turkey	4,000	3,000	
Ukraine	4,900	5,900	
United Kingdom	5,800	5,800	
Other countries	39,300	39,000	
World total (rounded)	286,000	280,000	

World Resources: World continental resources of salt are practically unlimited, and the salt content in the oceans is virtually inexhaustible. Domestic resources of rock salt and salt from brine are in the Northeast, Central Western, and Gulf Coast States. Saline lakes and solar evaporation salt facilities are near populated regions in the Western United States. Almost every country in the world has salt deposits or solar evaporation operations of various sizes.

Substitutes: There are no economic substitutes or alternates for salt. Calcium chloride and calcium magnesium acetate, hydrochloric acid, and potassium chloride can be substituted for salt in deicing, certain chemical processes, and food flavoring, but at a higher cost.

[e]Estimated.
[1]Excludes Puerto Rico production.
[2]Reported stock data are incomplete. For apparent consumption and net import reliance calculations, changes in annual stock totals are assumed to be the difference between salt produced and salt sold or used.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix C for resource/reserve definitions and information concerning data sources.

SAND AND GRAVEL (CONSTRUCTION)[1]

(Data in million metric tons unless otherwise noted)[2]

Domestic Production and Use: Construction sand and gravel valued at $6.4 billion was produced by an estimated 4,000 companies and government agencies from about 6,500 operations in 50 States. Leading producing States, in order of decreasing tonnage, were California, Texas, Minnesota, Michigan, Utah, Ohio, Colorado, New York, Washington, and Arizona, which together accounted for about 49% of the total output. It is estimated that about 43% of construction sand and gravel was used as concrete aggregates; 26% for road base and coverings and road stabilization; 12% each as asphaltic concrete aggregates and other bituminous mixtures and construction fill; 1% each for concrete products, such as blocks, bricks, and pipes; plaster and gunite sands; and snow and ice control; and the remaining 4% for filtration, golf courses, railroad ballast, roofing granules, and other miscellaneous uses.

The estimated output of construction sand and gravel in the 48 conterminous States, 366 million tons shipped for consumption in the first 6 months of 2012, was nearly 8% higher than the 340 million tons estimated for the same period in 2011. A milder than usual climate in the first quarter of 2012 contributed to a better than average production for the quarter. Additional production information by quarter for each State, geographic region, and the United States is published by the U.S. Geological Survey (USGS) in its quarterly Mineral Industry Surveys for Crushed Stone and Sand and Gravel.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production	1,060	831	795	[e]802	842
Imports for consumption	5	3	3	3	3
Exports	([3])	([3])	([3])	([3])	([3])
Consumption, apparent	1,060	834	798	[e]805	845
Price, average value, dollars per ton	7.44	7.51	7.31	[e]7.50	7.65
Employment, mines, mills, and shops, number	35,200	30,800	29,500	29,800	31,500
Net import reliance[4] as a percentage of apparent consumption	([3])	([3])	([3])	([3])	([3])

Recycling: Recycling of asphalt road surface layers, cement concrete surface layers, and concrete structures was increasing.

Import Sources (2008–11): Canada, 83%; The Bahamas, 8%; Mexico, 7%; and other, 2%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12–31–12**
Sand, silica and quartz, less than 95% silica	2505.10.5000	Free.
Sand, other	2505.90.0000	Free.
Pebbles and gravel	2517.10.0015	Free.

Depletion Allowance: Common varieties, 5% (Domestic and foreign).

Government Stockpile: None.

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SAND AND GRAVEL (CONSTRUCTION)

Events, Trends, and Issues: With U.S. economic activity slowly improving, construction sand and gravel output for 2012 increased about 5% compared with that of 2011. The total number of employees in the U.S. construction sand and gravel industry increased by 6% in 2012 compared with that of 2011. Growth in housing starts in 2012 is increasing demand for construction sand and gravel in many States. Growth was also seen in some nonresidential construction, especially within the sectors of communications, power generation, and nonhighway transportation. One analyst forecast an 8% increase in total construction in 2013 for the United States.[5]

The construction sand and gravel industry remained concerned with environmental, health, permitting, safety, and zoning regulations. Movement of sand and gravel operations away from densely populated centers was expected to continue where regulations and local sentiment discouraged them. Resultant shortages of construction sand and gravel would likely result in higher-than-average price increases in industrialized and urban areas.

World Mine Production and Reserves:

	Mine production		Reserves[6]
	2010	2011[e]	
United States	[e]802	842	Reserves are controlled largely by land use and/or environmental concerns.
Other countries[7]	NA	NA	
World total	NA	NA	

World Resources: Sand and gravel resources of the world are plentiful. However, because of environmental restrictions, geographic distribution, and quality requirements for some uses, sand and gravel extraction is uneconomic in some cases. The most important commercial sources of sand and gravel have been glacial deposits, river channels, and river flood plains. Use of offshore deposits in the United States is mostly restricted to beach erosion control and replenishment. Other countries routinely mine offshore deposits of aggregates for onshore construction projects.

Substitutes: Crushed stone, the other major construction aggregate, is often substituted for natural sand and gravel, especially in more densely populated areas of the Eastern United States. Crushed stone remains the dominant choice for construction aggregate use. Increasingly, recycled asphalt and portland cement concretes are being substituted for virgin aggregate, although the percentage of total aggregate supplied by recycled materials remained very small in 2012.

[e]Estimated. NA Not available.
[1]See also Sand and Gravel (Industrial) and Stone (Crushed).
[2]See Appendix A for conversion to short tons.
[3]Less than ½ unit.
[4]Defined as imports – exports.
[5]Rock Products. FMI releases third quarter construction outlook report. (Accessed November 19, 2012, at http://www.rockproducts.com/index.php/news-late/11814-fmi-releases-third-quarter-construction-outlook-report.html.)
[6]See Appendix C for resource/reserve definitions and information concerning data sources.
[7]No reliable production information for most countries is available owing to the wide variety of ways in which countries report their sand and gravel production. Some countries do not report production for this mineral commodity. Production information for some countries is available in the country chapters of the USGS Minerals Yearbook.

SAND AND GRAVEL (INDUSTRIAL)[1]

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Industrial sand and gravel valued at about $2.2 billion was produced by 87 companies from 159 operations in 33 States. Leading States, in order of tonnage produced, were Texas, Illinois, Wisconsin, Minnesota, Arkansas, Missouri, Michigan, and Oklahoma. Combined production from these States represented 73% of the domestic total. About 57% of the U.S. tonnage was used as hydraulic fracturing sand and well-packing and cementing sand, 17% as glassmaking sand, 11% as foundry sand, 4% as whole-grain fillers and building products, 2% as other whole-grain silica, 2% as ground and unground sand for chemicals, 1% as golf course sand, 1% for abrasive sand for sandblasting, and 5% for other uses.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production	30,400	27,500	32,300	43,700	49,500
Imports for consumption	355	95	132	316	280
Exports	3,100	2,150	3,950	4,330	4,700
Consumption, apparent	27,700	25,500	28,500	39,700	45,100
Price, average value, dollars per ton	30.82	34.25	35.60	45.76	44.78
Employment, quarry and mill, number[e]	1,400	1,400	1,400	1,400	1,400
Net import reliance[2] as a percentage of apparent consumption	E	E	E	E	E

Recycling: There is some recycling of foundry sand, and recycled cullet (pieces of glass) represents a significant proportion of reused silica.

Import Sources (2008–11): Canada, 55%; Mexico, 40%; and other, 5%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
95% or more silica and not more than 0.6% iron oxide	2505.10.1000	Free.

Depletion Allowance: Industrial sand or pebbles, 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: Domestic sales of industrial sand and gravel increased in 2012 compared with those of 2011. Mined output was sufficient to accommodate many uses, which included ceramics, chemicals, fillers (ground and whole-grain), container, filtration, flat and specialty glass, foundry, and recreational uses. Increased demand for hydraulic fracturing sand in support of production of natural gas from shale gas deposits has led to production capacity upgrades and ongoing permitting and opening of numerous new mines. U.S. apparent consumption was about 45.1 million tons in 2012, up 14% from that of the previous year. Imports of industrial sand and gravel in 2012 decreased to about 280,000 tons from 316,000 tons in 2011. Imports of silica are generally of two types—small shipments of very high-purity silica or a few large shipments of lower grade silica shipped only under special circumstances (for example, very low freight rates). Exports of industrial sand and gravel in 2012 increased to 4.7 million tons from 4.33 million tons in 2011.

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SAND AND GRAVEL (INDUSTRIAL)

The United States was the world's leading producer and consumer of industrial sand and gravel based on estimated world production figures. It was difficult to collect definitive data on silica sand and gravel production in most nations because of the wide range of terminology and specifications from country to country. The United States remained a major exporter of silica sand and gravel, shipping it to almost every region of the world. The high level of exports was attributed to the high-quality and advanced processing techniques used in the United States for a large variety of grades of silica sand and gravel, meeting virtually every specification.

The industrial sand and gravel industry continued to be concerned with safety and health regulations and environmental restrictions in 2012. Local shortages of industrial sand and gravel were expected to continue to increase owing to local zoning regulations and land development alternatives, including ongoing development and permitting of operations producing hydraulic fracturing sand. Operations that use hydraulic fracturing sand to produce hydrocarbons may also undergo increased scrutiny. These situations are expected to cause future sand and gravel operations to be located farther from high-population centers.

World Mine Production and Reserves:

	Mine production[e]		Reserves[3]
	2011	**2012**	
United States	43,700	49,500	
Australia	5,600	5,600	Large. Industrial sand and gravel deposits are widespread.
Belgium	1,800	1,800	
Canada	1,430	1,300	
Chile	1,240	1,300	
Czech Republic	1,350	1,400	
Egypt	1,800	1,800	
Finland	2,250	2,250	
France	5,000	5,000	
French Guyana	1,500	1,500	
Germany	7,770	7,500	
India	1,800	1,800	
Iran	1,500	1,500	
Italy	19,800	19,800	
Japan	2,900	3,000	
Latvia	1,360	1,360	
Mexico	2,570	2,600	
Norway	1,200	1,200	
Poland	2,460	2,600	
South Africa	2,900	2,900	
Spain	5,000	5,000	
Turkey	5,000	4,000	
United Kingdom	3,760	3,800	
Other countries	14,000	14,000	
World total (rounded)	138,000	140,000	

World Resources: Sand and gravel resources of the world are large. However, because of their geographic distribution, environmental restrictions, and quality requirements for some uses, extraction of these resources is sometimes uneconomic. Quartz-rich sand and sandstones, the main sources of industrial silica sand, occur throughout the world.

Substitutes: Alternative materials that can be used for glassmaking and for foundry and molding sands are chromite, olivine, staurolite, and zircon sands.

[e]Estimated. E Net exporter.

[1]See also Sand and Gravel (Construction).

[2]Defined as imports – exports + adjustments for Government and industry stock changes.

[3]See Appendix C for resource/reserve definitions and information concerning data sources.

SCANDIUM[1]

(Data in kilograms of scandium oxide content unless otherwise noted)

Domestic Production and Use: Domestically, scandium-bearing minerals have not been mined nor recovered from mine tailings since 1990, although quantities sufficient to meet demand were available in domestic mine tailings and process residues. Principal sources were imports from China, Russia, and Ukraine. Domestic companies with scandium-processing capabilities were in Mead, CO, and Urbana, IL. Capacity to produce ingot and distilled scandium metal was in Ames, IA; Phoenix, AZ; and Urbana, IL. Scandium used in the United States was derived from foreign sources.

Demand for scandium increased slightly in 2012. The principal use for scandium in 2012 was in aluminum alloys for aerospace components and sporting equipment. Other uses for scandium included analytical standards, electronics, high-intensity metal halide lamps, lasers, metallurgical research, and oil-well tracers.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Price, yearend, dollars:					
Per kilogram, oxide, 99.0% purity	900	900	900	900	NA
Per kilogram, oxide, 99.9% purity[2]	1,400	1,400	1,400	3,700	3,700
Per kilogram, oxide, 99.99% purity[2]	1,620	1,620	1,620	4,700	4,700
Per kilogram, oxide, 99.999% purity[2]	2,540	2,540	2,540	5,200	5,200
Per kilogram, oxide, 99.9995% purity[2]	3,260	3,260	3,260	5,900	5,900
Per gram, dendritic, metal[3]	188.00	189.00	193.00	199.00	206.00
Per gram, metal, ingot[4]	152.00	155.00	158.00	163.00	169.00
Per gram, scandium acetate, 99.99% purity[5, 6]	NA	NA	47.00	48.40	50.10
Per gram, scandium chloride, 99.9% purity[5]	57.40	60.40	62.40	138.00	143.00
Per gram, scandium fluoride, 99.9% purity[5]	224.20	224.60	229.00	235.80	244.00
Per gram, scandium iodide, 99.999% purity[5]	201.00	203.00	207.00	213.00	220.00
Per kilogram, scandium-aluminum alloy[2]	74.00	74.00	74.00	220.00	220.00
Net import reliance[7] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2008–11): Although no definitive data exist listing import sources, imported material is thought to be mostly from China.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Mineral substances not elsewhere specified or included, including scandium ores	2530.90.8050	Free.
Rare-earth metals, scandium and yttrium, whether or not intermixed or interalloyed, including scandium	2805.30.0000	5.0% ad val.
Mixtures of rare-earth oxides except cerium oxide, including scandium oxide mixtures	2846.90.2010	Free.
Rare-earth compounds, including individual rare-earth oxides, hydroxides, nitrates, and other individual compounds, including scandium oxide	2846.90.8000	3.7% ad val.
Aluminum alloys, other, including scandium-aluminum	7601.20.9090	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: The supply of domestic and foreign scandium metal remained stable. In New South Wales, Australia, a joint venture continued the development of the the Nyngan deposit; however, at yearend, the project was stalled pending the resolution of a legal dispute between the partners. In northern Queensland, Australia, metallurgical test work was completed in preparation for the development of a scandium-cobalt-nickel deposit. Several projects were underway to improve the technology to recover scandium.

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SCANDIUM

Global scandium consumption was estimated to be less than 10 tons. Scandium-aluminum baseball and softball bats remained popular high-end sports equipment, and sports equipment remained the leading use of scandium; however, scandium producers continued to compete with carbon fiber and carbon nanotube technology for market share. Scandium's use in metal halide lighting continued. Scandium, as the metal or the iodide, was added to halide light bulbs to adjust the color to simulate natural sunlight. New demand is expected to come from future fuel-cell markets and aerospace and specialty metal alloys.

Nominal prices for domestically produced scandium oxide remained unchanged while prices for other scandium compounds increased moderately compared with those of the previous year. Scandium metal prices increased moderately in 2012, and the total market remained very small.

World Mine Production and Reserves:[8] No scandium was mined in the United States in 2012. Scandium was produced as byproduct material in China, Kazakhstan, Russia, and Ukraine. Foreign mine production data were not available. Scandium occurs in many ores in trace amounts, but has not been found in sufficient concentration to be mined as a primary product. As a result of its low concentration, scandium has been produced exclusively as a byproduct during processing of various ores or recovered from previously processed tailings or residues.

World Resources: Resources of scandium are abundant, especially when considered in relation to demand. Scandium is rarely concentrated in nature because of its lack of affinity for the common ore-forming anions. It is widely dispersed in the lithosphere and forms solid solutions in more than 100 minerals. In the Earth's crust, scandium is primarily a trace constituent of ferromagnesium minerals. Concentrations in these minerals (amphibole-hornblende, biotite, and pyroxene) typically range from 5 to 100 parts per million scandium oxide equivalent. Ferromagnesium minerals commonly occur in mafic and ultramafic igneous rocks. Enrichment of scandium also occurs in aluminum phosphate minerals, beryl, cassiterite, columbite, garnet, muscovite, rare-earth minerals, and wolframite. Scandium that was produced domestically was primarily from the scandium-yttrium silicate mineral thortveitite, and from byproduct leach solutions from uranium operations. One of the principal domestic scandium resources is the fluorite tailings from the mined-out Crystal Mountain deposit near Darby, MT. Tailings from the mined-out fluorite operations, which were generated from 1952 to 1971, contain thortveitite and associated scandium-enriched minerals. Resources also are contained in the tantalum residues previously processed at Muskogee, OK. Smaller resources are associated with molybdenum, titanium-tungsten, and tungsten minerals from the Climax molybdenum deposit in Colorado and in crandallite, kolbeckite, and variscite at Fairfield, UT. Other lower grade domestic resources are present in ores of aluminum, cobalt, iron, molybdenum, nickel, phosphate, tantalum, tin, titanium, tungsten, zinc, and zirconium. Process residues from tungsten operations in the United States also contain significant amounts of scandium.

Foreign scandium resources are known in Australia, China, Kazakhstan, Madagascar, Norway, Russia, and Ukraine. Resources in Australia are contained in nickel and cobalt deposits in Lake Innes and Syerston, New South Wales. China's resources are in iron, tin, and tungsten deposits in Fujian, Guangdong, Guangxi, Jiangxi, and Zhejiang Provinces. Resources in Russia are in apatites and eudialytes in the Kola Peninsula and in uranium-bearing deposits in Kazakhstan. Scandium in Madagascar is contained in pegmatites in the Befanomo area. Resources in Norway are dispersed in the thortveitite-rich pegmatites of the Iveland-Evje Region and in a deposit in the northern area of Finnmark. In Ukraine, scandium is recovered as a byproduct of iron ore processing at Zheltye Voda. An occurrence of the mineral thortveitite is reported from Kobe, Japan. Undiscovered scandium resources are thought to be very large.

Substitutes: In applications such as lighting and lasers, scandium is generally not subject to substitution. Titanium and aluminum high-strength alloys, as well as carbon fiber and carbon nanotube material, may substitute in sporting goods, especially baseball and softball bats and bicycle frames. Light-emitting diodes, also known as LEDs, are beginning to displace halides in industrial lighting, residential safety and street lighting, and buoys and maritime lamp applications.

[e]Estimated. NA Not available.
[1]See also Rare Earths.
[2]Scandium oxide (as a white powder) and scandium-aluminum master alloy (with a 2% scandium metal content and sold in metric ton quantities) from Stanford Materials Corp. 2012. The significant price increase in 2011 was based on a price quote received in November 2012.
[3]Scandium pieces, 99.9% purity, distilled dendritic; prices converted from 2-gram prices, from Alfa Aesar, a Johnson Matthey company.
[4]Metal ingot pieces, 99.9% purity, from Alfa Aesar, a Johnson Matthey company.
[5]Acetate, chloride, and fluoride, in crystalline or crystalline aggregate form and scandium iodide as ultradry powder from Alfa Aesar, a Johnson Matthey company; fluoride price converted from 5-gram quantity.
[6]Scandium acetate, 99.9% purity listing beginning in 2010.
[7]Defined as imports – exports + adjustments for industry stock changes.
[8]See Appendix C for resource/reserve definitions and information concerning data sources.

SELENIUM

(Data in metric tons of selenium content unless otherwise noted)

Domestic Production and Use: Primary selenium was recovered from anode slimes generated in the electrolytic refining of copper. One copper refinery in Texas reported production of primary selenium. One copper refiner exported semirefined selenium for toll-refining in Asia, and one other refiner generated selenium-containing slimes, which were exported for processing.

In glass manufacturing, selenium is used to decolorize the green tint caused by iron impurities in container glass and other soda-lime silica glass and is used in architectural plate glass to reduce solar heat transmission. Cadmium sulfoselenide pigments are used in plastics, ceramics, and glass to produce a ruby-red color. Selenium is used in catalysts to enhance selective oxidation; in plating solutions, where it improves appearance and durability; in blasting caps and gun bluing; in rubber compounding chemicals; in the electrolytic production of manganese to increase yields; and in brass alloys to improve machinability.

Selenium is used as a human dietary supplement and in antidandruff shampoos. The leading agricultural uses are as a dietary supplement for livestock and as a fertilizer additive to enrich selenium-poor soils. It is used as a metallurgical additive to improve machinability of copper, lead, and steel alloys. Historically, the primary electronic use was as a photoreceptor on the replacement drums for older plain paper photocopiers; these have been replaced by newer models that do not use selenium in the reproduction process. Selenium is also used in thin-film photovoltaic copper indium gallium diselenide (CIGS) solar cells.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production, refinery	W	W	W	W	W
Imports for consumption, metal and dioxide	519	263	480	601	475
Exports, metal, waste and scrap	562	618	919	1,440	1,000
Consumption, apparent[1]	519	263	480	601	475
Price, dealers, average, dollars per pound, 100-pound lots, refined	32.29	23.07	37.83	66.35	58.00
Stocks, producer, refined, yearend	W	W	W	W	W
Net import reliance[2] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Domestic production of secondary selenium was estimated to be very small because most scrap xerographic and electronic materials were exported for recovery of the contained selenium.

Import Sources (2008–11): Belgium, 25%; Germany, 12%; Japan, 12%; China, 11%; and other, 40%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Selenium metal	2804.90.0000	Free.
Selenium dioxide	2811.29.2000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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SELENIUM

Events, Trends, and Issues: The supply of selenium is directly affected by the supply of the materials from which it is a byproduct—copper, and to a lesser extent, nickel. Estimated domestic selenium production was slightly higher in 2012 compared with that of 2011 owing to a slight increase in copper production.

In 2012, the price of selenium dropped owing to the decrease in consumption in China. During the first half of 2012, Chinese manganese producers were operating at 30% to 40% of capacity because of higher energy costs, export tariffs, and drop in demand for manganese. As a result, they consumed less selenium dioxide. Domestic and global use of selenium in glass increased with an increase in glass production. The use of selenium in fertilizers and supplements in the plant-animal-human food chain and as human vitamin supplements also increased as its health benefits were more widely documented. Although small amounts of selenium are considered beneficial, it can be hazardous in larger quantities. Selenium consumption in solar cells decreased, because in 2012, the solar cell market was oversupplied, which led several solar manufacturers to file for bankruptcy or curtail some of their production.

World Refinery Production and Reserves: Selenium reserves in Chile were revised substantially upward because of an increase in copper reserves based on company reports and new developments.

	Refinery production		Reserves[3]
	2011	2012[e]	
United States	W	W	10,000
Belgium	200	200	—
Canada	35	35	6,000
Chile	90	90	25,000
Finland	60	60	—
Germany	650	650	—
Japan	630	650	—
Peru	59	60	13,000
Philippines	65	70	500
Russia	145	145	20,000
Other countries[4]	46	40	23,000
World total (rounded)	[5]1,980	[5]2,000	98,000

World Resources: Reserves for selenium are based on identified copper deposits. Coal generally contains between 0.5 and 12 parts per million of selenium, or about 80 to 90 times the average for copper deposits. The recovery of selenium from coal, although technically feasible, does not appear likely in the foreseeable future because it is currently not economical.

Substitutes: High-purity silicon has replaced selenium in high-voltage rectifiers. Silicon is also the major substitute for selenium in low- and medium-voltage rectifiers and solar photovoltaic cells. Organic pigments have been developed as substitutes for cadmium sulfoselenide pigments. Other substitutes include cerium oxide as either a colorant or decolorant in glass; tellurium in pigments and rubber; bismuth, lead, and tellurium in free-machining alloys; and bismuth and tellurium in lead-free brasses. Sulfur dioxide can be used as a replacement for selenium dioxide in the production of electrolytic manganese metal.

The selenium-tellurium photoreceptors used in some xerographic copiers and laser printers have been replaced by organic photoreceptors in newer machines. Amorphous silicon and cadmium telluride are the two principal competitors to CIGS in thin-film photovoltaic power cells.

[e]Estimated. E Net exporter. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Imports for consumption were used as a proxy for apparent consumption.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix C for resource/reserve definitions and information concerning data sources.
[4]In addition to the countries listed, Australia, China, India, Iran, Kazakhstan, Mexico, Poland, the United Kingdom, and Uzbekistan are known to produce refined selenium, but output is not reported, and information is inadequate for formulation of reliable production estimates.
[5]Excludes U.S. production.

SILICON

(Data in thousand metric tons of silicon content unless otherwise noted)

Domestic Production and Use: Estimated value of silicon alloys and metal produced in the United States in 2012 was $1.44 billion. Three companies produced silicon materials in seven plants east of the Mississippi River. Ferrosilicon and metallurgical-grade silicon metal were each produced in four plants. One company produced both products at two plants. Most ferrosilicon was consumed in the ferrous foundry and steel industries, predominantly in the eastern United States. The main consumers of silicon metal were producers of aluminum and aluminum alloys and the chemical industry. The semiconductor and solar industries, which manufacture chips for computers and photovoltaic cells from high-purity silicon, respectively, accounted for only a small percentage of silicon demand.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production:					
Ferrosilicon, all grades[1]	180	139	176	W	W
Silicon metal[2]	W	W	W	W	W
Total	W	W	W	326	410
Imports for consumption:					
Ferrosilicon, all grades[1]	190	70	157	156	190
Silicon metal	168	113	171	187	140
Exports:					
Ferrosilicon, all grades[1]	10	9	15	20	13
Silicon metal	35	38	65	79	84
Consumption, apparent:					
Ferrosilicon, all grades[1]	352	207	312	W	W
Silicon metal[2]	W	W	W	W	W
Total	W	W	W	564	640
Price,[3] average, cents per pound Si:					
Ferrosilicon, 50% Si	116	76.9	109	111	100
Ferrosilicon, 75% Si	109	68.9	97.2	102	92
Silicon metal[2]	162	116	140	158	130
Stocks, producer, yearend:					
Ferrosilicon, all grades[1]	21	14	20	W	W
Silicon metal[2]	W	W	W	W	W
Total	W	W	W	23	29
Net import reliance[4] as a percentage of apparent consumption:					
Ferrosilicon, all grades[1]	49	33	44	<50	<60
Silicon metal[2]	<50	<50	<50	<40	<25
Total	W	W	W	42	36

Recycling: Insignificant.

Import Sources (2008–11): Ferrosilicon: Russia, 40%; China, 34%; Venezuela, 11%; Canada, 10%; and other, 5%. Silicon metal: Brazil, 41%; South Africa, 20%; Canada, 12%; Australia, 9%; and other, 18%. Total: Brazil, 23%; Russia, 19%; China, 17%; Canada, 11%; and other, 30%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Silicon, more than 99.99% Si	2804.61.0000	Free.
Silicon, 99.00%–99.99% Si	2804.69.1000	5.3% ad val.
Silicon, other	2804.69.5000	5.5% ad val.
Ferrosilicon, 55%–80% Si:		
More than 3% Ca	7202.21.1000	1.1% ad val.
Other	7202.21.5000	1.5% ad val.
Ferrosilicon, 80%–90% Si	7202.21.7500	1.9% ad val.
Ferrosilicon, more than 90% Si	7202.21.9000	5.8% ad val.
Ferrosilicon, other:		
More than 2% Mg	7202.29.0010	Free.
Other	7202.29.0050	Free.

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SILICON

Depletion Allowance: Quartzite, 14% (Domestic and foreign); gravel, 5% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: Combined domestic ferrosilicon and silicon metal production in 2012, expressed in terms of contained silicon, was expected to increase by 26% from that of 2011. Annual average U.S. ferrosilicon spot market prices in 2012 were expected to decrease by 10% from those of 2011, despite increased domestic crude steel production for the year, because of domestic ferrosilicon oversupply and the effect of declining international prices toward yearend.

Demand for silicon metal comes primarily from the aluminum and chemical industries, with more than 75% of silicon metal typically consumed by the chemical industry. The annual average silicon metal spot market price was expected to decrease by about 20% in 2012 from that in 2011. While domestic secondary aluminum production—the primary materials source for aluminum-silicon alloys—was projected to increase by 10% in 2012 compared with that in 2011, domestic chemical production was projected to increase only slightly (less than 1%) in 2012.

World production of silicon materials increased in 2012 compared with that in 2011, mainly as a result of ferrosilicon and silicon smelter expansions, furnace conversions, and new plant construction. About 200,000 tons of annual production capacity (gross weight) was added to the global silicon industry in China, India, Malaysia, Sweden, and Uzbekistan.

World Production and Reserves:

	Production[e, 5]		Reserves[6]
	2011	2012	
United States	326	410	The reserves in most major producing countries are ample in relation to demand. Quantitative estimates are not available.
Brazil	225	230	
Bhutan[7]	61	62	
Canada	50	50	
China	4,780	5,000	
France	164	170	
Iceland	78	80	
India[7]	68	70	
Norway	297	170	
Russia	647	650	
South Africa	142	140	
Ukraine[7]	98	91	
Venezuela[7]	46	60	
Other countries	383	430	
World total (rounded)	7,370	7,600	

Ferrosilicon accounts for about four-fifths of world silicon production (gross-weight basis). The leading countries for ferrosilicon production, in descending order, were China, Russia, the United States, Brazil, and Ukraine, and for silicon metal production were China, the United States, Norway, Brazil, and France. China was by far the leading producer of both ferrosilicon (5,600,000 tons) and silicon metal (1,400,000 tons) in 2012.

World Resources: World and domestic resources for making silicon metal and alloys are abundant and, in most producing countries, adequate to supply world requirements for many decades. The source of the silicon is silica in various natural forms, such as quartzite.

Substitutes: Aluminum, silicon carbide, and silicomanganese can be substituted for ferrosilicon in some applications. Gallium arsenide and germanium are the principal substitutes for silicon in semiconductor and infrared applications.

[e]Estimated. W Withheld to avoid disclosing company proprietary data.
[1]Ferrosilicon grades include the two standard grades of ferrosilicon—50% and 75% silicon—plus miscellaneous silicon alloys.
[2]Metallurgical-grade silicon metal.
[3]Based on U.S. dealer import price.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]Production quantities are combined totals of estimated silicon content for ferrosilicon and silicon metal, as applicable, except as noted.
[6]See Appendix C for resource/reserve definitions and information concerning data sources.
[7]Ferrosilicon only.

SILVER

(Data in metric tons[1] of silver content unless otherwise noted)

Domestic Production and Use: In 2012, the United States produced approximately 1,050 tons of silver with an estimated value of $1.01 billion. Silver was produced as a byproduct from 35 domestic base- and precious-metal mines. Alaska continued as the country's leading silver-producing State, followed by Nevada. There were 21 U.S. refiners of commercial-grade silver, with an estimated total output of 6,500 tons from domestic and foreign ores and concentrates, and from old and new scrap. Silver's traditional use categories include coins and medals, electrical and electronics, jewelry and silverware, and photography. The physical properties of silver include ductility, electrical conductivity, malleability, and reflectivity. The demand for silver in other applications includes use of silver in bandages for wound care, batteries, brazing and soldering, in catalytic converters in automobiles, in cell phone covers to reduce the spread of bacteria, in clothing to minimize odor, electroplating, hardening bearings, inks, mirrors, solar cells, water purification, and wood treatment to resist mold. Silver was used for miniature antennas in radio frequency identification devices that were used in casino chips, freeway toll transponders, gasoline speed purchase devices, passports, and on packages to keep track of inventory shipments. Mercury and silver, the main components of dental amalgam, are biocides, and their use in amalgam inhibits recurrent decay. In 2012, the estimated uses were electrical and electronics, 35%; coins and medals, 25%; photography, 10%; jewelry and silverware, 8%; and other, 22%.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production:					
Mine	1,250	1,250	1,280	1,120	1,050
Refinery:					
Primary	779	796	819	790	750
Secondary (new and old scrap)	1,210	1,340	1,330	1,710	1,500
Imports for consumption[2]	4,430	3,450	5,370	6,410	5,300
Exports[2]	638	419	709	904	1,200
Consumption, apparent	6,320	6,110	7,540	7,910	5,900
Price, dollars per troy ounce[3]	15.00	14.69	20.20	35.26	30.00
Stocks, yearend:					
Treasury Department[4]	220	220	220	220	220
COMEX	3,970	3,500	3,250	3,650	4,400
Exchange Traded Funds[5]	10,600	14,600	18,400	17,600	19,000
Employment, mine and mill,[6] number	770	740	760	950	1,100
Net import reliance[7] as a percentage of apparent consumption	61	58	65	64	57

Recycling: In 2012, approximately 1,500 tons of silver was recovered from new and old scrap.

Import Sources (2008–11):[2] Mexico, 51%; Canada, 23%; Peru, 6%; Poland, 6%; and other, 14%.

Tariff: No duties are imposed on imports of unrefined silver or refined bullion.

Depletion Allowance: 15% (Domestic), 14% (Foreign).

Government Stockpile: None.

Events, Trends, and Issues: Through October 2012, silver prices averaged $30.34 per troy ounce, 16% lower than the average of the first 10 months of 2011. The overall decline in silver prices corresponded to drop in industrial consumption because of a depressed global economic environment. However, investment demand for silver continued to increase as investors sought safe-haven investments and helped to keep the price of silver above $30 per troy ounce. Holdings in 13 silver exchange traded funds (ETF), including 2 ETF that began in 2011, were about 19,000 tons at the end of October.

Industrial demand for silver in photography continued to decline, and in the United States, demand for silver in photography fell to about 550 tons, compared with a high of about 2,000 tons in 2000. Although silver was still used in x-ray films, many hospitals have begun to use digital imaging systems. Approximately 99% of the silver in photographic wastewater may be recycled. Silver demand for use in photographic applications, jewelry, electronic applications, and coins declined; however, the use of silver in brazing alloys and solders and other industrial applications increased slightly. Silver was used as a replacement metal for platinum in catalytic converters in automobiles, and silver was also used as a catalyst in numerous chemical reactions. Silver also was used in clothing to help regulate body heat and to control odor in shoes and in sports and everyday clothing. The use of trace amounts of silver in bandages for wound care and minor skin infections was also increasing.

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SILVER

World silver mine production increased to a new record of 24,000 tons as a result of increased production from mines in China, Kazakhstan, and Mexico, as well as increased recoveries from mines in Indonesia and Peru. Production also increased in Australia because of the start up of the Wonawinta Mine (lead-zinc) in New South Wales and a major expansion for the Mount Isa (copper-lead-zinc), which was processing ore from the newly opened Lady Loretta Mine (copper) in Queensland. In 2012, the Sindesar Khurd Mine (lead-zinc) in India was estimated to have produced 70 tons more of silver than it produced in 2011. Overall, domestic silver production declined, with the temporary closure of Lucky Friday Mine, ID, in January 2012, the leading domestic primary silver mine in 2011. The mine was ordered closed by the Mine Safety and Health Administration after an accident and rock burst at yearend 2011 that led to a buildup of material in the Silver Shaft, the primary access to Lucky Friday. Production was expected to resume in early 2013. Output also fell at Bingham Canyon Mine, UT (copper-molybdenum), at the Mission Complex, AZ (copper-molybdenum), and at the Midas Mine, NV (gold). Some of the output losses were partially offset by production gains at the Rochester Mine (primary silver) and at the Smoky Valley Common Operations (gold), both in Nevada.

World Mine Production and Reserves: Reserve data for Chile were revised based on new information from Government and industry sources.

	Mine production		Reserves[8]
	2011	2012[e]	
United States	1,120	1,050	25,000
Australia	1,730	1,900	69,000
Bolivia	1,210	1,300	22,000
Canada	572	530	7,000
Chile	1,290	1,130	77,000
China	3,700	3,800	43,000
Mexico	4,150	4,250	37,000
Peru	3,410	3,450	120,000
Poland	1,170	1,170	85,000
Russia	1,350	1,500	NA
Other countries	3,600	3,900	50,000
World total (rounded)	23,300	24,000	540,000

World Resources: Silver was obtained as a byproduct from lead-zinc mines, copper mines, and gold mines, in descending order of production. The polymetallic ore deposits from which silver was recovered account for more than two-thirds of U.S. and world resources of silver. Most recent silver discoveries have been associated with gold occurrences; however, copper and lead-zinc occurrences that contain byproduct silver will continue to account for a significant share of future reserves and resources.

Substitutes: Digital imaging, film with reduced silver content, silverless black-and-white film, and xerography substitute for silver that has traditionally been used in black-and-white as well as color printing applications. Surgical pins and plates may be made with tantalum and titanium in place of silver. Stainless steel may be substituted for silver flatware, and germanium added to silver flatware will make it tarnish resistant. Nonsilver batteries may replace silver batteries in some applications. Aluminum and rhodium may be used to replace silver that was traditionally used in mirrors and other reflecting surfaces. Silver may be used to replace more costly metals in catalytic converters for off-road vehicles.

[e]Estimated. NA Not available.
[1]One metric ton (1,000 kilograms) = 32,150.7 troy ounces.
[2]Ores and concentrates, refined bullion, and doré; excludes coinage, and waste and scrap material.
[3]Handy & Harman quotations.
[4]Balance in U.S. Mint only.
[5]Held in 13 ETFs in which silver was part or whole of the ETF. Represents only the amount of silver held in the ETF.
[6]Source: U.S. Department of Labor, Mine Safety and Health Administration.
[7]Defined as imports – exports + adjustments for Government and industry stock changes.
[8]See Appendix C for resource/reserve definitions and information concerning data sources.

SODA ASH

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: The total value of domestic soda ash (sodium carbonate) produced in 2012 was estimated to be about $1.6 billion.[1] The U.S. soda ash industry comprised four companies in Wyoming operating five plants, one company in California with one plant, and one company with one mothballed plant in Colorado that owns one of the Wyoming plants. The five producers have a combined annual nameplate capacity of 14.5 million tons. Salt, sodium sulfate, and borax were produced as coproducts of sodium carbonate production in California. Sodium bicarbonate, sodium sulfite, and chemical caustic soda were manufactured as coproducts at several of the Wyoming soda ash plants. Sodium bicarbonate was produced at the Colorado operation using soda ash feedstock shipped from the company's Wyoming facility.

Based on final 2011 reported data, the estimated 2012 distribution of soda ash by end use was glass, 48%; chemicals, 29%; soap and detergents, 8%; distributors, 6%; flue gas desulfurization and miscellaneous uses, 3% each; pulp and paper, 2%; and water treatment, 1%.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production[2]	11,300	9,310	10,600	10,700	10,900
Imports for consumption	13	6	20	27	15
Exports	5,370	4,410	5,390	5,470	6,000
Consumption:					
Reported	5,700	5,020	5,270	5,150	5,000
Apparent	5,860	4,950	5,200	5,220	5,000
Price:					
Quoted, yearend, soda ash, dense, bulk:					
F.o.b. Green River, WY, dollars per short ton	260.00	260.00	260.00	260.00	275.00
F.o.b. Searles Valley, CA, same basis	285.00	285.00	285.00	285.00	285.00
Average sales value (natural source), f.o.b. mine or plant, dollars per short ton	122.11	129.88	116.47	133.57	135.00
Stocks, producer, yearend	259	217	220	282	250
Employment, mine and plant, number	2,500	2,400	2,400	2,400	2,500
Net import reliance[3] as a percentage of apparent consumption	E	E	E	E	E

Recycling: There is no recycling of soda ash by producers; however, glass container producers are using cullet glass, thereby reducing soda ash consumption.

Import Sources (2008–11): Canada, 20%; China, 16%; United Kingdom, 14%; Mexico, 11%; and other, 39%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Disodium carbonate	2836.20.0000	1.2% ad val.

Depletion Allowance: Natural, 14% (Domestic and foreign).

Government Stockpile: None.

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SODA ASH

Events, Trends, and Issues: The Bureau of Geology and Mineral Exploration of Henan Province in China announced that it had discovered a large trona deposit in Tongbai County, ranking it the largest trona deposit in Asia and the second largest in the world behind the deposit in the Green River Basin in Wyoming. Preliminary exploration data indicated approximately 72 million tons of identified resources with an additional 100 million tons of trona mixed with mirabilite.

The natural soda ash producer in Turkey announced that it intended to develop the Kazan trona deposit near its existing trona mine at Beypazari. The company stated that it planned to double production capacity at Beypazari to 2.0 million tons per year in early 2013 and have a combined capacity of 4.5 million tons per year online by 2016. The majority owner of both operations was seeking partners for the project.

In July, one of the major Wyoming soda ash producers announced that it would increase its off-list price of soda ash effective August 1, 2012, or as contracts permitted. Other producers followed with similar announcements. The increase was necessary to recover production cost increases and assist in continued investments in the operations.

Economic conditions were improving in many parts of the world. Overall global demand for soda ash was expected to increase by 1.5% to 2% annually for the next several years, with most of the growth expected to be in China, India, Russia, and South America. If the domestic economy and export sales improve, U.S. production may be higher in 2013. If the reports about a new trona discovery in China are confirmed, China may become the lowest-cost soda ash producer in Asia and a strong competitor with the United States in the Far East soda ash markets.

World Production and Reserves:

	Production		Reserves[4, 5]
Natural:	2011	2012[e]	
United States	10,700	10,900	[6]23,000,000
Botswana	250	250	400,000
Kenya	560	600	7,000
Mexico	—	—	200,000
Turkey	1,500	1,600	200,000
Uganda	NA	NA	20,000
Other countries	—	—	260,000
World total, natural (rounded)	13,000	13,000	24,000,000
World total, synthetic (rounded)	38,300	39,000	XX
World total (rounded)	51,300	52,000	XX

World Resources: Soda ash is obtained from trona and sodium carbonate-rich brines. The world's largest deposit of trona is in the Green River Basin of Wyoming. About 47 billion tons of identified soda ash resources could be recovered from the 56 billion tons of bedded trona and the 47 billion tons of interbedded or intermixed trona and halite that are in beds more than 1.2 meters thick. Underground room-and-pillar mining, using conventional and continuous mining, is the primary method of mining Wyoming trona ore. This method has an average 45% mining recovery, whereas average recovery from solution mining is 30%. Improved solution-mining techniques, such as horizontal drilling to establish communication between well pairs, could increase this extraction rate and entice companies to develop some of the deeper trona beds. Wyoming trona resources are being depleted at the rate of about 15 million tons per year (8.3 million tons of soda ash). Searles Lake and Owens Lake in California contain an estimated 815 million tons of soda ash reserves. At least 95 natural sodium carbonate deposits have been identified in the world, only some of which have been quantified. Although soda ash can be manufactured from salt and limestone, both of which are practically inexhaustible, synthetic soda ash is more costly to produce and generates environmentally deleterious wastes.

Substitutes: Caustic soda can be substituted for soda ash in certain uses, particularly in the pulp and paper, water treatment, and certain chemical sectors. Soda ash, soda liquors, or trona can be used as feedstock to manufacture chemical caustic soda, which is an alternative to electrolytic caustic soda.

[e]Estimated. E Net exporter. NA Not available. XX Not applicable. — Zero.
[1]Does not include values for soda liquors and mine waters.
[2]Natural only.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]The reported quantities are sodium carbonate only. About 1.8 tons of trona yields 1 ton of sodium carbonate.
[5]See Appendix C for resource/reserve definitions and information concerning data sources.
[6]From trona, nahcolite, and dawsonite sources.

SODIUM SULFATE

(Data in thousand metric tons unless otherwise noted)

NOTE: Data collection for total sodium sulfate production was terminated by the U.S. Census Bureau in mid-2011. Because alternative sources for sodium sulfate data are no longer available, sodium sulfate coverage by the USGS has been discontinued. This section will not appear in future Mineral Commodity Summaries.

Domestic Production and Use: The domestic natural sodium sulfate industry consisted of two producers operating two plants, one each in California and Texas. Nine companies operating 11 plants in 9 States recovered byproduct sodium sulfate from various manufacturing processes or products, including battery reclamation, cellulose, resorcinol, silica pigments, and sodium dichromate. About one-half of the total output was a byproduct of these plants in 2012. The total value of natural and synthetic sodium sulfate sold was an estimated $42 million. Estimates of U.S. sodium sulfate consumption by end use were soap and detergents, 35%; glass, 18%; pulp and paper, 15%; carpet fresheners and textiles, 4% each; and miscellaneous, 24%.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production, total (natural and synthetic)[1]	319	260	297	NA	NA
Imports for consumption	69	77	77	85	85
Exports	107	140	196	199	210
Consumption, apparent (natural and synthetic)	281	197	178	NA	NA
Price, quoted, sodium sulfate (100% Na_2SO_4), bulk, f.o.b. works, East, dollars per short ton	134	134	134	134	140
Employment, well and plant, number[e]	225	225	225	225	225
Net import reliance[2] as a percentage of apparent consumption	E	E	E	E	E

Recycling: There was some recycling of sodium sulfate by consumers, particularly in the pulp and paper industry, but no recycling by sodium sulfate producers.

Import Sources (2008–11): Canada, 87%; China, 4%; Japan, 3%; Finland, 2%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Disodium sulfate:		
Saltcake (crude)	2833.11.1000	Free.
Other:	2833.11.5000	0.4% ad val.
Anhydrous	2833.11.5010	0.4% ad val.
Other	2833.11.5050	0.4% ad val.

Depletion Allowance: Natural, 14% (Domestic and foreign); synthetic, none.

Government Stockpile: None.

Prepared by **Dennis S. Kostick [Contact Thomas P. Dolley, (703) 648–7710, tdolley@usgs.gov]**

SODIUM SULFATE

Events, Trends, and Issues: China remained the leading exporter and producer of natural and synthetic sodium sulfate in the world. Jiangsu Province is the major area for sodium sulfate production. It was anticipated that this area will produce 4.8 million tons of sodium sulfate annually by 2013. As of 2008, China represented about three-fourths of world production capacity and more than 70% of world production.

The primary use of sodium sulfate worldwide is in powdered detergents. Sodium sulfate is a low-cost, inert, white filler in home laundry detergents. Although powdered home laundry detergents may contain as much as 50% sodium sulfate in their formulation, the market for liquid detergents, which do not contain any sodium sulfate, continued to increase. However, with the major downturn in the world economies beginning in 2008, many consumers have reverted to using more powdered laundry detergents because they are less expensive than their liquid counterparts. Sodium sulfate consumption in the domestic textile industry also has been declining because of imports of less-expensive textile products. In nations with strengthening economies, sodium sulfate consumption increased by yearend 2012.

Sodium sulfate consumption in 2013 is expected to be comparable with that of 2012, with detergents remaining the leading sodium-sulfate-consuming sector. If the winter of 2012–13 is relatively mild, byproduct recovery of sodium sulfate from automobile batteries may decline because fewer battery failures during mild winter weather reduce recycling. World production and consumption of sodium sulfate have been stagnant but are expected to increase between 2% to 3% per year in the next few years, especially in Asia and South America.

World Production and Reserves: Although data on mine production for natural sodium sulfate are not available, total world production of natural sodium sulfate is estimated to be about 8 million tons. Total world production of byproduct sodium sulfate is estimated to be between 2.0 and 4.0 million tons.

	Reserves[3]
United States	860,000
Canada	84,000
China	NA
Mexico	170,000
Spain	180,000
Turkey	100,000
Other countries	1,900,000
World total (rounded)	3,300,000

World Resources: Sodium sulfate resources are sufficient to last hundreds of years at the present rate of world consumption. In addition to the countries with reserves listed above, the following countries also possess identified resources of sodium sulfate: Botswana, Egypt, Italy, Mongolia, Romania, and South Africa. Commercial production from domestic resources is from deposits in California and Texas. The brine in Searles Lake, CA, contains about 450 million tons of sodium sulfate resource, representing about 35% of the lake's brine. In Utah, about 12% of the dissolved salts in the Great Salt Lake is sodium sulfate, representing about 400 million tons of resource. An irregular, 21-meter-thick mirabilite deposit is associated with clay beds 4.5 to 9.1 meters below the lake bottom near Promontory Point, UT. Several playa lakes in west Texas contain underground sodium-sulfate-bearing brines and crystalline material. Other economic and subeconomic deposits of sodium sulfate are near Rhodes Marsh, NV; Grenora, ND; Okanogan County, WA; and Bull Lake, WY. Sodium sulfate also can be obtained as a byproduct from the production of ascorbic acid, boric acid, cellulose, chromium chemicals, lithium carbonate, rayon, resorcinol, silica pigments, and from battery recycling. The quantity and availability of byproduct sodium sulfate are dependent on the production capabilities of the primary industries and the sulfate recovery rates.

Substitutes: In pulp and paper, emulsified sulfur and caustic soda (sodium hydroxide) can replace sodium sulfate. In detergents, a variety of products can substitute for sodium sulfate. In glassmaking, soda ash and calcium sulfate have been substituted for sodium sulfate with less-effective results.

[e]Estimated. E Net exporter. NA Not available.

[1]Source: U.S. Census Bureau. Synthetic production data are revised in accordance with recent updated Census Bureau statistics.

[2]Defined as imports – exports + adjustments for Government and industry stock changes (if available).

[3]See Appendix C for resource/reserve definitions and information concerning data sources.

STONE (CRUSHED)[1]

(Data in million metric tons unless otherwise noted)[2]

Domestic Production and Use: Crushed stone valued at more than $11 billion was produced by 1,550 companies operating 4,000 quarries, 91 underground mines, and 210 sales/distribution yards in 50 States. Leading States, in descending order of production, were Texas, Pennsylvania, Missouri, Ohio, Illinois, Virginia, Indiana, Tennessee, Florida, and North Carolina, which together accounted for one-half of the total crushed stone output. Of the total crushed stone produced in 2012, about 69% was limestone and dolomite; 14%, granite; 7%, traprock; 5%, miscellaneous stone; 4%, sandstone and quartzite; and the remaining 1% was divided, in descending order of tonnage, among marble, volcanic cinder and scoria, slate, shell, and calcareous marl. It is estimated that of the 1.24 billion tons of crushed stone consumed in the United States in 2012, 46% was reported by use, 27% was reported for unspecified uses, and 27% of the total consumed was estimated for nonrespondents to the U.S. Geological Survey (USGS) canvasses. Of the 512 million tons reported by use, 82% was used as construction material, mostly for road construction and maintenance; 10%, for cement manufacturing; 2% each, for lime manufacturing and for agricultural uses; and 4%, for special and miscellaneous uses and products. To provide a more accurate estimate of the consumption patterns for crushed stone, the “unspecified uses—reported and estimated,” as defined in the USGS Minerals Yearbook, are not included in the above percentages.

The estimated output of crushed stone in the 48 conterminous States shipped for consumption in the first 6 months of 2012 was 532 million tons, a increase of 5.8% compared with that of the same period of 2011. Second quarter shipments for consumption increased slightly compared with those of the same period of 2011. Additional production information, by quarter for each State, geographic division, and the United States, is reported in the USGS quarterly Mineral Industry Surveys for Crushed Stone and Construction Sand and Gravel.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production	1,450	1,160	1,160	1,160	1,240
Recycled material	29	29	26	27	28
Imports for consumption	21	12	15	15	14
Exports	1	1	1	1	1
Consumption, apparent	1,500	1,200	1,200	1,200	1,280
Price, average value, dollars per metric ton	9.36	9.73	9.57	9.68	9.78
Employment, quarry and mill, number[e, 3]	81,000	81,000	79,000	79,000	79,000
Net import reliance[4] as a percentage of apparent consumption	1	1	1	1	1

Recycling: Road surfaces made of asphalt and crushed stone and, to a lesser extent, cement concrete surface layers and structures were recycled on a limited but increasing basis in most States. Asphalt road surfaces and concrete were recycled in 49 States and Puerto Rico. The amount of material reported to be recycled increased by 11% in 2012 compared with that of the previous year.

Import Sources (2008–11): Canada, 43%; Mexico, 38%; The Bahamas, 17%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Crushed stone	2517.10.00	Free.

Depletion Allowance: (Domestic) 14% for some special uses; 5%, if used as ballast, concrete aggregate, riprap, road material, and similar purposes.

Government Stockpile: None.

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STONE (CRUSHED)

Events, Trends, and Issues: Crushed stone production was about 1.24 billion tons in 2012, a 7% increase compared with that of 2011. Apparent consumption also increased to about 1.28 billion tons. Demand for crushed stone was slightly higher in 2012 because of the apparent end of the slowdown in activity that some of the principal construction markets have experienced during the last 6 years. Long-term increases in construction aggregates demand will be influenced by activity in the public and private construction sectors, as well as by construction work related to security measures being implemented around the Nation. The underlying factors that would support a rise in prices of crushed stone are expected to be present in 2013, especially in and near metropolitan areas.

The crushed stone industry continued to be concerned with environmental, health, and safety regulations. Shortages of crushed stone in some urban and industrialized areas are expected to continue to increase owing to local zoning regulations and land-development alternatives. These issues are expected to continue and to cause new crushed stone quarries to locate away from large population centers.

World Mine Production and Reserves:

	Mine production		Reserves[5]
	2011	2012[e]	
United States	1,160	1,240	Adequate except where special
Other countries[6]	NA	NA	types are needed or where
World total	NA	NA	local shortages exist.

World Resources: Stone resources of the world are very large. Supply of high-purity limestone and dolomite suitable for specialty uses is limited in many geographic areas. The largest resources of high-purity limestone and dolomite in the United States are in the central and eastern parts of the country.

Substitutes: Crushed stone substitutes for roadbuilding include sand and gravel, and iron and steel slag. Substitutes for crushed stone used as construction aggregates include sand and gravel, iron and steel slag, sintered or expanded clay or shale, and perlite or vermiculite.

[e]Estimated. NA Not available.
[1]See also Stone (Dimension).
[2]See Appendix A for conversion to short tons.
[3]Including office staff.
[4]Defined as imports – exports.
[5]See Appendix C for resource/reserve definitions and information concerning data sources.
[6]Consistent production information is not available for other countries owing to a wide variety of ways in which countries report their crushed stone production. Some countries do not report production for this mineral commodity. Production information for some countries is available in the country chapters of the USGS Minerals Yearbook.

STONE (DIMENSION)[1]

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Approximately 1.7 million tons of dimension stone, valued at $340 million, was sold or used by U.S. producers in 2012. Dimension stone was produced by 141 companies, operating 219 quarries, in 36 States. Leading producer States, in descending order by tonnage, were South Dakota, Texas, Wisconsin, Indiana, and Georgia. These five States accounted for about 52% of the production and contributed about 43% of the value of domestic production. Approximately 38%, by tonnage, of dimension stone sold or used was granite, followed by limestone (27%), miscellaneous stone (16%), sandstone (15%), marble (2%), and slate (2%). By value, the leading sales or uses were for granite (34%), followed by limestone (29%), miscellaneous stone (16%), sandstone (11%), marble (5%), and slate (5%). Rough stone represented 56% of the tonnage and 43% of the value of all the dimension stone sold or used by domestic producers, including exports. The leading uses and distribution of rough stone, by tonnage, were in building and construction (56%), and in irregular-shaped stone (24%). Dressed stone mainly was sold for ashlars and partially squared pieces (31%), curbing (22%), and flagging (20%), by tonnage.

Salient Statistics—United States:[2]	**2008**	**2009**	**2010**	**2011**	**2012**[e]
Sold or used by producers:					
Tonnage	1,800	1,620	1,670	1,710	1,720
Value, million dollars	326	328	323	323	340
Imports for consumption, value, million dollars	2,150	1,350	1,500	1,590	2,070
Exports, value, million dollars	66	48	55	66	170
Consumption, apparent, value, million dollars	2,410	1,630	1,770	1,840	2,240
Price	Variable, depending on type of product				
Employment, quarry and mill, number[3]	3,000	3,000	3,000	3,000	3,000
Net import reliance[4] as a percentage of apparent consumption (based on value)	87	80	88	83	85
Granite only:					
Production	464	469	699	653	650
Exports (rough and finished)	103	75	96	80	80
Price	Variable, depending on type of product				
Employment, quarry and mill, number[3]	1,500	1,500	1,500	1,500	1,500

Recycling: Small amounts of dimension stone were recycled, principally by restorers of old stone work.

Import Sources (2008–11 by value): All dimension stone: China, 31%; Brazil, 27%; Italy, 20%; Turkey, 8%; and other, 14%. Granite only: Brazil, 42%; China, 22%; India, 14%; Italy, 13%; and other, 9%.

Tariff: Dimension stone tariffs ranged from free to 6.5% ad valorem, according to type, degree of preparation, shape, and size, for countries with normal trade relations in 2012. Most crude or rough trimmed stone was imported at 3.0% ad valorem or less.

Depletion Allowance: 14% (Domestic and foreign); slate used or sold as sintered or burned lightweight aggregate, 7.5% (Domestic and foreign); dimension stone used for rubble and other nonbuilding purposes, 5% (Domestic and foreign).

Government Stockpile: None.

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STONE (DIMENSION)

Events, Trends, and Issues: The United States is the world's leading market for dimension stone. Imports of dimension stone increased in value to about $2.1 billion compared with $1.59 billion in 2011. Slow growth in the U.S. economy coupled with marginal increases in new residential construction starts resulted in a slight increase in production and imports of dimension stone. Dimension stone exports increased to about $169 million. The weakening of the U.S. dollar has aided the U.S. export market for dimension stone. Apparent consumption, by value, was $2.2 billion in 2012—a $390 million, or 21%, increase from that of 2011. Dimension stone for construction and refurbishment was used in commercial and residential markets; 2012 refurbishment activity was slightly higher compared with that of 2011.

World Mine Production and Reserves:

	Mine production		Reserves[5]
	2011	2012[e]	
United States	1,710	1,720	Adequate except for certain special types and local shortages.
Other countries	NA	NA	
World total	NA	NA	

World Resources: Dimension stone resources of the world are sufficient. Resources can be limited on a local level or occasionally on a regional level by the lack of a particular kind of stone that is suitable for dimension purposes.

Substitutes: Substitutes for dimension stone include aluminum, brick, ceramic tile, concrete, glass, plastics, resin-agglomerated stone, and steel.

[e]Estimated. NA Not available.
[1]See also Stone (Crushed).
[2]Includes Puerto Rico.
[3]Excluding office staff.
[4]Defined as imports – exports.
[5]See Appendix C for resource/reserve definitions and information concerning data sources.

STRONTIUM

(Data in metric tons of strontium content[1] unless otherwise noted)

Domestic Production and Use: Although deposits of strontium minerals occur widely throughout the United States, strontium minerals have not been mined in the United States since 1959. Domestic production of strontium carbonate, the principal strontium compound, ceased in 2006. A few domestic companies produce small quantities of downstream strontium chemicals. Estimates of primary strontium compound end uses in the United States were pyrotechnics and signals, 30%; ferrite ceramic magnets, 30%; master alloys, 10%; pigments and fillers, 10%; electrolytic production of zinc, 10%; and other applications, including glass, 10%.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production	—	—	—	—	—
Imports for consumption:					
Strontium minerals	2,030	6,420	2,370	7,320	8,400
Strontium compounds	9,420	5,860	8,640	10,000	8,000
Exports, compounds	70	94	72	18	75
Consumption, apparent, celestite and compounds	11,400	12,200	10,900	17,300	16,300
Price, average value of mineral imports at port of exportation, dollars per ton	64	47	45	46	50
Net import reliance[2] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2008–11): Strontium minerals: Mexico, 100%. Strontium compounds: Mexico, 63%; Germany, 19%; China, 15%; and other, 3%. Total imports: Mexico, 78%; Germany, 11%; China, 9%; and other, 2%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–12**
Celestite	2530.90.8010	Free.
Strontium metal	2805.19.1000	3.7% ad val.
Compounds:		
Strontium oxide, hydroxide, peroxide	2816.40.1000	4.2% ad val.
Strontium nitrate	2834.29.2000	4.2% ad val.
Strontium carbonate	2836.92.0000	4.2% ad val.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: None.

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STRONTIUM

Events, Trends, and Issues: Strontium compounds are mostly consumed by the ceramics and glass and pyrotechnics industries, with smaller amounts consumed by a multitude of other industries. Ceramics and glass manufacture remained the top end-use industries through strontium's use in ceramic ferrite magnets and other ceramic and glass applications. The use of strontium nitrate in pyrotechnics was thought to equal the use of strontium carbonate in ferrite magnets.

With expected improvements to global economic conditions, demand for strontium carbonate in more traditional applications is expected to increase. Use of strontium by the ceramics, glass, and pyrotechnic industries is expected to continue, with solid demand for strontium used in ferrite magnets. With improvements in advanced applications, consumption of strontium in new end uses may increase.

In descending order of production, China, Spain, and Mexico are the world's leading producers of celestite. China also is a major importer of celestite. Iranian celestite production was expected to increase owing to increased exports to China.

World Mine Production and Reserves:[3]

	Mine production		Reserves[4]
	2011	2012[e]	
United States	—	—	—
Argentina	8,000	8,000	All other:
China	190,000	190,000	6,800,000
Iran	2,000	2,000	
Mexico	31,500	31,500	
Morocco	2,500	2,500	
Spain	140,000	145,000	
Turkey	1,100	1,100	
World total (rounded)	375,000	380,000	6,800,000

World Resources: World resources of strontium are thought to exceed 1 billion tons.

Substitutes: Barium can be substituted for strontium in ferrite ceramic magnets; however, the resulting barium composite will have reduced maximum operating temperature when compared with that of strontium composites. Substituting for strontium in pyrotechnics is hindered by difficulty in obtaining the desired brilliance and visibility imparted by strontium and its compounds.

[e]Estimated. — Zero.
[1]The strontium content of celestite is 43.88%; this factor was used to convert units of celestite to strontium content.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]Metric tons of strontium minerals.
[4]See Appendix C for resource/reserve definitions and information concerning data sources.

SULFUR

(Data in thousand metric tons of sulfur unless otherwise noted)

Domestic Production and Use: In 2012, elemental sulfur and byproduct sulfuric acid were produced at 109 operations in 26 States and the U.S. Virgin Islands, although the U.S. Virgin Islands plant closed in February. Total shipments were valued at about $1.3 billion. Elemental sulfur production was 8.4 million tons; Louisiana and Texas accounted for about 53% of domestic production. Elemental sulfur was recovered, in descending order of tonnage, at petroleum refineries, natural-gas-processing plants, and coking plants by 39 companies at 103 plants in 25 States and the U.S. Virgin Islands. Byproduct sulfuric acid, representing about 7% of production of sulfur in all forms, was recovered at seven nonferrous smelters in five States by five companies. Domestic elemental sulfur provided 59% of domestic consumption, and byproduct acid accounted for about 5%. The remaining 36% of sulfur consumed was provided by imported sulfur and sulfuric acid. About 90% of sulfur consumed was in the form of sulfuric acid. Agricultural chemicals (primarily fertilizers) composed about 67% of identified sulfur demand; petroleum refining, 23%; and metal mining, 4%. Other uses, accounting for 6% of demand, were widespread because a multitude of industrial products required sulfur in one form or another during some stage of their manufacture.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production:					
Recovered elemental	8,550	8,190	8,290	8,210	8,400
Other forms	753	749	791	720	650
Total (rounded)	9,300	8,940	9,080	8,930	9,050
Shipments, all forms	9,280	8,860	9,140	8,910	8,400
Imports for consumption:					
Recovered, elemental[e]	3,000	1,700	2,950	3,270	2,990
Sulfuric acid, sulfur content	1,690	413	690	871	932
Exports:					
Recovered, elemental	953	1,430	1,450	1,310	1,790
Sulfuric acid, sulfur content	86	83	71	109	57
Consumption, apparent, all forms	12,900	9,460	11,300	11,600	11,200
Price, reported average value, dollars per ton of elemental sulfur, f.o.b., mine and (or) plant	264.04	1.73	70.16	159.83	160.00
Stocks, producer, yearend	208	231	166	175	142
Employment, mine and/or plant, number	2,600	2,600	2,600	2,600	2,600
Net import reliance[1] as a percentage of apparent consumption	28	6	19	23	19

Recycling: Typically, between 2.5 million and 5 million tons of spent sulfuric acid is reclaimed from petroleum refining and chemical processes during any given year.

Import Sources (2008–11): Elemental: Canada, 79%; Mexico, 11%; Venezuela, 6%; and other, 4%. Sulfuric acid: Canada, 55%; India, 18%; Mexico, 9%; and other, 18%. Total sulfur imports: Canada, 73%; Mexico, 10%; Venezuela, 4%; and other, 13%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12–31–12**
Sulfur, crude or unrefined	2503.00.0010	Free.
Sulfur, all kinds, other	2503.00.0090	Free.
Sulfur, sublimed or precipitated	2802.00.0000	Free.
Sulfuric acid	2807.00.0000	Free.

Depletion Allowance: 22% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: Total U.S. sulfur production increased slightly and shipments increased about 3% compared with those of 2011. Domestic production of elemental sulfur from petroleum refineries and recovery from natural gas operations increased slightly. Domestically, refinery sulfur production is expected to continue to increase, sulfur from natural gas processing is expected to decline over time, and byproduct sulfuric acid is expected to remain relatively stable, unless one or more of the remaining nonferrous smelters close.

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SULFUR

World sulfur production decreased slightly but is likely to steadily increase for the foreseeable future. Significantly increased production is expected from sulfur recovery at liquefied natural gas operations in the Middle East and expanded oil sands operations in Canada, unless a downturn in the world economy limits investments in those areas.

The contract sulfur prices in Tampa, FL, began 2012 at around $220 per ton. The price decreased to $170 per ton in May and remained at that level through the end of October, when prices decreased to $160 per ton. Export prices were similar to the domestic prices.

Domestic phosphate rock consumption was lower in 2012 than in 2011, which resulted in decreased demand for sulfur to process the phosphate rock into phosphate fertilizers.

World Production and Reserves:

	Production—All forms		Reserves[2]
	2011	2012[e]	
United States	8,930	9,050	Reserves of sulfur in crude oil, natural gas, and sulfide ores are large. Because most sulfur production is a result of the processing of fossil fuels, supplies should be adequate for the foreseeable future. Because petroleum and sulfide ores can be processed long distances from where they are produced, sulfur production may not be in the country to which the reserves were attributed. For instance, sulfur from Saudi Arabian oil may be recovered at refineries in the United States.
Australia	940	900	
Brazil	480	500	
Canada	6,520	6,600	
Chile	1,720	1,700	
China	9,700	9,700	
Finland	590	590	
France	1,310	1,310	
Germany	3,910	3,700	
India	1,190	1,200	
Iran	1,780	1,800	
Italy	740	740	
Japan	3,300	3,200	
Kazakhstan	2,700	2,700	
Korea, Republic of	1,200	1,200	
Kuwait	830	830	
Mexico	1,660	1,650	
Netherlands	530	530	
Poland	1,140	1,100	
Qatar	1,200	1,200	
Russia	7,280	7,300	
Saudi Arabia	4,600	4,600	
South Africa	370	370	
Spain	637	640	
United Arab Emirates	1,800	1,800	
Uzbekistan	520	520	
Venezuela	800	850	
Other countries	4,080	4,100	
World total (rounded)	70,500	70,000	

World Resources: Resources of elemental sulfur in evaporite and volcanic deposits and sulfur associated with natural gas, petroleum, tar sands, and metal sulfides amount to about 5 billion tons. The sulfur in gypsum and anhydrite is almost limitless, and some 600 billion tons of sulfur is contained in coal, oil shale, and shale rich in organic matter, but low-cost methods have not been developed to recover sulfur from these sources. The domestic sulfur resource is about one-fifth of the world total.

Substitutes: Substitutes for sulfur at present or anticipated price levels are not satisfactory; some acids, in certain applications, may be substituted for sulfuric acid.

[e]Estimated.
[1]Defined as imports – exports + adjustments for Government and industry stock changes.
[2]See Appendix C for resource/reserve definitions and information concerning data sources.

TALC AND PYROPHYLLITE

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Domestic talc production in 2012 was estimated to be 623,000 tons valued at $22 million. Three companies operated six talc-producing mines in three States in 2011. These three companies accounted for more than 99% of the U.S. talc production. Two other companies, one in California and one in Virginia, worked from stocks. Montana was the leading producer State, followed by Texas and Vermont. Sales of talc were estimated to be 571,000 tons valued at $90 million. Talc produced and sold in the United States was used for ceramics, 26%; paint and paper, 20% each; plastics and roofing, 9% each; cosmetics, 4%; rubber, 3%; and other, 9%. About 260,000 tons of talc was imported; more than 75% of the imported talc was used for plastics, cosmetics, and paint applications, in decreasing order by tonnage. The total estimated use of talc in the United States, with imported talc included, was plastics, 26%; ceramics, 17%; paint, 16%; paper, 15%; cosmetics and roofing, 6% each; rubber, 3%; and other, 11%. One company in North Carolina mined pyrophyllite. Production of pyrophyllite decreased slightly from that of 2011. Consumption was, in decreasing order by tonnage, in refractory products, ceramics, and paint.

Salient Statistics—United States:[1]	2008	2009	2010	2011	2012[e]
Production, mine	706	511	604	616	623
Sold by producers	667	512	567	567	571
Imports for consumption	193	134	242	270	260
Exports	244	188	240	233	250
Shipments from Government stockpile excesses	([2])	—	—	—	—
Consumption, apparent	655	457	606	653	633
Price, average, processed, dollars per metric ton	125	111	150	155	157
Employment, mine and mill	350	285	280	290	300
Net import reliance[3] as a percentage of apparent consumption	E	E	1	6	2

Recycling: Insignificant.

Import Sources (2008–11): China, 46%; Canada, 35%; Japan, 4%; and other, 15%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Not crushed, not powdered	2526.10.0000	Free.
Crushed or powdered	2526.20.0000	Free.
Cut or sawed	6815.99.2000	Free.

Depletion Allowance: Block steatite talc: 22% (Domestic), 14% (Foreign). Other: 14% (Domestic and foreign).

Government Stockpile: Although a disposal plan was established for fiscal year 2012, sales of talc from the stockpile have been suspended by the Defense Logistics Agency since September 2010.

Stockpile Status—9–30–12[4]
(Metric tons)

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2012	Disposals FY 2012
Talc, block and lump	865	865	[5]580	—
Talc, ground	621	621	—	—

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TALC AND PYROPHYLLITE

Events, Trends, and Issues: Talc production and sales increased slightly in 2012. U.S. exports increased 7% from those of 2011. Canada, Japan, and France accounted for most of the increase in talc exports and Mexico and Canada accounted for 31% and 28%, respectively, of U.S. talc exports, based on trade data through August. U.S. imports decreased 4% from those of 2011. Canada and China supplied more than 80% of the talc imported into the United States.

The Board of Governors of the Federal Reserve System reported a 4% increase in general manufacturing and the U.S. Census Bureau reported that housing starts increased by 29.1% between August 2011 and August 2012. These trends could lead to increased consumption of talc, if they can be sustained, because talc is used in manufacturing catalytic converter bodies (ceramics), automotive and truck body and underhood components (plastics), paint and coatings (fillers and extenders), and plastics and rubber (fillers and extenders in plastic products, tires, and other rubber components). In construction, talc is used to manufacture such product applications as adhesives, caulks, ceramics, joint compounds, paint, and roofing.

Sales of pyrophyllite declined slightly in 2012. Sales to industries that use pyrophyllite to manufacture ceramics and paints had limited growth in 2012 owing to the slow recovery of that sector of the economy.

World Mine Production and Reserves:

	Mine production		Reserves[6]
	2011	2012[e]	
United States[1]	616	623	140,000
Brazil	656	660	230,000
China	2,200	2,200	Large
Finland	500	500	Large
France	420	420	Large
India	650	660	75,000
Japan	374	375	100,000
Korea, Republic of	706	530	14,000
Other countries	1,570	1,600	Large
World total (rounded)	7,690	7,600	Large

World Resources: The United States is self-sufficient in most grades of talc and related minerals. Domestic and world resources are estimated to be approximately five times the quantity of reserves.

Substitutes: Substitutes for talc include bentonite, chlorite, kaolin, and pyrophyllite in ceramics; chlorite, kaolin, and mica in paint; calcium carbonate and kaolin in paper; bentonite, kaolin, mica, and wollastonite in plastics; and kaolin and mica in rubber.

[e]Estimated. E Net exporter. — Zero.
[1]Excludes pyrophyllite.
[2]Less than ½ unit.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix B for definitions.
[5]Included talc, block and lump, and talc, ground.
[6]See Appendix C for resource/reserve definitions and information concerning data sources.

TANTALUM

(Data in metric tons of tantalum content unless otherwise noted)

Domestic Production and Use: No significant U.S. tantalum mine production has been reported since 1959. Domestic tantalum resources are of low grade, some mineralogically complex, and most are not commercially recoverable. Companies in the United States produced tantalum alloys, compounds, and metal from imported concentrates, and metal and alloys were recovered from foreign and domestic scrap. Tantalum was consumed mostly in the form of alloys, compounds, fabricated forms, ingot, and metal powder. Tantalum capacitors were estimated to account for more than 60% of tantalum use. Major end uses for tantalum capacitors include automotive electronics, pagers, personal computers, and portable telephones. The value of tantalum consumed in 2011 was estimated at about $219 million and was expected to exceed $290 million in 2012 as measured by the value of imports.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production:					
Mine	—	—	—	—	—
Secondary	NA	NA	NA	NA	NA
Imports for consumption[e, 1]	1,290	798	1,600	1,850	1,000
Exports[e, 1]	662	326	438	648	500
Government stockpile releases[e, 2]	—	—	—	—	—
Consumption, apparent	629	473	1,160	1,210	500
Price, tantalite, dollars per pound of Ta_2O_5 content[3]	44	40	54	125	110
Net import reliance[4] as a percentage of apparent consumption	100	100	100	100	100

Recycling: Tantalum was recycled mostly from new scrap that was generated during the manufacture of tantalum-containing electronic components and from tantalum-containing cemented carbide and superalloy scrap.

Import Sources (2008–11): Tantalum contained in niobium (columbium) and tantalum ore and concentrate; tantalum metal; and tantalum waste and scrap—China, 17%; Estonia, 13%; Germany, 11%; Kazakhstan, 9%; and other, 50%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Synthetic tantalum-niobium concentrates	2615.90.3000	Free.
Tantalum ores and concentrates	2615.90.6060	Free.
Tantalum oxide[5]	2825.90.9000	3.7% ad val.
Potassium fluotantalate[5]	2826.90.9000	3.1% ad val.
Tantalum, unwrought:		
Powders	8103.20.0030	2.5% ad val.
Alloys and metal	8103.20.0090	2.5% ad val.
Tantalum, waste and scrap	8103.30.0000	Free.
Tantalum, other	8103.90.0000	4.4% ad val.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: In fiscal year (FY) 2012, which ended on September 30, 2012, the Defense Logistics Agency, DLA Strategic Materials sold no tantalum materials. The DLA Strategic Materials has not yet announced maximum disposal limits for tantalum carbide powder in FY 2013. The DLA Strategic Materials exhausted stocks of tantalum minerals in FY 2007, metal powder in FY 2006, metal oxide in FY 2006, and metal ingots in FY 2005.

Stockpile Status—9–30–12[6]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2012	Disposals FY 2012
Tantalum carbide powder	1.82	[7]—	[7]—	—

Inventory in FY2012 is greater than that of FY2011 owing to revised inventory in September 2012, not material purchase.

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TANTALUM

Events, Trends, and Issues: U.S. tantalum apparent consumption in 2012 was estimated to have been less than one-half that of 2011. Tantalum waste and scrap was the leading imported tantalum material, accounting for about 74% of tantalum imports. By weight, averaged from 2008 through 2011, the leading suppliers of tantalum imports for consumption were: mineral concentrate, Australia, 54%; Mozambique, 22%; and Canada, 19%: metal, China, 31%; Kazakhstan, 27%; and Germany, 14%: and waste and scrap, Estonia, 22%; Russia, 14%; and Mexico, 12%.`

World Mine Production and Reserves: Reserves for Brazil were revised based on a Departamento Nacional de Produção Mineral publication. Reserves for Mozambique were revised based on a company report.

	Mine production[8]		Reserves[9]
	2011	2012[e]	
United States	—	—	—
Australia	—	—	[10]53,000
Brazil	180	180	88,000
Burundi	13	13	NA
Canada	—	—	4,000
Congo (Kinshasa)	95	95	NA
Ethiopia	76	76	4,000
Mozambique	260	260	NA
Nigeria	50	50	NA
Rwanda	93	90	NA
World total (rounded)	767	765	>150,000

World Resources: Identified resources of tantalum, most of which are in Australia and Brazil, are considered adequate to meet projected needs. The United States has about 1,500 tons of tantalum resources in identified deposits, all of which are considered uneconomic at 2012 prices.

Substitutes: The following materials can be substituted for tantalum, but usually with less effectiveness: niobium in carbides; aluminum and ceramics in electronic capacitors; glass, niobium, platinum, titanium, and zirconium in corrosion-resistant equipment; and hafnium, iridium, molybdenum, niobium, rhenium, and tungsten in high-temperature applications.

[e]Estimated. NA Not available. — Zero.
[1]Imports and exports include the estimated tantalum content of niobium and tantalum ores and concentrates, unwrought tantalum alloys and powder, tantalum waste and scrap, and other tantalum articles.
[2]Government stockpile inventory reported by DLA Strategic Materials is the basis for estimating Government stockpile releases.
[3]Price is annual average price reported in Ryan's Notes.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]This category includes other than tantalum-containing material.
[6]See Appendix B for definitions.
[7]Actual quantity limited to remaining sales authority or inventory.
[8]Excludes production of tantalum contained in tin slags.
[9]See Appendix C for resource/reserve definitions and information concerning data sources.
[10]For Australia, Joint Ore Reserves Committee (JORC)-compliant reserves were 19,000 tons.

TELLURIUM

(Data in metric tons of tellurium content unless otherwise noted)

Domestic Production and Use: In the United States, one firm produced commercial-grade tellurium at its refinery complex in Texas, mainly from copper anode slimes but also from lead refinery skimmings, both of domestic origin. Primary and intermediate producers further refined domestic and imported commercial-grade metal and tellurium dioxide, producing tellurium and tellurium compounds in high-purity form for specialty applications.

Tellurium was increasingly used in the production of cadmium-tellurium-based solar cells and was the major end use for tellurium. Other uses were for alloying additive in steel to improve machining characteristics. It was also used as a minor additive in copper alloys to improve machinability without reducing conductivity; in lead alloys to improve resistance to vibration and fatigue; in cast iron to help control the depth of chill; and in malleable iron as a carbide stabilizer. It was used in the chemical industry as a vulcanizing agent and accelerator in the processing of rubber, and as a component of catalysts for synthetic fiber production. Other uses included those in photoreceptor and thermoelectric electronic devices, other thermal cooling devices, as an ingredient in blasting caps, and as a pigment to produce various colors in glass and ceramics.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production, refinery	W	W	W	W	W
Imports for consumption, unwrought, waste and scrap	102	84	42	71	55
Exports	50	9	59	39	70
Consumption, apparent	W	W	W	W	W
Price, dollars per kilogram, 99.95% minimum[1]	211	150	220	349	155
Stocks, producer, refined, yearend	W	W	W	W	W
Net import reliance[2] as a percentage of apparent consumption	W	W	W	W	W

Recycling: For traditional uses, there was little or no old scrap from which to extract secondary tellurium because these uses of tellurium were nearly all dissipative. A very small amount of tellurium was recovered from scrapped selenium-tellurium photoreceptors employed in older plain paper copiers in Europe. A plant in the United States recycled tellurium from cadmium-tellurium-based solar cells; however, most of this was new scrap because cadmium-tellurium-based solar cells were relatively new and had not reached the end of their useful life.

Import Sources (2008–11): China, 42%; Canada, 34%; Philippines, 9%; Belgium, 5%; and other, 10%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Tellurium	2804.50.0020	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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TELLURIUM

Events, Trends, and Issues: In 2012, estimated domestic tellurium production was slightly less than production in 2011. Although detailed information on the world tellurium market was not available, world tellurium consumption was estimated to have decreased in 2012. The price of tellurium significantly decreased in 2012 owing to the decreased use of tellurium in solar cells because in 2012, the solar cell market was oversupplied, which led several solar manufacturers to file for bankruptcy or curtail some of their production.

World Refinery Production and Reserves:

	Refinery production		Reserves[3]
	2011	2012[e]	
United States	W	W	3,500
Canada	6	10	800
Japan	40	35	—
Peru	—	—	3,600
Russia	34	35	NA
Other countries[4]	NA	NA	16,000
World total (rounded)	NA	NA	24,000

World Resources: The figures shown for reserves include only tellurium contained in copper reserves. These estimates assume that more than one-half of the tellurium contained in unrefined copper anodes was actually recovered. With increased concern for supply of tellurium, companies were investigating other potential sources, such as gold telluride and lead-zinc ores with higher concentrations of tellurium, which were not included in estimated world resources.

More than 90% of tellurium was produced from anode slimes collected from electrolytic copper refining, and the remainder was derived from skimmings at lead refineries and from flue dusts and gases generated during the smelting of bismuth, copper, and lead ores. In copper production, tellurium was recovered only from the electrolytic refining of smelted copper. Increased use of the leaching solvent extraction-electrowinning processes for copper extraction, which does not capture tellurium, has limited the future supply of tellurium supply from certain copper deposit types.

Substitutes: Several materials can replace tellurium in most of its uses, but usually with losses in production efficiency or product characteristics. Bismuth, calcium, lead, phosphorus, selenium, and sulfur can be used in place of tellurium in many free-machining steels. Several of the chemical process reactions catalyzed by tellurium can be carried out with other catalysts or by means of noncatalyzed processes. In rubber compounding, sulfur and (or) selenium can act as vulcanization agents in place of tellurium. The selenides of the refractory metals can function as high-temperature, high-vacuum lubricants in place of tellurides. The selenides and sulfides of niobium and tantalum can serve as electrically conducting solid lubricants in place of tellurides of those metals.

The selenium-tellurium photoreceptors used in some xerographic copiers and laser printers have been replaced by organic photoreceptors in newer machines. Amorphous silicon and copper indium diselenide were the two principal competitors to cadmium telluride in photovoltaic power cells.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.

[1]For 2008 and 2009, the price listed was the average price published by Mining Journal for United Kingdom lump and powder, 99.95% tellurium. In 2010 through 2012, the price listed was the average price published by Metal-Pages for 99.95% tellurium.

[2]Defined as imports – exports + adjustments for Government and industry stock changes.

[3]Estimates include tellurium contained in copper resources only. See Appendix C for resource/reserve definitions and information concerning data sources.

[4]In addition to the countries listed, Australia, Belgium, Chile, China, Colombia, Germany, India, Kazakhstan, Mexico, the Philippines, and Poland produce refined tellurium, but output was not reported, and available information was inadequate for formulation of reliable production estimates.

THALLIUM

(Data in kilograms of thallium content unless otherwise noted)

Domestic Production and Use: Thallium is a byproduct metal recovered in some countries from flue dusts and residues collected in the smelting of copper, zinc, and lead ores. Although thallium was contained in ores mined or processed in the United States, it has not been recovered domestically since 1981. Consumption of thallium metal and thallium compounds continued for most of its established end uses. These included the use of radioactive thallium-201 for medical purposes in cardiovascular imaging; thallium as an activator (sodium iodide crystal doped with thallium) in gamma radiation detection equipment (scintillometer); thallium-barium-calcium-copper oxide high-temperature superconductor (HTS) used in filters for wireless communications; thallium in lenses, prisms, and windows for infrared detection and transmission equipment; thallium-arsenic-selenium crystal filters for light diffraction in acousto-optical measuring devices; and thallium as an alloying component with mercury for low-temperature measurements. Other uses included an additive in glass to increase its refractive index and density, a catalyst for organic compound synthesis, and a component in high-density liquids for sink-float separation of minerals.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production, mine	([1])	([1])	([1])	([1])	([1])
Imports for consumption (gross weight):					
Unwrought and powders	916	1,600	2,000	1,300	800
Other	—	160	200	200	200
Total	916	1,760	2,200	1,500	1,000
Exports (gross weight):					
Unwrought and powders	43	260	45	34	50
Waste and scrap	51	75	55	42	50
Other	153	595	835	469	200
Total	247	930	935	545	300
Consumption[e]	670	830	1,270	955	700
Price, metal, dollars per kilogram[2]	4,900	5,700	5,930	6,000	6,800
Net import reliance[3] as a percentage of estimated consumption	100	100	100	100	100

Recycling: None.

Import Sources (2008–11): Germany, 85%; Russia, 13%; and other, 2%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12–31–12**
Unwrought and powders	8112.51.0000	4.0% ad val.
Waste and scrap	8112.52.0000	Free.
Other	8112.59.0000	4.0% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: The price for thallium metal remained high in 2012 as global supply continued to be relatively constrained. Price increases for thallium in recent years were attributed to the limited availability of thallium produced in China. In 2012, China maintained its policy of eliminating toll-trading tax benefits on exports of thallium that began in 2006, thus contributing to reduced supply conditions on the world market. In July 2010, China canceled a 5% value-added-tax rebate on exports of many minor metals, including fabricated thallium products. Higher internal demand for many metals has prompted China to begin importing greater quantities of thallium.

In late 2011, a Brazilian minerals exploration company discovered a substantial thallium deposit in northwest Bahia, Brazil. According to the company, the deposit was unique because it was the only known occurrence in the world that thallium had been found with cobalt and manganese. In 2012, the company was investigating partnerships with other firms to help finance the project and continue exploration activities with the intention of eventually producing thallium.

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THALLIUM

Beginning in 2009, there was a global shortage of the medical isotope technetium-99, which was widely used by physicians for medical imaging tests owing to its availability, cost, and the superior diagnostic quality of images produced. Following the closure of two isotope-producing nuclear reactors in Canada and the Netherlands, medical care facilities had a difficult time acquiring adequate supplies of technetium-99 and were forced to cancel scans or use alternative types of tests. Thallium-201 was the most common alternative to technetium-99 for use in scans, such as the cardiac-stress test that monitors blood perfusion into heart tissue during vigorous exercise. In response to the shortage of technetium-99, some medical imaging equipment producers increased production of thallium-201 in order to meet anticipated demand. In late 2010, the National Research Universal reactor in eastern Ontario, Canada, was restarted and produced medical isotopes, including technetium-99. During the first three quarters of 2012, leading producers of thallium isotopes reported declines in sales compared with those of the same period in 2011, owing to the renewed availability of technetium-99.

Thallium metal and its compounds are highly toxic materials and are strictly controlled to prevent a threat to humans and the environment. Thallium and its compounds can be absorbed into the human body by skin contact, ingestion, or inhalation of dust or fumes. Further information on thallium toxicity can be found in the U.S. Environmental Protection Agency (EPA) Integrated Risk Information System database. Under its national primary drinking water regulations, the EPA has set an enforceable Maximum Contaminant Level for thallium at 2 parts per billion. All public water supplies must abide by these regulations. The EPA continued to conduct studies at its National Risk Management Research Laboratory (NRMRL) to develop and promote technologies that protect and improve human health and the environment, including methods to remove thallium from mine wastewaters.

World Mine Production and Reserves:[4]

	Mine production		Reserves[5]
	2011	2012[e]	
United States	([1])	([1])	32,000
Other countries	10,000	10,000	350,000
World total (rounded)	10,000	10,000	380,000

World Resources: World resources of thallium contained in zinc resources total about 17 million kilograms; most are in Canada, Europe, and the United States. Kazakhstan is believed to be one of the leading global producers of refined thallium. An additional 630 million kilograms is in world coal resources. The average thallium content of the Earth's crust has been estimated to be 0.7 part per million.

Substitutes: The apparent leading potential demand for thallium could be in the area of HTS materials, but demand will be based on which HTS formulation has a combination of favorable electrical and physical qualities and is best suited for fabrication. A firm presently using a thallium HTS material in filters for wireless communications is considering using a nonthallium HTS. While research in HTS continues, and thallium is part of that research effort, it is not guaranteed that HTS products will be a large user of thallium in the future.

Although other materials and formulations can substitute for thallium in gamma radiation detection equipment and optics used for infrared detection and transmission, thallium materials are presently superior and more cost effective for these very specialized uses.

Nonpoisonous substitutes like tungsten compounds are being marketed as substitutes for thallium in high-density liquids for sink-float separation of minerals.

[e]Estimated. — Zero.
[1]No reported mine production; flue dust and residues from base-metal smelters, from which thallium metal and compounds may be recovered, are exported to Canada, France, the United Kingdom, and other countries.
[2]Estimated price of 99.99%-pure granules or rods in 100- to 250-gram or larger lots.
[3]Defined as imports – exports + adjustments for Government and industry stock changes. Consumption and exports of unwrought thallium were from imported material or from a drawdown in unreported inventories.
[4]Estimates are based on thallium content of zinc ores.
[5]See Appendix C for resource/reserve definitions and information concerning data sources.

THORIUM

(Data in metric tons of thorium oxide (ThO_2) equivalent unless otherwise noted)

Domestic Production and Use: The world's primary source of thorium is the rare-earth and thorium phosphate mineral monazite. In the United States, thorium has been a byproduct of refining monazite for its rare-earth content. Monazite itself is recovered as a byproduct of processing heavy-mineral sands for titanium and zirconium minerals. In 2012, monazite was not recovered domestically as a salable product. Essentially all thorium compounds and alloys consumed by the domestic industry were derived from imports, stocks of previously imported materials, or materials previously shipped from U.S. Government stockpiles. About eight companies processed or fabricated various forms of thorium for nonenergy uses, such as catalysts, high-temperature ceramics, and welding electrodes. Thorium's use in most products has generally decreased because of its naturally occurring radioactivity. The estimated value of thorium compounds used by the domestic industry was $400,000, unchanged compared with the revised value for 2011.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production, refinery[1]	—	—	—	—	—
Imports for consumption:					
Thorium ore and concentrates (monazite), gross weight	—	26	—	30	43
Thorium ore and concentrates (monazite), ThO_2 content	—	1.82	—	2.10	3.0
Thorium compounds (oxide, nitrate, etc.), gross weight[2]	0.69	2.25	3.03	5.71	4.6
Thorium compounds (oxide, nitrate, etc.), ThO_2 content[2]	0.47	1.66	2.24	4.22	3.4
Exports:					
Thorium ore and concentrates (monazite), gross weight	61	18	1	—	—
Thorium ore and concentrates (monazite), ThO_2 content	4.27	1.26	0.07	—	—
Thorium compounds (oxide, nitrate, etc.), gross weight[2]	2.00	4.73	1.50	4.28	2.1
Thorium compounds (oxide, nitrate, etc.), ThO_2 content[2]	9.32	3.51	1.11	3.17	1.6
Consumption, apparent[2]	([3])	([3])	1.13	1.05	1.8
Price, thorium compounds, gross weight, dollars per kilogram:[4]					
France	138	193	131	158	153
India	NA	51	58	58	60
Net import reliance[5] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2008–11): Monazite: United Kingdom, 100%. Thorium compounds: India, 76%; and France, 24%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Thorium ores and concentrates (monazite)	2612.20.0000	Free.
Thorium compounds	2844.30.1000	5.5% ad val.

Depletion Allowance: Monazite, 22% on thorium content, and 14% on rare-earth and yttrium content (Domestic); 14% (Foreign).

Government Stockpile: None.

Events, Trends, and Issues: Domestic mine production of thorium-bearing monazite ceased at the end of 1994 as world demand for ores containing naturally occurring radioactive thorium declined. Imports and existing stocks supplied essentially all thorium consumed in the United States in 2012. Domestic demand for thorium alloys, compounds, metals, and ores has exhibited a long-term declining trend.

On the basis of data through September 2012, the average value of imported thorium compounds decreased to $68 per kilogram from the 2011 average of $70 per kilogram (gross weight). The average value of exported thorium compounds increased to $424 per kilogram based on data through September 2012, compared with $178 for 2011. The increase was attributed to variations in the type and purity of compounds exported in each year.

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THORIUM

In 2012, thorium consumption was thought to be primarily in catalysts, microwave tubes, and optical equipment and was thought to have increased. Increased costs to monitor and dispose of thorium have caused domestic processors to switch to thorium-free materials. Real and potential costs related to compliance with State and Federal regulations, proper disposal, and monitoring of thorium's radioactivity have limited its commercial value. It is likely that thorium's use will continue to decline unless a low-cost disposal process is developed or new technology, such as a nonproliferative nuclear fuel, creates renewed demand.

In Australia, mining at the Mount Weld, Western Australia, operation entered its second year. As of September, 14,400 tons of concentrate containing 5,200 tons of rare-earth oxides containing trace amounts of thorium were ready for export pending the startup of processing operations in Malaysia. In South Africa, plans were underway to resume mining and processing of monazite at the Steenkampskraal operation for the production of rare earths. When commissioned, thorium produced during the production of rare earths may be sold or stored onsite in a recoverable form. In 2012, a National Instruments 43–01 report for Steenkampskraal included an indicated resource of about 14,000 tons of rare-earth oxides.

World Refinery Production and Reserves:

	Refinery production		Reserves[6]
	2011	2012	
United States	—	—	440,000
Australia	NA	NA	[7]410,000
Brazil	NA	NA	16,000
Canada	NA	NA	100,000
India	NA	NA	290,000
Malaysia	—	—	4,500
South Africa	—	—	35,000
Other countries	NA	NA	90,000
World total	NA	NA	1,400,000

Reserves are contained primarily in the rare-earth ore mineral monazite and the thorium mineral thorite. Without demand for the rare earths, monazite would probably not be recovered for its thorium content. Other ore minerals with higher thorium contents, such as thorite, would be more likely sources if demand significantly increased. New demand is possible with the development and testing of thorium nuclear fuel in Russia and India. Reserves exist primarily in recent and ancient placer deposits and in thorium vein deposits such as those in the Lemhi Pass area of Idaho. Lesser quantities of thorium-bearing monazite and thorite reserves occur in certain iron ore deposits and carbonatites. Thorium enrichment is known in iron (Fe)-rare-earth-element-thorium-apatite (FRETA) deposits, as found in the deposits at Mineville, NY; Pea Ridge, MO; and Scrub Oaks, NJ.

World Resources: The world's leading thorium resources occur in placer deposits. Resources of more than 500,000 tons are contained in placer, vein, and carbonatite deposits. Disseminated deposits in various other alkaline igneous rocks contain additional resources of more than 2 million tons. Large thorium resources are found in Australia, Brazil, Canada, Greenland (Denmark), India, South Africa, and the United States.

Substitutes: Nonradioactive substitutes have been developed for many applications of thorium. Yttrium compounds have replaced thorium compounds in incandescent lamp mantles. A magnesium alloy containing lanthanides, yttrium, and zirconium can substitute for magnesium-thorium alloys in aerospace applications.

[e]Estimated. NA Not available. — Zero.
[1]All domestically consumed thorium was derived from imported materials.
[2]Thorium compound imports from the United Kingdom were believed to be material for nuclear fuel reprocessing or waste and were not used in calculating domestic apparent consumption. Thorium compound exports to Mexico were believed to be waste material shipped for disposal and were not used in calculating domestic apparent consumption. Apparent consumption calculation excludes ore and concentrates.
[3]Apparent consumption calculations in 2008 and 2009 result in negative numbers.
[4]Based on U.S. Census Bureau customs value.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]See Appendix C for resource/reserve definitions and information concerning data sources.
[7]Includes thorium contained in mineralized sands.

TIN

(Data in metric tons of tin content unless otherwise noted)

Domestic Production and Use: Tin has not been mined or smelted in the United States since 1993 and 1989, respectively. Twenty-five firms used about 90% of the primary tin consumed domestically in 2012. The major uses were as follows: cans and containers, 23%; construction, 18%; transportation, 17%; electrical, 12%; and other, 30%. On the basis of the average New York composite price, the estimated values of some critical items in 2012 were as follows: primary metal consumed, $1.02 billion; imports for consumption, refined tin, $1.38 billion; and secondary production (old scrap), $381 million.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production, secondary:					
Old scrap[e]	11,700	11,100	11,100	11,000	10,500
New scrap	2,640	2,310	2,680	2,530	2,600
Imports for consumption, refined tin	36,300	33,000	35,300	34,200	38,000
Exports, refined tin	9,800	3,170	5,630	5,450	6,000
Shipments from Government stockpile excesses	60	—	—	—	—
Consumption, reported:					
Primary	23,100	24,800	25,300	25,200	28,000
Secondary	6,250	7,750	4,820	1,830	6,000
Consumption, apparent	38,800	42,400	41,400	39,900	42,300
Price, average, cents per pound:					
New York market	865	642	954	1,216	1,270
New York composite	1,129	837	1,240	1,575	1,645
London	837	615	925	1,184	1,230
Kuala Lumpur	838	609	922	1,188	1,236
Stocks, consumer and dealer, yearend	8,560	7,070	6,410	5,780	6,000
Net import reliance[1] as a percentage of apparent consumption	70	74	74	73	75

Recycling: About 13,100 tons of tin from old and new scrap was recycled in 2012. Of this, about 10,500 tons was recovered from old scrap at 2 detinning plants and 74 secondary nonferrous metal-processing plants.

Import Sources (2008–11): Peru, 47%; Bolivia, 17%; Indonesia, 11%; China, 3%; and other, 22%.

Tariff: Most major imports of tin, including unwrought metal, waste and scrap, and unwrought tin alloys, enter the United States duty free.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: The Defense Logistics Agency, DLA Strategic Materials made no tin sales in fiscal year 2012. Tin was last sold in fiscal year 2008. When tin was available it was offered via the basic ordering agreement and the negotiated offering. The tin inventory was stored in the Hammond, IN, depot.

Stockpile Status—9–30–12[2]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2012	Disposals FY 2012
Pig tin	4,020	—	—	—

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TIN

Events, Trends, and Issues: Apparent consumption of tin in the United States increased slightly in 2012 compared with that of 2011. The monthly average composite price of tin remained in a fairly narrow range throughout the year. Price stability in 2012 was attributed to lower production in some key producing countries and moderately higher world tin consumption.

China, the world's leading tin producer, experienced large tin imports and declining exports. Tin production in China declined because of drought conditions, pollution controls by local governments, and declining prices in the first part of the year. By midyear, more than 100 small tin mines and processors were closed in Kafang and Gejiu City, Yunnan Province, in an attempt to reduce pollution in the Hong River in Yunnan and the Mekong River in Vietnam.

World consumption of secondary tin materials experienced marked growth. Industry analysts attributed this pattern to occasional difficulty in obtaining primary tin.

World Mine Production and Reserves: Reserve figures were revised for Brazil based on new information from official Government sources in that country.

	Mine production		Reserves[3]
	2011	2012[e]	
United States	—	—	—
Australia	6,500	6,000	240,000
Bolivia	20,300	20,000	400,000
Brazil	11,000	11,500	710,000
China	120,000	100,000	1,500,000
Congo (Kinshasa)	2,900	5,700	NA
Indonesia	42,000	41,000	800,000
Malaysia	3,350	3,300	250,000
Peru	28,900	29,000	310,000
Russia	160	160	350,000
Rwanda	1,400	3,600	NA
Thailand	200	300	170,000
Vietnam	5,400	5,400	NA
Other countries	2,000	2,000	180,000
World total (rounded)	244,000	230,000	4,900,000

World Resources: U.S. resources of tin, primarily in Alaska, were insignificant compared with those of the rest of the world. World resources, principally in western Africa, southeastern Asia, Australia, Bolivia, Brazil, China, Indonesia, and Russia, are sufficient to sustain recent annual production rates well into the future.

Substitutes: Aluminum, glass, paper, plastic, or tin-free steel substitute for tin in cans and containers. Other materials that substitute for tin are epoxy resins for solder; aluminum alloys, copper-base alloys, and plastics for bronze; plastics for bearing metals that contain tin; and compounds of lead and sodium for some tin chemicals.

[e]Estimated. NA Not available. — Zero.
[1]Defined as imports - exports + adjustments for Government and industry stock changes.
[2]See Appendix B for definitions.
[3]See Appendix C for resource/reserve definitions and information concerning data sources.

TITANIUM AND TITANIUM DIOXIDE[1]

(Data in metric tons unless otherwise noted)

Domestic Production and Use: Titanium sponge metal was produced by three operations in Nevada and Utah. Ingot was produced by 10 operations in 8 States. Numerous firms consumed ingot to produce wrought products and castings. In 2012, an estimated 72% of the titanium metal was used in aerospace applications. The remaining 28% was used in armor, chemical processing, marine, medical, power generation, sporting goods, and other nonaerospace applications. The value of sponge metal consumed was about $388 million, assuming an average selling price of $11.75 per kilogram.

In 2012, titanium dioxide (TiO_2) pigment, which was valued at about $3.9 billion, was produced by four companies at six facilities in five States. The estimated use of TiO_2 pigment by end use was paint (includes lacquers and varnishes), 59%; plastic, 28%; paper, 9%; and other, 4%. Other uses of TiO_2 included catalysts, ceramics, coated fabrics and textiles, floor coverings, printing ink, and roofing granules.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Titanium sponge metal:					
Production	W	W	W	W	W
Imports for consumption	23,900	16,600	20,500	33,800	40,300
Exports	2,370	820	293	256	1,700
Consumption, reported	W	W	34,900	48,400	33,000
Price, dollars per kilogram, yearend	15.64	15.58	10.74	9.93	11.75
Stocks, industry yearend[e]	14,200	15,300	10,500	10,800	14,000
Employment, number[e]	350	300	300	300	300
Net import reliance[2] as a percentage of reported consumption	W	W	72	69	64
Titanium dioxide:					
Production	1,350,000	1,230,000	1,320,000	1,290,000	1,300,000
Imports for consumption	183,000	175,000	204,000	200,000	216,000
Exports	733,000	649,000	758,000	789,000	674,000
Consumption, apparent	800,000	757,000	767,000	706,000	842,000
Producer price index, yearend	170	164	194	268	298
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, number[e]	4,200	3,800	3,400	3,400	3,400
Net import reliance[2] as a percentage of apparent consumption	E	E	E	E	E

Recycling: New scrap metal recycled by the titanium industry totaled about 35,000 tons in 2012. Estimated use of titanium as scrap and ferrotitanium by the steel industry was about 10,000 tons; by the superalloy industry, 1,000 tons; and in other industries, 1,000 tons. Old scrap reclaimed totaled about 1,000 tons.

Import Sources (2008–11): Sponge metal: Japan, 40%; Kazakhstan, 40%; China; 8%; Ukraine, 4%; and other, 8%. Titanium dioxide pigment: Canada, 43%; China, 14%; Germany, 6%; Finland, 6%; and other, 31%.

Tariff:

Item	**Number**	**Normal Trade Relations 12–31–12**
Titanium oxides (unfinished TiO_2 pigments)	2823.00.0000	5.5% ad val.
TiO_2 pigments, 80% or more TiO_2	3206.11.0000	6.0% ad val.
TiO_2 pigments, other	3206.19.0000	6.0% ad val.
Ferrotitanium and ferrosilicon titanium	7202.91.0000	3.7% ad val.
Unwrought titanium metal	8108.20.0000	15.0% ad val.
Titanium waste and scrap metal	8108.30.0000	Free.
Other titanium metal articles	8108.90.3000	5.5% ad val.
Wrought titanium metal	8108.90.6000	15.0% ad val.

Depletion Allowance: Not applicable.

Government Stockpile: None.

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TITANIUM AND TITANIUM DIOXIDE

Events, Trends, and Issues: Owing to rising feedstock prices, depressed economic conditions in Europe and China, and the depletion of existing stocks, global consumption of TiO_2 pigment was expected to be down in 2012. Consumption and production of TiO_2 pigment was led by China, and several TiO_2 pigment producers in China suspended production on reduced market demand. Domestic production of TiO_2 pigment in 2012 was expected to remain the same as that of 2011. Apparent consumption of TiO_2 pigment in the United States was expected to increase by 19% owing to a 15% decrease in exports in 2012 compared with those of 2011.

Consumption of titanium metal in the commercial aerospace industry continued to increase. In the United States, a titanium sponge facility in Rowley, UT, completed the standard-grade qualification process necessary to produce titanium for aerospace, industrial, and medical applications. New titanium-powder production capacity of 1,800 tons per year neared completion in Ottawa, IL. Instead of sponge produced by magnesium reduction via the Kroll process, the plant produced titanium metal powder by sodium reduction by the Armstrong process. Production capacity was expected to be 2,000 tons per year by yearend 2012. A new titanium production facility was inaugurated in Martinsville, VA, to produce mill products for the commercial aerospace industry. Production capacity was expected to be 6,300 tons per year.

Japan and Kazakhstan were the leading U.S. import sources of titanium sponge in 2012. Increased imports of titanium sponge were led by Ukraine and Japan.

World Sponge Metal Production and Sponge and Pigment Capacity:

	Sponge production		Capacity 2012[3]	
	2011	2012[e]	Sponge	Pigment
United States	W	W	24,000	1,470,000
Australia	—	—	—	281,000
Belgium	—	—	—	74,000
Canada	—	—	—	90,000
China[e]	60,000	80,000	114,000	2,000,000
Finland	—	—	—	130,000
France	—	—	—	125,000
Germany	—	—	—	440,000
Italy	—	—	—	80,000
Japan[e]	40,000	40,000	62,200	309,000
Kazakhstan[e]	20,700	20,700	26,000	1,000
Mexico	—	—	—	130,000
Russia[e]	25,800	40,000	46,500	20,000
Spain	—	—	—	80,000
Ukraine[e]	9,000	9,000	10,000	120,000
United Kingdom	—	—	—	300,000
Other countries	—	—	—	900,000
World total (rounded)	[4]156,000	[4]190,000	283,000	6,550,000

World Resources:[5] Resources and reserves of titanium minerals are discussed in Titanium Mineral Concentrates. The commercial feedstock sources for titanium are ilmenite, leucoxene, rutile, slag, and synthetic rutile.

Substitutes: There are few materials that possess titanium metal's strength-to-weight ratio and corrosion resistance. In high-strength applications, titanium competes with aluminum, composites, intermetallics, steel, and superalloys. Aluminum, nickel, specialty steels, and zirconium alloys may be substituted for titanium for applications that require corrosion resistance. Ground calcium carbonate, precipitated calcium carbonate, kaolin, and talc compete with titanium dioxide as a white pigment.

[e]Estimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]See also Titanium Mineral Concentrates.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]Yearend operating capacity.
[4]Excludes U.S. production.
[5]See Appendix C for resource/reserve definitions and information concerning data sources.

TITANIUM MINERAL CONCENTRATES[1]

(Data in thousand metric tons of contained TiO_2 unless otherwise noted)

Domestic Production and Use: Two firms produced ilmenite and rutile concentrates from surface-mining operations in Florida and Virginia. The value of titanium mineral concentrates consumed in the United States in 2012 was about $735 million. Zircon was a coproduct of mining from ilmenite and rutile deposits. About 95% of titanium mineral concentrates was consumed by domestic titanium dioxide (TiO_2) pigment producers. The remaining 5% was used in welding rod coatings and for manufacturing carbides, chemicals, and metal.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production[2] (rounded)	200	200	200	300	300
Imports for consumption	1,110	927	958	1,030	1,110
Exports,[e] all forms	7	9	12	16	18
Consumption, estimated	1,440	1,360	1,460	1,310	1,410
Price, dollars per metric ton, yearend:					
Ilmenite, bulk, minimum 54% TiO_2, f.o.b. Australia	111	73	75	195	300
Rutile, bulk, minimum 95% TiO_2, f.o.b. Australia	525	533	540	1,400	2,250
Slag, 80%–95% TiO_2[3]	393–407	401–439	367–433	468–494	747–2,095
Stocks, mine, consumer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill, number[e]	144	194	178	195	186
Net import reliance[4] as a percentage of estimated consumption	78	68	65	77	77

Recycling: None.

Import Sources (2008–11): South Africa, 39%; Australia, 35%; Canada, 16%; Mozambique, 7%; and other, 3%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Synthetic rutile	2614.00.3000	Free.
Ilmenite and ilmenite sand	2614.00.6020	Free.
Rutile concentrate	2614.00.6040	Free.
Titanium slag	2620.99.5000	Free.

Depletion Allowance: Ilmenite and rutile; 22% (Domestic), 14% (Foreign).

Government Stockpile: None.

Events, Trends, and Issues: Consumption of titanium mineral concentrates is tied to production of TiO_2 pigments primarily used in paint, paper, and plastics. Owing to increased production of TiO_2 pigment, domestic consumption of titanium mineral concentrates was estimated to have increased by 8% in 2012 compared with that in 2011.

Although world mine production increased in 2012, the price of titanium mineral concentrates continued to rise significantly. Rising costs for titanium minerals has encouraged vertical integration between the mineral and pigment industries.

In Kazakhstan, plans were underway to construct an ore-processing plant with a production capacity of 12,000 tons per year of rutile and 50,000 tons per year of ilmenite by 2014. In April, the first consignment of ilmenite from the Birzulovo deposit in the Kirovograd region of Ukraine was delivered to European and Asian markets. The initial production capacity at Birzulovo was 185,000 tons per year of ilmenite. In Sierra Leone, a tailings treatment project was under development to recover rutile from 22 million tons of tailings near the mineral separation plant in Mogwembo commencing in 2013. A feasibility study and continued preparations were underway to upgrade the ilmenite processing plant in Tyssedal, Norway. The upgrade would double the current capacity of 200,000 tons per year of titanium slag and process ilmenite from the Grand Côte mineral sands project in Senegal. The Grand Côte project was projected to produce 575,000 tons per year of ilmenite with mining operations anticipated to begin in 2013. In Madagascar, heavy-mineral resources at the Ranobe Mine were increased by 36% to 959 million tons at 6.1% heavy minerals with reserves of 161 million tons at 8.2% heavy minerals. Production of ilmenite was expected to begin in the second half of 2014. A study of the Koivu titanium project in Finland was completed for ilmenite production of 250,000 tons per year.

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TITANIUM MINERAL CONCENTRATES

World Mine Production and Reserves:

	Mine production 2011	Mine production 2012[e]	Reserves[5]
Ilmenite:			
United States[2]	[6]300	[6]300	2,000
Australia	960	940	100,000
Brazil	45	45	43,000
Canada[7]	750	700	31,000
China	660	700	200,000
India	330	550	85,000
Madagascar	280	280	40,000
Mozambique	380	380	16,000
Norway[7]	360	350	37,000
South Africa[7]	1,110	1,030	63,000
Sri Lanka	31	60	NA
Ukraine	300	300	5,900
Vietnam	550	500	1,600
Other countries	40	40	26,000
World total (ilmenite, rounded)	6,100	6,200	650,000
Rutile:			
United States	([8])	([8])	([8])
Australia	440	480	18,000
Brazil	3	5	1,200
India	24	25	7,400
Mozambique	6	8	480
Sierra Leone	64	100	3,800
South Africa	122	131	8,300
Ukraine	56	60	2,500
Other countries	18	17	400
World total (rutile, rounded)	[8]730	[8]830	42,000
World total (ilmenite and rutile, rounded)	6,700	7,000	700,000

World Resources: Ilmenite accounts for about 92% of the world's consumption of titanium minerals. World resources of anatase, ilmenite, and rutile total more than 2 billion tons.

Substitutes: Ilmenite, leucoxene, rutile, slag, and synthetic rutile compete as feedstock sources for producing TiO_2 pigment, titanium metal, and welding-rod coatings.

[e]Estimated. NA Not available.
[1]See also Titanium and Titanium Dioxide.
[2]Rounded to one significant digit to avoid disclosing company proprietary data.
[3]Landed duty-paid value based on U.S. imports for consumption.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]See Appendix C for resource/reserve definitions and information concerning data sources.
[6]Includes rutile.
[7]Mine production is primarily used to produce titaniferous slag.
[8]U.S. rutile production and reserve data are included with ilmenite.

TUNGSTEN

(Data in metric tons of tungsten content unless otherwise noted)

Domestic Production and Use: A tungsten mine in California produced concentrates in 2012. Approximately eight companies in the United States processed tungsten concentrates, ammonium paratungstate, tungsten oxide, and (or) scrap to make tungsten powder, tungsten carbide powder, and (or) tungsten chemicals. More than one-half of the tungsten consumed in the United States was used in cemented carbide parts for cutting and wear-resistant materials, primarily in the construction, metalworking, mining, and oil- and gas-drilling industries. The remaining tungsten was consumed to make tungsten heavy alloys for applications requiring high density; electrodes, filaments, wires, and other components for electrical, electronic, heating, lighting, and welding applications; steels, superalloys, and wear-resistant alloys; and chemicals for various applications. The estimated value of apparent consumption in 2012 was approximately $1 billion.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production:					
Mine	NA	NA	NA	NA	NA
Secondary	5,510	3,690	5,680	11,000	9,500
Imports for consumption:					
Concentrate	3,990	3,590	2,740	3,640	3,600
Other forms	9,060	6,410	9,690	9,600	8,400
Exports:					
Concentrate	496	38	276	169	130
Other forms	5,480	2,730	4,350	6,960	6,800
Government stockpile shipments:					
Concentrate	1,470	688	2,060	1,180	1,700
Other forms	51	12	([1])	46	4
Consumption:					
Reported, concentrate	W	W	4,820	W	W
Apparent,[2, 3] all forms	13,800	11,600	15,500	18,100	16,400
Price, concentrate, dollars per mtu WO_3,[4] average:					
U.S. spot market, Platts Metals Week	184	151	183	248	360
European market, Metal Bulletin	164	150	150	150	150
Stocks, industry, yearend:					
Concentrate	W	W	W	W	W
Other forms	2,240	2,210	2,530	W	W
Net import reliance[5] as a percentage of apparent consumption	60	68	63	40	42

Recycling: In 2012, the tungsten contained in scrap consumed by processors and end users represented approximately 52% of apparent consumption of tungsten in all forms.

Import Sources (2008–11): Tungsten contained in ores and concentrates, intermediate and primary products, wrought and unwrought tungsten, and waste and scrap: China, 45%; Bolivia, 8%; Canada, 6%; Germany, 6%; and other, 35%.

Tariff: **Item**	**Number**	**Normal Trade Relations[6] 12–31–12**
Ores	2611.00.3000	Free.
Concentrates	2611.00.6000	37.5¢/kg tungsten content.
Tungsten oxides	2825.90.3000	5.5% ad val.
Ammonium tungstates	2841.80.0010	5.5% ad val.
Tungsten carbides	2849.90.3000	5.5% ad val.
Ferrotungsten	7202.80.0000	5.6% ad val.
Tungsten powders	8101.10.0000	7.0% ad val.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

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TUNGSTEN

Government Stockpile:

Stockpile Status—9–30–12[7]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2012	Disposals FY 2012
Metal powder	121	121	136	39
Ores and concentrates	14,200	14,200	3,630	1,610

Events, Trends, and Issues: World tungsten supply was dominated by Chinese production and exports. China was also the world's leading tungsten consumer. China's Government has regulated its tungsten industry by limiting the number of exploration, mining, and export licenses; limiting or forbidding foreign investment; imposing constraints on mining and processing; establishing quotas on production and exports; adjusting export quotas to favor value-added downstream materials and products; and imposing export taxes on tungsten materials. To conserve its resources and meet increasing domestic demand, the Chinese Government planned the following: to expand exploration and increase ore reserves in approved mines, to continue to use quotas to control tungsten mine production, to improve its tungsten-processing technology and increase tungsten recovery from tailings and low-grade and mixed scheelite-wolframite ores, to limit the export of upstream tungsten materials, and to increase the development and sales of value-added downstream tungsten products.

In the next few years, mine production from outside China is expected to increase. Numerous companies worked towards developing tungsten deposits or restarting tungsten production from inactive mines in Asia, Australia, Europe, and North America.

Scrap was an important source of raw material for the tungsten industry. In 2011 and 2012, U.S. net import reliance for tungsten was lower than that of prior years owing to an increase in scrap consumption (secondary production).

World Mine Production and Reserves: Reserves for "Other countries" were revised upward based on company and Government data.

	Mine production		Reserves[8]
	2011	2012[e]	
United States	NA	NA	140,000
Austria	1,100	1,100	10,000
Bolivia	1,100	1,100	53,000
Canada	1,970	2,000	120,000
China	61,800	62,000	1,900,000
Portugal	820	820	4,200
Russia	3,500	3,500	250,000
Other countries	2,700	3,000	760,000
World total (rounded)	[3]73,100	[3]73,000	3,200,000

World Resources: World tungsten resources are geographically widespread. China ranks first in the world in terms of tungsten resources and reserves and has some of the largest deposits. Canada, Kazakhstan, Russia, and the United States also have significant tungsten resources.

Substitutes: Potential substitutes for cemented tungsten carbides include cemented carbides based on molybdenum carbide and titanium carbide, ceramics, ceramic-metallic composites (cermets), and tool steels. Potential substitutes for other applications are as follows: molybdenum for certain tungsten mill products; molybdenum steels for tungsten steels; lighting based on carbon nanotube filaments, induction technology, and light-emitting diodes for lighting based on tungsten electrodes or filaments; depleted uranium or lead for tungsten or tungsten alloys in applications requiring high-density or the ability to shield radiation; and depleted uranium alloys or hardened steel for cemented tungsten carbides or tungsten alloys in armor-piercing projectiles. In some applications, substitution would result in increased cost or a loss in product performance.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Less than ½ unit.
[2]The sum of U.S. net import reliance and secondary production.
[3]Does not include U.S. mine production.
[4]A metric ton unit (mtu) of tungsten trioxide (WO_3) contains 7.93 kilograms of tungsten.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]No tariff for Canada. Tariffs for other countries for some items may be eliminated under special trade agreements.
[7]See Appendix B for definitions.
[8]See Appendix C for resource/reserve definitions and information concerning data sources.

VANADIUM

(Data in metric tons of vanadium content unless otherwise noted)

Domestic Production and Use: Seven U.S. firms that comprise most of the domestic vanadium industry produced ferrovanadium, vanadium pentoxide, vanadium metal, and vanadium-bearing chemicals or specialty alloys by processing materials such as petroleum residues, spent catalysts, utility ash, and vanadium-bearing pig iron slag. Metallurgical use, primarily as an alloying agent for iron and steel, accounted for about 93% of the domestic vanadium consumption in 2011. Of the other uses for vanadium, the major nonmetallurgical use was in catalysts for the production of maleic anhydride and sulfuric acid.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012**[e]
Production, mine, mill[1]	520	230	1,060	590	270
Imports for consumption:					
Ferrovanadium	2,800	353	1,340	2,220	3,400
Vanadium pentoxide, anhydride	3,700	1,120	4,000	2,810	1,570
Oxides and hydroxides, other	144	25	167	886	1,210
Aluminum-vanadium master alloys (gross weight)	618	282	951	278	180
Ash and residues	1,040	791	521	1,420	1,500
Sulfates	2	16	48	42	40
Vanadates	187	214	158	303	320
Vanadium metal, including waste and scrap	5	22	10	44	110
Exports:					
Ferrovanadium	452	672	611	314	530
Vanadium pentoxide, anhydride	249	401	140	89	40
Oxides and hydroxides, other	1,040	506	1,100	254	190
Aluminum-vanadium master alloys (gross weight)	1,390	447	1,190	920	1,400
Vanadium metal, including waste and scrap	57	23	21	102	10
Consumption:					
Apparent	5,820	1,040	5,190	6,963	6,400
Reported	5,170	4,690	5,030	5,120	5,200
Price, average, dollars per pound V_2O_5	12.92	5.43	6.46	6.76	6.52
Stocks, consumer, yearend	335	295	248	[2]185	[2]220
Net import reliance[3] as a percentage of apparent consumption	91	78	81	92	96

Recycling: Some tool steel scrap was recycled primarily for its vanadium content. The vanadium content of other recycled steels was lost to slag during processing and was not recovered. Vanadium recycled from spent chemical process catalysts was significant and may comprise as much as 40% of total supply.

Import Sources (2008–11): Ferrovanadium: Republic of Korea, 43%; Canada, 33%; Austria, 18%; Czech Republic, 3%; and other, 3%. Vanadium pentoxide: Russia, 47%; South Africa, 32%; China, 19%; and other, 2%.

Tariff: Ash, residues, slag, and waste and scrap enter duty-free.

Item	Number	Normal Trade Relations 12–31–12
Vanadium pentoxide anhydride	2825.30.0010	5.5% ad val.
Vanadium oxides and hydroxides, other	2825.30.0050	5.5% ad val.
Vanadates	2841.90.1000	5.5% ad val.
Ferrovanadium	7202.92.0000	4.2% ad val.
Aluminum-vanadium master alloys	7601.20.9030	Free.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: None.

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VANADIUM

Events, Trends, and Issues: U.S. apparent consumption of vanadium in 2012 decreased by 9% from its 2011 level; however, it was still almost six times higher than its level in 2009. Apparent consumption of vanadium declined dramatically in 2009 from that of 2008 owing to the global economic recession in 2009. Among the major uses for vanadium, production of carbon, full-alloy, and high-strength low-alloy steels accounted for 16%, 45%, and 33% of domestic consumption, respectively. U.S. imports for consumption of vanadium in 2012 increased 4% from those of the previous year. U.S. exports increased 29% from those of the previous year.

In the fourth quarter of 2011, vanadium pentoxide (V_2O_5) prices continued to decrease to a year-to-date low of $6.22 per pound of V_2O_5 in December 2011. In January 2012, prices continued to decrease to a year-to-date low of $5.83 per pound of V_2O_5 until February when prices began to slowly increase again. In August 2012, V_2O_5 prices averaged $6.60 per pound of V_2O_5, slightly more than average V_2O_5 prices in August 2011. In the fourth quarter of 2011, U.S. ferrovanadium (FeV) prices continued to slowly decrease to a year-to-date low of $13.19 per pound FeV (contained vanadium) in December 2011. In January 2012, prices continued to decrease until February when prices began to slowly increase. In August 2012, FeV prices averaged $15.60 per pound of FeV.

World Mine Production and Reserves: Production data for the United States were revised based on new company information.

	Mine production		Reserves[4]
	2011	2012[e]	(thousand metric tons)
United States	[1]590	[1]270	45
China	23,000	23,000	5,100
Russia	15,200	16,000	5,000
South Africa	22,000	22,000	3,500
Other countries	1,600	1,600	NA
World total (rounded)	62,400	63,000	14,000

World Resources: World resources of vanadium exceed 63 million tons. Vanadium occurs in deposits of phosphate rock, titaniferous magnetite, and uraniferous sandstone and siltstone, in which it constitutes less than 2% of the host rock. Significant amounts are also present in bauxite and carboniferous materials, such as coal, crude oil, oil shale, and tar sands. Because vanadium is usually recovered as a byproduct or coproduct, demonstrated world resources of the element are not fully indicative of available supplies. While domestic resources and secondary recovery are adequate to supply a large portion of domestic needs, a substantial part of U.S. demand is currently met by foreign material.

Substitutes: Steels containing various combinations of other alloying elements can be substituted for steels containing vanadium. Certain metals, such as manganese, molybdenum, niobium (columbium), titanium, and tungsten, are to some degree interchangeable with vanadium as alloying elements in steel. Platinum and nickel can replace vanadium compounds as catalysts in some chemical processes. There is currently no acceptable substitute for vanadium in aerospace titanium alloys.

[e]Estimated. NA Not available.
[1]In 2008, a Canadian company began publishing data for vanadium production as a coproduct from the mining of uraniferous sandstones in Utah.
[2]Does not include vanadium pentoxide.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix C for resource/reserve definitions and information concerning data sources.

VERMICULITE

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Two companies with mining and processing facilities in South Carolina and Virginia produced vermiculite concentrate and reported production of approximately 100,000 tons. Most of the vermiculite concentrate was shipped to 18 exfoliating plants in 11 States. The end uses for exfoliated vermiculite were estimated to be agriculture/horticulture, 40%; lightweight concrete aggregates (including cement premixes, concrete, and plaster), 20%; insulation, 8%; and other, 32%.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012**[e]
Production[e, 1]	100	100	100	100	100
Imports for consumption[e, 2]	73	39	29	53	50
Exports[e]	5	3	2	2	2
Consumption, apparent, concentrate[3]	170	140	130	150	150
Consumption, exfoliated[e]	82	69	73	70	70
Price, average, concentrate, dollars per ton, ex-plant	140	130	150	160	160
Employment, number[e]	100	75	80	80	80
Net import reliance[4] as a percentage of apparent consumption[5]	40	30	20	30	30

Recycling: Insignificant.

Import Sources (2008–11): South Africa, 49%; China, 40%; Brazil, 7%; Australia, 2%; and other, 2%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–12**
Vermiculite, perlite and chlorites, unexpanded	2530.10.0000	Free.
Exfoliated vermiculite, expanded clays, foamed slag, and similar expanded materials	6806.20.0000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: U.S. imports of vermiculite are not collected as a separate category by the U.S. Census Bureau. However, according to a nongovernmental source, United States imports, excluding any material from Canada and Mexico, were about 37,000 tons for the first 9 months of 2012, the monthly average being slightly below the monthly average of imports during 2011. South Africa provided 35%, China, 30%, and Brazil, 30% of vermiculite imports. Although supplies of coarse grades continued to be tight, prices that had risen significantly in mid-2011 began to level off in 2012.

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VERMICULITE

An Australian company continued development of and production at the East African Namekara vermiculite deposit in Uganda, a portion of the larger East African vermiculite project (EAVP). The EAVP has about 55 million tons of inferred resources and is considered to be one of the world's largest deposits. The company, which increased production capacity from 4,000 tons per year of raw vermiculite concentrate in 2010 to about 18,000 tons per year in 2011, expected to reach the company's nameplate production capacity of 30,000 tons per year by yearend 2012. With the addition of a 50,000-ton-per-year plant, the company anticipated reaching a production capacity of 80,000 tons per year at Namekara by 2014. Challenges that lay ahead were transportation and related infrastructure improvement, negotiating a mining agreement with the Ugandan Government, and stabilizing its supply of electricity. The Namekara deposit has sufficient resources for more than 50 years of production at the expanded rate.

A South African company began evaluation and exploration of properties adjacent to and nearby its ongoing vermiculite mining operations in the country. Based on early drilling results, the reserves may be sufficient to allow the company to double its annual vermiculite production and still exceed the mine's current expected 24-year mine life, based on its recent average production of about 200,000 tons per year.

A Brazilian company with a mine in central Brazil planned to increase production capacity at the mine to about 100,000 tons per year of vermiculite in 2012 from 70,000 tons per year in 2011. The company also owned mining rights to an estimated 2 million tons of vermiculite ore reserve located near Brasilia. It planned to bring that deposit online, reaching a production capacity of 20,000 tons per year by 2013 and 100,000 tons per year in 2016.

World Mine Production and Reserves: The estimate of reserves was revised for Brazil based on new information from an official Government source in that country.

	Mine production		Reserves[6]
	2011	2012[e]	
United States[e, 1]	100	100	25,000
Australia	13	13	NA
Brazil	50	50	9,500
China	120	120	NA
Egypt	5	—	NA
India	13	14	NA
Russia	25	25	NA
South Africa	170	195	14,000
Uganda	20	30	NA
Other countries	26	25	15,000
World total	542	570	NA

World Resources: Marginal reserves of vermiculite in Colorado, Nevada, North Carolina, Texas, and Wyoming are estimated to be 2 million to 3 million tons. Reserves have been reported in Australia, Brazil, China, Russia, South Africa, Uganda, the United States, Zimbabwe, and some other countries. However, reserve information comes from many sources, and in most cases, it is not clear whether the numbers refer to vermiculite alone or vermiculite plus host rock and overburden.

Substitutes: Expanded perlite is a substitute for vermiculite in lightweight concrete and plaster. Other more dense but less costly material substitutes in these applications are expanded clay, shale, slag, and slate. Alternate materials for loosefill fireproofing insulation include fiberglass, perlite, and slag wool. In agriculture, substitutes include peat, perlite, sawdust, bark and other plant materials, and synthetic soil conditioners.

[e]Estimated. NA Not available. — Zero.
[1]Concentrate sold and used by producers. Data are rounded to one significant digit to avoid disclosing company proprietary data.
[2]Excludes Canada and Mexico.
[3]Rounded to two significant digits to protect proprietary data.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]Rounded to one significant digit to protect proprietary data.
[6]See Appendix C for resource/reserve definitions and information concerning data sources.

WOLLASTONITE

(Data in metric tons unless otherwise noted)

Domestic Production and Use: Wollastonite was mined by two companies in New York. U.S. production statistics are withheld by the U.S. Geological Survey (USGS) to protect company proprietary data. Wollastonite mined in the United States formed when impure limestone was metamorphosed or silica-bearing fluids were introduced into calcareous sediments during metamorphism. In both cases, calcite reacted with silica to produce wollastonite and carbon dioxide. Wollastonite also can crystallize directly from a magma that has high carbon content, but this is a less common occurrence. Domestic deposits of wollastonite have been identified in Arizona, California, Idaho, Nevada, New Mexico, New York, and Utah, but New York is the only State where long-term continuous mining has taken place.

The USGS does not collect consumption statistics for wollastonite. Plastics and rubber products, however, were estimated to account for 30% to 35% of U.S. consumption, followed by ceramics with 20% to 25%; metallurgical applications, 10% to 20%; paint, 10% to 15%; friction products, 10% to 15%; and miscellaneous, 10% to 15%.

Salient Statistics—United States: U.S. production was withheld to protect company proprietary data. In 2012, U.S. production and apparent consumption estimated to be 2% to 4% greater than in 2011. Some wollastonite end-use markets have improved since the 2008–09 economic recession but construction-related markets remained sluggish. Comprehensive trade data are not available (but the United States was a net exporter of wollastonite). Exports were estimated to be less than 10,000 tons. Imports probably remained less than 4,000 tons in 2012. Prices for wollastonite were reported in the trade literature to range from $80 to $440 per metric ton. Products with finer grain sizes and being more acicular in morphology sold for higher prices. Surface treatment, when necessary, also increased the selling price.

Recycling: None.

Import Sources (2008–11): Trade data are not available, but wollastonite has been imported from Canada, China, Finland, India, Mexico, and Spain. Shipments from Canada were transshipments because no wollastonite was commercially produced in Canada.

Tariff:

Item	Number	Normal Trade Relations 12–31–12
Mineral substances not elsewhere specified or included	2530.90.8050	Free.

Depletion Allowance: 10% (Domestic and foreign).

Government Stockpile: None.

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WOLLASTONITE

Events, Trends, and Issues: U.S. production and exports of wollastonite increased slightly in 2012, primarily because of growth in certain U.S. manufacturing sectors and growth in markets in Southeast Asia. Imports were likely to have remained unchanged in 2012.

The wollastonite industry is strongly dependent on sales to the ceramics, metallurgical, paints, and plastic industries, all of which declined during the global recession. The recovery from the global recession has been slow in the United States and Western Europe. Additionally, growth in China slowed in 2011 and 2012. Despite this, sales of products from industries on which wollastonite sales are dependent, including plastics and rubber, metallurgical, and automobile and truck manufacture, increased slightly in 2012 compared with sales in 2011. Sales to construction-related markets, such as adhesives, caulks, ceramic tile, and paints, likely remained steady in 2012 because of the continued sluggish residential and commercial construction industries. In general, sales of wollastonite by U.S. producers may have increased by 2% to 4% in 2012.

World Mine Production and Reserves: World production data for wollastonite are not available for many countries.

	Mine production	
	2011	2012[e]
United States	W	W
China	[e]305,000	300,000
Finland	[e]15,000	16,000
India	[e]150,000	150,000
Mexico	47,500	40,000
Other countries	[e]8,000	8,000
World total (rounded)[2]	525,000	510,000

Reserves[1]

World reserves of wollastonite were estimated to exceed 90 million tons, with probable reserves estimated to be 270 million tons. However, many large deposits have not been surveyed, so accurate reserve estimates are not available.

World Resources: World resources have not been estimated for wollastonite. The larger reserves were in China, Finland, India, Mexico, and the United States. Significant wollastonite resources also are in Canada, Chile, Kenya, Namibia, South Africa, Spain, Sudan, Tajikistan, Turkey, and Uzbekistan.

Substitutes: The acicular nature of many wollastonite products allows it to compete with other acicular materials, such as ceramic fiber, glass fiber, steel fiber, and several organic fibers, such as aramid, polyethylene, polypropylene, and polytetrafluoroethylene in products where improvements in dimensional stability, flexural modulus, and heat deflection are sought. Wollastonite also competes with several nonfibrous minerals or rocks, such as kaolin, mica, and talc, which are added to plastics to increase flexural strength, and such minerals as barite, calcium carbonate, gypsum, and talc, which impart dimensional stability to plastics. In ceramics, wollastonite competes with carbonates, feldspar, lime, and silica as a source of calcium and silica. Its use in ceramics depends on the formulation of the ceramic body and the firing method.

[e]Estimated. W Withheld to avoid disclosing company proprietary data.
[1]See Appendix C for resource/reserve definitions and information concerning data sources.
[2]Excludes U.S. production.

YTTRIUM[1]

[Data in metric tons of yttrium oxide (Y_2O_3) content unless otherwise noted]

Domestic Production and Use: Rare earths were mined by one U.S. company in 2012. Bastnasite, a rare-earth fluorocarbonate mineral, was mined as a primary product in California. Principal uses were in phosphors for color televisions and computer monitors, temperature sensors, trichromatic fluorescent lights, and x-ray-intensifying screens. Yttria-stabilized zirconia was used in alumina-zirconia abrasives, bearings and seals, high-temperature refractories for continuous-casting nozzles, jet-engine coatings, oxygen sensors in automobile engines, simulant gemstones, and wear-resistant and corrosion-resistant cutting tools. In electronics, yttrium-iron garnets were components in microwave radar to control high-frequency signals. Yttrium was an important component in yttrium-aluminum-garnet laser crystals used in dental and medical surgical procedures, digital communications, distance and temperature sensing, industrial cutting and welding, nonlinear optics, photochemistry, and photoluminescence. Yttrium also was used in heating-element alloys, high-temperature superconductors, and superalloys. The approximate distribution in 2012 by end use was as follows: phosphors, 44%; metallurgical, 13%; and other, 43%.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production, mine	—	—	—	—	NA
Imports for consumption:					
In monazite	—	—	—	—	—
Yttrium, alloys, compounds, and metal[e, 2]	616	450	670	549	200
Exports, in ore and concentrate	NA	NA	NA	NA	NA
Consumption, estimated[3]	616	450	670	549	NA
Price,[e] dollars:					
Monazite concentrate, per metric ton[4]	480	480	NA	1,600	NA
Yttrium oxide, per kilogram, minimum 99.9% purity[5]	10–85	10–85	38–41	165–185	90-110
Yttrium metal, per kilogram, minimum 99.9% purity[6]	36–46	35–45	50–60	162–172	152-162
Stocks, processor, yearend	NA	NA	NA	NA	NA
Net import reliance[e, 7] as a percentage of apparent consumption	100	100	100	100	NA

Recycling: Small quantities, primarily from laser crystals and synthetic garnets.

Import Sources (2008–11): Yttrium compounds, greater than 19% to less than 85% weight percent yttrium oxide equivalent: China, 73%; Japan, 8%; Austria, 6%; France, 6%; and other, 7%.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Thorium ores and concentrates (monazite)	2612.20.0000	Free.
Rare-earth metals, scandium and yttrium, whether or not intermixed or interalloyed	2805.30.0000	5.0% ad val.
Yttrium-bearing materials and compounds containing by weight >19% to <85% Y_2O_3	2846.90.4000	Free.
Other rare-earth compounds, including yttrium oxide $\geq$85% Y_2O_3, yttrium nitrate, and other individual compounds	2846.90.8000	3.7% ad val.

Depletion Allowance: Monazite, thorium content, 22% (Domestic), 14% (Foreign); yttrium, rare-earth content, 14% (Domestic and foreign); and xenotime, 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: Yttrium consumption in the United States decreased in 2012 based on import data. The United States required yttrium for energy and defense applications such as electronics, phosphors, and yttria-stabilized-zirconia refractories. Owing to reduced demand, imports and prices of yttrium metal and oxide decreased significantly. Although prices for yttrium metal and oxides were relatively stable for first three quarters of 2012, prices decreased significantly in the fourth quarter.

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YTTRIUM

China was the source of most of the world's supply of yttrium, from its weathered clay ion-adsorption ore deposits in the southern Provinces, primarily Fujian, Guangdong, and Jiangxi, with a lesser number of deposits in Guangxi and Hunan. Processing was primarily at facilities in Guangdong, Jiangsu, and Jiangxi Provinces. In India, a 10,000-ton-per-year monazite processing plant was expected to be commissioned by yearend. In Malaysia, the commissioning of a rare-earth-oxide-processing plant was delayed by appeals from environmental activists. Yttrium was consumed mainly in the form of high-purity oxide compounds for phosphors. Smaller amounts were used in ceramics, electronic devices, lasers, and metallurgical applications. Imports of yttrium declined because of economic conditions, economizing of materials, substitution, and increased imports of value-added products. In 2012, on a gross weight basis, about 95% of the imported yttrium-bearing materials and compounds containing by weight >19% to <85% Y_2O_3 were sourced from China (35%) and Japan (60%). The leading source of yttrium metal was China.

World Mine Production and Reserves: Reserve estimates for Australia have been revised based on new information available through Government reports. Mine production of rare-earth oxides in Australia, including yttrium oxide, was estimated to be 2,200 tons in 2011 and 4,000 tons in 2012. Domestic rare-earth oxide production in 2012 was estimated to be about 7,000 tons. The yttrium oxide content of these production estimates was not available.

	Mine production[e, 8]		Reserves[9]
	2011	2012	
United States	—	NA	120,000
Australia	NA	NA	100,000
Brazil	15	15	2,200
China	8,800	8,800	220,000
India	55	56	72,000
Malaysia	4	4	13,000
Sri Lanka	—	—	240
Other countries	—	—	17,000
World total (rounded)	8,900	8,900	540,000

World Resources: The world's resources of yttrium are probably very large. Yttrium is associated with most rare-earth deposits. It occurs in various minerals in differing concentrations and occurs in a wide variety of geologic environments, including alkaline granites and intrusives, carbonatites, hydrothermal deposits, laterites, placers, and vein-type deposits. Although reserves may be sufficient to satisfy near-term demand at current rates of production, economics, environmental issues, and permitting and trade restrictions could affect the mining or availability of many of the rare-earth elements, including yttrium. Large resources of yttrium in monazite and xenotime are available worldwide in placer deposits, carbonatites, uranium ores, and weathered clay deposits (ion-adsorption ore). Measured yttrium resources have been documented in the Dubbo Zirconia deposit New South Wales, Australia. Significant yttrium resources are inferred to be in the Bokan Mountain deposit, Prince of Wales Island, Alaska. Additional resources of yttrium occur in apatite-magnetite-bearing rocks, deposits of niobium-tantalum minerals, non-placer monazite-bearing deposits, sedimentary phosphate deposits, and uranium ores, especially those of the Blind River District near Elliot Lake, Ontario, Canada, which contain yttrium in brannerite, monazite, and uraninite. Canadian resources are also present in allanite, apatite, and britholite at Eden Lake, Manitoba; allanite and apatite at Hoidas Lake, Saskatchewan; and fergusonite and xenotime at Thor Lake, Northwest Territories.

Substitutes: Substitutes for yttrium are available for some applications but generally are much less effective. In most uses, especially in electronics, lasers, and phosphors, yttrium is not subject to substitution by other elements. As a stabilizer in zirconia ceramics, yttria (yttrium oxide) may be substituted with calcia (calcium oxide) or magnesia (magnesium oxide), but they generally impart lower toughness.

[e]Estimated. NA Not available. — Zero.
[1]See also Rare Earths; trade data for yttrium are included in those data shown for rare earths.
[2]Imports based on data from the Port Import/Export Reporting Service, Journal of Commerce.
[3]Essentially, all yttrium consumed domestically was imported or refined from imported ores and concentrates.
[4]Monazite price estimated for 2007 through 2010; estimate for 2011 based on sale of concentrate to China from Vietnam; anonymous marketing source.
[5]Yttrium oxide prices for 5-kilogram to 1-metric-ton quantities from Rhodia Rare Earths, Inc., Shelton, CT; the China Rare Earth Information Center, Baotou, China; Hefa Rare Earth Canada Co., Ltd., Vancouver, Canada; Metal-Pages and Stanford Materials Corp., Aliso Viejo, CA.
[6]Yttrium metal prices for 500-kilogram quantities from Metal-Pages Ltd., Teddington, United Kingdom.
[7]Defined as imports – exports + adjustments for Government and industry stock changes.
[8]Includes yttrium contained in rare-earth ores.
[9]See Appendix C for resource/reserve definitions and information concerning data sources.

ZEOLITES (NATURAL)

(Data in metric tons unless otherwise noted)

Domestic Production and Use: Natural zeolites were mined by six companies in the United States, with another company working from stockpiled materials or zeolites purchased from other producers for resale. Chabazite was mined in Arizona; clinoptilolite was mined in California, Idaho, New Mexico, and Texas. New Mexico was the leading producing State in 2012, followed by Idaho, Texas, Arizona, and California.

Natural zeolites mined in the United States are associated with the alteration of volcanic tuffs in alkaline lake deposits and open hydrologic systems. Smaller, noncommercial deposits are found in several other Midwestern and Western States. Zeolite minerals such as chabazite, clinoptilolite, erionite, mordenite, and phillipsite occur in these deposits, but the most commonly mined zeolites are chabazite, clinoptilolite, and mordenite.

Domestic uses for natural zeolites were, in decreasing order by tonnage, animal feed, pet litter, cement, odor control, water purification, wastewater cleanup, fungicide or pesticide carrier, gas absorbent, fertilizer carrier, oil absorbent, desiccant, catalyst, and aquaculture. Animal feed, cement, odor control, pet litter, wastewater treatment, and water purification applications accounted for more than 70% of the domestic sales tonnage.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production	60,100	59,500	61,300	65,400	68,000
Sales, mill	58,500	59,400	60,000	65,200	68,000
Imports for consumption[e]	200	200	150	100	100
Exports[e]	200	500	400	1,100	1,100
Consumption, apparent[e]	60,100	59,200	61,050	64,400	66,500
Price, range of value, dollars per metric ton[1]	30–900	30–900	30–900	40–800	45–800
Net import reliance[2] as a percentage of estimated consumption	E	E	E	E	E

Recycling: Natural zeolites used for most applications are not recycled. Natural zeolites used for such applications as desiccants, gas absorbents, wastewater cleanup, or water purification may be reused after reprocessing of the spent zeolites.

Import Sources (2008–11): Comprehensive trade data are not available for natural zeolites. Nearly all exports and imports are synthetic zeolites.

Tariff: Item	Number	Normal Trade Relations 12–31–12
Mineral substances not elsewhere specified or included	2530.90.8050	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: U.S. consumption of natural zeolites increased mainly in markets such as animal feed, cement (as a pozzolan in specialty applications), gas absorbent, odor control, and wastewater treatment. Sales to other markets were more erratic, with sales increasing in some years and declining in others. Increased demand for natural zeolites to remove radioactive isotopes from nuclear-plant cooling waters and runoff continued in 2012, mainly as the result of remediation work done following the 2011 earthquake and tsunami in Japan that caused structural damage to several nuclear reactors. Although data is not available on U.S. trade of natural zeolites, the United States was believed to be a net exporter of natural zeolites in 2012.

In the United States, natural zeolite markets were smaller and less associated with construction and manufacturing than other industrial minerals. Construction markets outside of the United States, where natural zeolites were widely used as dimension stone, lightweight aggregate, and pozzolan, continued to be affected by the sluggish economic growth because of the reduced level of building activity.

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ZEOLITES (NATURAL)

World Mine Production and Reserves:[2] Natural zeolite production data are not available for most countries. Countries mining large tonnages of zeolites typically use them in low-value applications. The ready availability of zeolite-rich rock at low cost and the shortage of competing minerals and rocks are probably the most important factors enabling its large-scale use. It is also likely that a significant percentage of the material sold as zeolites in some countries is ground or sawn volcanic tuff that contains only a small amount of zeolites. Some examples of such usage are dimension stone (as an altered volcanic tuff), lightweight aggregate, pozzolanic cement, and soil conditioners.

World reserves of natural zeolites have not been estimated. Deposits occur in many countries, but companies rarely, if ever, publish reserve data. Further complicating estimates of reserves is the fact that much of the reported world production includes altered volcanic tuffs that contain low to moderate concentrations of zeolites. These typically are used in high-volume construction applications, and therefore some deposits should be excluded from reserve estimates because it is the rock itself and not its zeolite content that makes the deposit valuable.

	Mine production[3]		Reserves[4]
	2011	2012[e]	
United States	65,400	68,000	
China[5]	2,000,000	2,000,000	
Japan[5]	155,000	150,000	World reserves are
Jordan	12,000	12,000	not determined but are
Korea, Republic of	240,000	230,000	estimated to be large.
Slovakia	80,000	85,000	
Turkey	150,000	100,000	
Other	120,000	110,000	
World total (rounded)	2,820,000	2,800,000	

World Resources: World resources have not been estimated for natural zeolites. An estimated 120 million tons of clinoptilolite, chabazite, erionite, mordenite, and phillipsite is present in near-surface deposits in the Basin and Range province in the United States. Resources in the United States may approach 10 trillion tons for zeolite-rich deposits.

Substitutes: For pet litter, natural zeolites compete with other mineral-based litters, such as those manufactured using attapulgite, bentonite, diatomite, fuller's earth, and sepiolite; organic litters made from shredded corn stalks and paper, straw, and wood shavings; and litters made using silica gel. Diatomite, perlite, pumice, vermiculite, and volcanic tuff compete with natural zeolite as lightweight aggregate. Zeolite desiccants compete against such products as magnesium perchlorate and silica gel. Zeolites compete with bentonite, gypsum, montmorillonite, peat, perlite, silica sand, and vermiculite in various soil amendment applications. Carbon, diatomite, or silica sand may substitute for zeolites in water purification applications. As an oil absorbent, zeolites compete mainly with bentonite, diatomite, fuller's earth, sepiolite, and a variety of polymer and natural organic products.

[e]Estimated. E Net exporter.
[1]Estimate based on values reported by U.S. producers and prices published in the trade literature. Bulk shipments typically range from $100 to $250 per ton.
[2]Defined as imports – exports.
[3]Estimates for countries that do not report production represent a range with possibly 15% to 20% variability, rather than an absolute value.
[4]See Appendix C for resource/reserve definitions and information concerning data sources.
[5]Includes materials appropriate for pozzolan applications.

ZINC

(Data in thousand metric tons of zinc content unless otherwise noted)

Domestic Production and Use: The value of zinc mined in 2012, based on zinc contained in concentrate, was about $1.53 billion. It was produced in 3 States at 13 mines operated by 4 companies. Two facilities—one primary and the other secondary—produced the bulk of refined zinc metal of commercial grade in 2012. Of the total zinc consumed, about 55% was used in galvanizing, 21% in zinc-based alloys, 16% in brass and bronze, and 8% in other uses. Zinc compounds and dust were used principally by the agricultural, chemical, paint, and rubber industries.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production:					
Mine, zinc in ore and concentrate	778	736	748	769	748
Primary slab zinc	125	94	120	110	115
Secondary slab zinc	161	109	129	138	150
Imports for consumption:					
Zinc in ore and concentrate	63	74	32	27	6
Refined zinc	725	686	671	716	680
Exports:					
Zinc in ore and concentrate	725	785	752	660	448
Refined zinc	3	3	4	19	13
Shipments from Government stockpile	([1])	([1])	—	—	—
Consumption, apparent, refined zinc	1,010	893	907	939	942
Price, average, cents per pound:					
North American[2]	88.9	77.9	102.0	106.2	93.0
London Metal Exchange (LME), cash	85.0	75.1	98.0	99.5	86.0
Reported producer and consumer stocks, slab zinc, yearend	58	85	108	114	104
Employment:					
Mine and mill, number[3]	2,520	1,580	1,790	2,240	2,250
Smelter primary, number	250	248	255	244	244
Net import reliance[4] as a percentage of apparent consumption (refined zinc)	72	77	73	74	72

Recycling: In 2012, about 57% (150,000 tons) of the slab zinc produced in the United States was recovered from secondary materials—mainly electric arc furnace dust, as well as galvanizing residues.

Import Sources (2008–11): Ore and concentrate: Peru, 81%; Canada, 7%; Ireland, 6%; Mexico, 6%. Metal: Canada, 74%; Mexico, 12%; Peru, 6%; Spain, 2%; and other, 6%. Waste and scrap: Canada, 63%; Mexico, 32%; Dominican Republic, 2%; Netherlands, 1%; and other, 2%. Combined total: Canada, 69%; Mexico, 12%; Peru, 10%; Spain, 2%; and other, 7%.

Tariff: Item	Number	Normal Trade Relations[5] 12–31–12
Zinc ores and concentrates, Zn content	2608.00.0030	Free.
Hard zinc spelter	2620.11.0000	Free.
Zinc oxide and zinc peroxide	2817.00.0000	Free.
Unwrought zinc, not alloyed:		
Containing 99.99% or more zinc	7901.11.0000	1.5% ad val.
Containing less than 99.99% zinc:		
Casting-grade	7901.12.1000	3% ad val.
Other	7901.12.5000	1.5% ad val.
Zinc alloys	7901.20.0000	3% ad val.
Zinc waste and scrap	7902.00.0000	Free.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile:

Stockpile Status—9–30–12[6]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2012	Disposals FY 2012
Zinc	7	7	[7]7	—

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ZINC

Events, Trends, and Issues: Global zinc mine production in 2012 increased slightly to 13 million tons. According to the International Lead and Zinc Study Group, refined metal production decreased by 2% to 12.9 million tons in 2012, and world metal consumption also declined slightly to 12.7 million tons, resulting in a market surplus of 153,000 tons of metal. A larger surplus was anticipated in 2013. Significant increases in zinc consumption in 2012 took place in India, Indonesia, the Republic of Korea, and Turkey. Consumption rose slightly in the United States while remaining flat in Japan. In China, consumption rose by only 0.5%, and in Europe, zinc consumption contracted by 5%.

Domestic zinc mine production decreased in 2012 from that of 2011 despite an increase in zinc production from zinc mines in Tennessee. A zinc-lead mine in Alaska produced significantly less zinc as a result of lower ore-processing rates, and a zinc-producing mine in Idaho was temporarily idled for the year while the company carried out underground structural work. Zinc metal production rose in 2012 owing mostly to increased secondary zinc production from a smelter in Pennsylvania, which began sourcing higher quality raw materials in the first quarter, and subsequently improved zinc recovery rates during the year. Apparent zinc consumption increased in 2012 from that of 2011 owing to increased demand for zinc at continuous galvanizing plants.

Monthly average North American Special High Grade (SHG) zinc prices began the year at $0.97 per pound in January, peaked in February at $1.01 per pound, and then declined through the following months, reaching a low of $0.91 per pound in August. By mid-October, prices averaged about $0.92 per pound. North American SHG zinc premiums began the year at 7 cents per pound and increased to 7.5 cents per pound by September.

World Mine Production and Reserves: Reserve estimates for Canada, India, Ireland, Mexico, Peru, and the United States were revised based on a commercially available database of reserves and resources of mines and potential mines. The reserve estimate for Australia was revised based on new information provided by Geoscience Australia, and the reserve estimate for Kazakhstan was revised based on new company information.

	Mine production[8]		Reserves[9]
	2011	2012[e]	
United States	769	748	11,000
Australia	1,520	1,490	70,000
Bolivia	427	430	6,000
Canada	612	640	7,800
China	4,310	4,600	43,000
India	710	690	12,000
Ireland	340	345	1,300
Kazakhstan	495	420	10,000
Mexico	632	630	16,000
Peru	1,260	1,270	18,000
Other countries	1,730	1,770	55,000
World total (rounded)	12,800	13,000	250,000

World Resources: Identified zinc resources of the world are about 1.9 billion metric tons.

Substitutes: Aluminum, plastics, and steel substitute for galvanized sheet. Aluminum, magnesium, and plastics are major competitors as diecasting materials. Aluminum alloy, cadmium, paint, and plastic coatings replace zinc for corrosion protection; aluminum alloys substitute for brass. Many elements are substitutes for zinc in chemical, electronic, and pigment uses.

[e]Estimated. — Zero.
[1]Less than ½ unit.
[2]Platts Metals Week price for North American SHG zinc; based on the London Metal Exchange cash price plus premiums or discounts, depending on market conditions.
[3]Includes mine and mill employment at all zinc-producing mines. Source: Mine Safety and Health Administration.
[4]Defined as imports – exports + adjustments for Government and industry stock changes. Apparent consumption from 2008 through 2010 does not necessarily reflect reported industry stock changes. Stocks increased during these years owing to an increased response rate from industry.
[5]No tariff for Canada, Mexico, and Peru for items shown.
[6]See Appendix B for definitions.
[7]Actual quantity limited to remaining inventory.
[8]Zinc content of concentrate and direct shipping ore.
[9]See Appendix C for resource/reserve definitions and information concerning data sources.

ZIRCONIUM AND HAFNIUM

(Data in metric tons unless otherwise noted)

Domestic Production and Use: The zirconium-silicate mineral zircon is produced as a coproduct from the mining and processing of heavy minerals. Typically, zirconium and hafnium are contained in zircon at a ratio of about 50 to 1. Two firms produced zircon from surface-mining operations in Florida and Virginia. Zirconium metal and hafnium metal were produced from zirconium chemical intermediates by two domestic producers, one in Oregon and the other in Utah. Zirconium chemicals were produced by the metal producer in Oregon and by at least 10 other companies. Ceramics, foundry applications, opacifiers, and refractories are the leading end uses for zircon. Other end uses of zircon include abrasives, chemicals, metal alloys, and welding rod coatings. The leading consumers of zirconium metal and hafnium metal are the nuclear energy and chemical process industries.

Salient Statistics—United States:	**2008**	**2009**	**2010**	**2011**	**2012[e]**
Production, zircon (ZrO_2 content)	W	W	W	W	W
Imports:					
Zirconium, ores and concentrates (ZrO_2 content)	22,300	9,370	14,900	17,200	26,000
Zirconium, unwrought, powder, and waste and scrap	318	451	727	485	370
Zirconium, wrought	715	526	424	365	280
Zirconium oxide[1]	5,060	2,810	2,920	3,020	5,000
Hafnium, unwrought, powder, and waste and scrap	12	5	8	10	23
Exports:					
Zirconium ores and concentrates (ZrO_2 content)	27,400	25,700	30,800	15,800	21,000
Zirconium, unwrought, powder, and waste and scrap	591	223	519	675	551
Zirconium, wrought	2,080	2,080	1,540	1,330	1,200
Zirconium oxide[1]	2,970	3,050	5,630	6,710	6,000
Consumption, zirconium ores and concentrates, apparent (ZrO_2 content)	W	W	W	W	W
Prices:					
Zircon, dollars per metric ton (gross weight):					
Domestic[2]	788	830	860	2,650	2,650
Imported, f.o.b.[3]	773	850	870	2,500	2,500
Zirconium, unwrought, import, France, dollars per kilogram[4]	41	51	74	64	110
Hafnium, unwrought, import, France, dollars per kilogram[4]	225	472	453	544	530
Net import reliance[5] as a percentage of apparent consumption:					
Zirconium	E	E	E	NA	NA
Hafnium	NA	NA	NA	NA	NA

Recycling: Companies in Oregon and Utah recycled zirconium from scrap generated during metal production and fabrication. Scrap zirconium metal and alloys were recycled by companies in California and Oregon. Zircon foundry mold cores and spent or rejected zirconia refractories are often recycled. Hafnium metal recycling was insignificant.

Import Sources (2008–11): Zirconium mineral concentrates: Australia, 52%; South Africa, 42%; and other, 6%. Zirconium, unwrought, including powder: Germany, 65%; Kazakhstan, 8%; France, 5%; Japan, 3%; and other, 19%. Hafnium, unwrought: France, 72%; Germany, 14%; United Kingdom, 3%; and other, 11%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12–31–12**
Zirconium ores and concentrates	2615.10.0000	Free.
Germanium oxides and zirconium dioxide	2825.60.0000	3.7% ad val.
Ferrozirconium	7202.99.1000	4.2% ad val.
Zirconium, unwrought and zirconium powder	8109.20.0000	4.2% ad val.
Zirconium waste and scrap	8109.30.0000	Free.
Other zirconium articles	8109.90.0000	3.7% ad val.
Hafnium, unwrought, powder, and waste and scrap	8112.92.2000	Free.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: None.

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ZIRCONIUM AND HAFNIUM

Events, Trends, and Issues: Domestic production of zirconium mineral concentrates increased compared with that of 2011, and consumption was stable. Domestic mining of heavy minerals continued near Stony Creek, VA, and Starke, FL. Permitting applications were submitted for a new zircon mine in Georgia; construction was planned to begin in early 2013, and production was expected to begin in August 2013, with 16,000 tons per year of zircon production anticipated.

Global production of zirconium concentrates (excluding the United States) decreased significantly compared with that of 2011, in response to weakening demand that began in the final quarter of 2011. Chinese consumption decreased relative to that of 2011 owing to a slowdown in the Chinese economy and resulting slowdown in housing construction, in which zircon is used in ceramic tiles and sanitaryware.

In the Eucla Basin, Australia, zircon production from the Cyclone project was expected to begin in 2015, with production of about 65,000 tons per year expected during a mine life of 10 years. The Lethbridge South Mine on Tiwi Islands was commissioned early in 2012, and a total of 29,000 tons of zircon and rutile was anticipated to be produced by late 2012, but mining was expected to be completed there in 2013. The Kilimiraka project, also on Tiwi Islands, was expected to begin production in 2014 and to have a mine life of 8 to 10 years. In Senegal, the Grande Cote project was expected to produce about 80,000 tons per year of zircon by the end of 2013.

China planned to increase its nuclear power development, which would likely increase demand for nuclear-grade zirconium and hafnium, which are used for nuclear fuel cladding.

World Mine Production and Reserves: World primary hafnium production data are not available. Hafnium occurs with zirconium in the minerals zircon and baddeleyite. Quantitative estimates of hafnium reserves are not available.

	Zirconium mine production (thousand metric tons)		Zirconium reserves[6] (thousand metric tons, ZrO_2)
	2011	2012[e]	
United States	W	W	500
Australia	762	610	21,000
China	150	150	500
India	39	40	3,400
Indonesia	130	60	NA
Mozambique	44	47	1,200
South Africa	383	400	14,000
Other countries	110	109	7,200
World total (rounded)	[7]1,620	[7]1,420	48,000

World Resources: Resources of zircon in the United States included about 14 million tons associated with titanium resources in heavy-mineral sand deposits. Phosphate and sand and gravel deposits could potentially yield substantial amounts of zircon as a byproduct. Eudialyte and gittinsite are zirconium silicate minerals that have a potential for zirconia production. Identified world resources of zircon exceed 60 million tons. World resources of hafnium are associated with those of zircon and baddeleyite. Quantitative estimates of hafnium resources are not available.

Substitutes: Chromite and olivine can be used instead of zircon for some foundry applications. Dolomite and spinel refractories can also substitute for zircon in certain high-temperature applications. Niobium (columbium), stainless steel, and tantalum provide limited substitution in nuclear applications, while titanium and synthetic materials may substitute in some chemical processing plant applications.

Silver-cadmium-indium control rods are used in lieu of hafnium at numerous nuclear powerplants. Zirconium can be used interchangeably with hafnium in certain superalloys.

[e]Estimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Includes germanium oxides.
[2]Yearend average of high-low price range.
[3]Unit value based on U.S. imports for consumption.
[4]Unit value based on U.S. imports for consumption from France.
[5]Defined as imports – exports.
[6]See Appendix C for resource/reserve definitions and information concerning data sources.
[7]Excludes U.S. production.

APPENDIX A

Abbreviations and Units of Measure

1 carat (metric) (diamond)	= 200 milligrams
1 flask (fl)	= 76 pounds, avoirdupois
1 karat (gold)	= one twenty-fourth part
1 kilogram (kg)	= 2.2046 pounds, avoirdupois
1 long ton (lt)	= 2,240 pounds, avoirdupois
1 long ton unit (ltu)	= 1% of 1 long ton or 22.4 pounds avoirdupois
long calcined ton (lct)	= excludes water of hydration
long dry ton (ldt)	= excludes excess free moisture
Mcf	= 1,000 cubic feet
1 metric ton (t)	= 2,204.6 pounds, avoirdupois or 1,000 kilograms
1 metric ton (t)	= 1.1023 short ton
1 metric ton unit (mtu)	= 1% of 1 metric ton or 10 kilograms
metric dry ton (mdt)	= excludes excess free moisture
1 pound (lb)	= 453.6 grams
1 short ton (st)	= 2,000 pounds, avoirdupois
1 short ton unit (stu)	= 1% of 1 short ton or 20 pounds, avoirdupois
short dry ton (sdt)	= excludes excess free moisture
1 troy ounce (tr oz)	= 1.09714 avoirdupois ounces or 31.103 grams
1 troy pound	= 12 troy ounces

APPENDIX B

Definitions of Selected Terms Used in This Report

Terms Used for Materials in the National Defense Stockpile and Helium Stockpile

Uncommitted inventory refers to the quantity of mineral materials held in the National Defense Stockpile. Nonstockpile-grade materials may be included in the table; where significant, the quantities of these stockpiled materials will be specified in the text accompanying the table.

Authorized for disposal refers to quantities that are in excess of the stockpile goal for a material, and for which Congress has authorized disposal over the long term at rates designed to maximize revenue but avoid undue disruption of the usual markets and financial loss to the United States.

Disposal plan FY 2012 indicates the total amount of a material in the National Defense Stockpile that the U.S. Department of Defense is permitted to sell under the Annual Materials Plan approved by Congress for the fiscal year. FY 2012 (fiscal year 2012) is the period October 1, 2011, through September 30, 2012. For mineral commodities that have a disposal plan greater than the inventory, actual quantity will be limited to remaining disposal authority or inventory. Note that, unlike the National Defense Stockpile, helium stockpile sales by the Bureau of Land Management under the Helium Privatization Act of 1996 are permitted to exceed disposal plans.

Disposals FY 2012 refers to material sold or traded from the stockpile in FY 2012.

Depletion Allowance

The depletion allowance is a business tax deduction analogous to depreciation, but which applies to an ore reserve rather than equipment or production facilities. Federal tax law allows this deduction from taxable corporate income, recognizing that an ore deposit is a depletable asset that must eventually be replaced.

APPENDIX C—Reserves and Resources

Reserves data are dynamic. They may be reduced as ore is mined and/or the extraction feasibility diminishes, or more commonly, they may continue to increase as additional deposits (known or recently discovered) are developed, or currently exploited deposits are more thoroughly explored and/or new technology or economic variables improve their economic feasibility. Reserves may be considered a working inventory of mining companies' supply of an economically extractable mineral commodity. As such, the magnitude of that inventory is necessarily limited by many considerations, including cost of drilling, taxes, price of the mineral commodity being mined, and the demand for it. Reserves will be developed to the point of business needs and geologic limitations of economic ore grade and tonnage. For example, in 1970, identified and undiscovered world copper resources were estimated to contain 1.6 billion metric tons of copper, with reserves of about 280 million metric tons of copper. Since then, more than 400 million metric tons of copper have been produced worldwide, but world copper reserves in 2012 were estimated to be 680 million metric tons of copper, more than double those in 1970, despite the depletion by mining of more than the original estimated reserves.

Future supplies of minerals will come from reserves and other identified resources, currently undiscovered resources in deposits that will be discovered in the future, and material that will be recycled from current in-use-stocks of mineral or from minerals in waste disposal sites. Undiscovered deposits of minerals constitute an important consideration in assessing future supplies. USGS reports provide estimates of undiscovered mineral resources using a three-part assessment methodology (Singer and Menzie, 2010). Mineral-resource assessments have been carried out for small parcels of land being evaluated for land reclassification, for the Nation, and for the world.

Reference Cited

Singer, D.A., and Menzie, W.D., 2010, Quantitative mineral resource assessments—An integrated approach: Oxford, United Kingdom, Oxford University Press, 219 p.

Part A—Resource/Reserve Classification for Minerals[1]

INTRODUCTION

Through the years, geologists, mining engineers, and others operating in the minerals field have used various terms to describe and classify mineral resources, which as defined herein include energy materials. Some of these terms have gained wide use and acceptance, although they are not always used with precisely the same meaning.

The USGS collects information about the quantity and quality of all mineral resources. In 1976, the USGS and the U.S. Bureau of Mines developed a common classification and nomenclature, which was published as USGS Bulletin 1450–A—*"Principles of the Mineral Resource Classification System of the U.S. Bureau of Mines and U.S. Geological Survey."* Experience with this resource classification system showed that some changes were necessary in order to make it more workable in practice and more useful in long-term planning. Therefore, representatives of the USGS and the U.S. Bureau of Mines collaborated to revise Bulletin 1450–A. Their work was published in 1980 as USGS Circular 831—*"Principles of a Resource/Reserve Classification for Minerals."*

Long-term public and commercial planning must be based on the probability of discovering new deposits, on developing economic extraction processes for currently unworkable deposits, and on knowing which resources are immediately available. Thus, resources must be continuously reassessed in the light of new geologic knowledge, of progress in science and technology, and of shifts in economic and political conditions. To best serve these planning needs, known resources should be classified from two standpoints: (1) purely geologic or physical/chemical characteristics—such as grade, quality, tonnage, thickness, and depth—of the material in place; and (2) profitability analyses based on costs of extracting and marketing the material in a given economy at a given time. The former constitutes important objective scientific information of the resource and a relatively unchanging foundation upon which the latter more valuable economic delineation can be based.

The revised classification system, designed generally for all mineral materials, is shown graphically in figures 1 and 2; its components and their usage are described in the text. The classification of mineral and energy resources is necessarily arbitrary, because definitional criteria do not always coincide with natural boundaries. The system can be used to report the status of mineral and energy-fuel resources for the Nation or for specific areas.

RESOURCE/RESERVE DEFINITIONS

A dictionary definition of resource, "something in reserve or ready if needed," has been adapted for mineral and energy resources to comprise all materials, including those only surmised to exist, that have present or anticipated future value.

Resource.—A concentration of naturally occurring solid, liquid, or gaseous material in or on the Earth's crust in such form and amount that economic extraction of a commodity from the concentration is currently or potentially feasible.

Original Resource.—The amount of a resource before production.

Identified Resources.—Resources whose location, grade, quality, and quantity are known or estimated from specific geologic evidence. Identified resources include economic, marginally economic, and sub-economic components. To reflect varying degrees of geologic certainty, these economic divisions can be subdivided into measured, indicated, and inferred.

[1]Based on U.S. Geological Survey Circular 831, 1980.

Demonstrated.—A term for the sum of measured plus indicated.

Measured.—Quantity is computed from dimensions revealed in outcrops, trenches, workings, or drill holes; grade and(or) quality are computed from the results of detailed sampling. The sites for inspection, sampling, and measurements are spaced so closely and the geologic character is so well defined that size, shape, depth, and mineral content of the resource are well established.

Indicated.—Quantity and grade and(or) quality are computed from information similar to that used for measured resources, but the sites for inspection, sampling, and measurement are farther apart or are otherwise less adequately spaced. The degree of assurance, although lower than that for measured resources, is high enough to assume continuity between points of observation.

Inferred.—Estimates are based on an assumed continuity beyond measured and(or) indicated resources, for which there is geologic evidence. Inferred resources may or may not be supported by samples or measurements.

Reserve Base.—That part of an identified resource that meets specified minimum physical and chemical criteria related to current mining and production practices, including those for grade, quality, thickness, and depth. The reserve base is the in-place demonstrated (measured plus indicated) resource from which reserves are estimated. It may encompass those parts of the resources that have a reasonable potential for becoming economically available within planning horizons beyond those that assume proven technology and current economics. The reserve base includes those resources that are currently economic (reserves), marginally economic (marginal reserves), and some of those that are currently subeconomic (subeconomic resources). The term “geologic reserve” has been applied by others generally to the reserve-base category, but it also may include the inferred-reserve-base category; it is not a part of this classification system.

Inferred Reserve Base.—The in-place part of an identified resource from which inferred reserves are estimated. Quantitative estimates are based largely on knowledge of the geologic character of a deposit and for which there may be no samples or measurements. The estimates are based on an assumed continuity beyond the reserve base, for which there is geologic evidence.

Reserves.—That part of the reserve base which could be economically extracted or produced at the time of determination. The term reserves need not signify that extraction facilities are in place and operative. Reserves include only recoverable materials; thus, terms such as “extractable reserves” and “recoverable reserves” are redundant and are not a part of this classification system.

Marginal Reserves.—That part of the reserve base which, at the time of determination, borders on being economically producible. Its essential characteristic is economic uncertainty. Included are resources that would be producible, given postulated changes in economic or technological factors.

Economic.—This term implies that profitable extraction or production under defined investment assumptions has been established, analytically demonstrated, or assumed with reasonable certainty.

Subeconomic Resources.—The part of identified resources that does not meet the economic criteria of reserves and marginal reserves.

Undiscovered Resources.—Resources, the existence of which are only postulated, comprising deposits that are separate from identified resources. Undiscovered resources may be postulated in deposits of such grade and physical location as to render them economic, marginally economic, or subeconomic. To reflect varying degrees of geologic certainty, undiscovered resources may be divided into two parts:

Hypothetical Resources.—Undiscovered resources that are similar to known mineral bodies and that may be reasonably expected to exist in the same producing district or region under analogous geologic conditions. If exploration confirms their existence and reveals enough information about their quality, grade, and quantity, they will be reclassified as identified resources.

Speculative Resources.—Undiscovered resources that may occur either in known types of deposits in favorable geologic settings where mineral discoveries have not been made, or in types of deposits as yet unrecognized for their economic potential. If exploration confirms their existence and reveals enough information about their quantity, grade, and quality, they will be reclassified as identified resources.

Restricted Resources/Reserves.—That part of any resource/reserve category that is restricted from extraction by laws or regulations. For example, restricted reserves meet all the requirements of reserves except that they are restricted from extraction by laws or regulations.

Other Occurrences.—Materials that are too low grade or for other reasons are not considered potentially economic, in the same sense as the defined resource, may be recognized and their magnitude estimated, but they are not classified as resources. A separate category, labeled other occurrences, is included in figures 1 and 2. In figure 1, the boundary between subeconomic and other occurrences is limited by the concept of current or potential feasibility of economic production, which is required by the definition of a resource. The boundary is obviously uncertain, but limits may be specified in terms of grade, quality, thickness, depth, percent extractable, or other economic-feasibility variables.

Cumulative Production.—The amount of past cumulative production is not, by definition, a part of the resource. Nevertheless, a knowledge of what has been produced is important in order to understand current resources, in terms of both the amount of past production and the amount of residual or remaining in-place resource. A separate space for cumulative production is shown in figures 1 and 2. Residual material left in the ground during current or future extraction should be recorded in the resource category appropriate to its economic-recovery potential.

FIGURE 1.—Major Elements of Mineral-Resource Classification, Excluding *Reserve Base* and *Inferred Reserve Base*

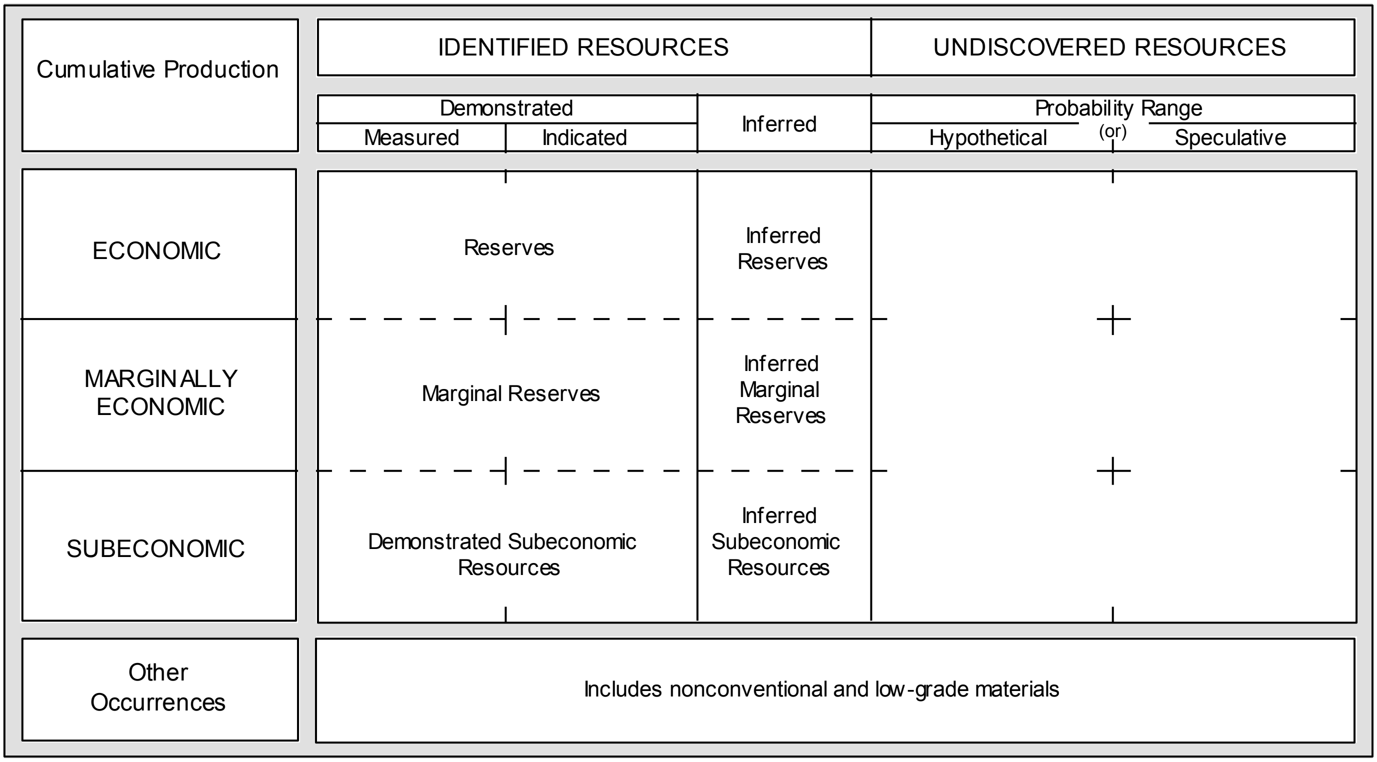
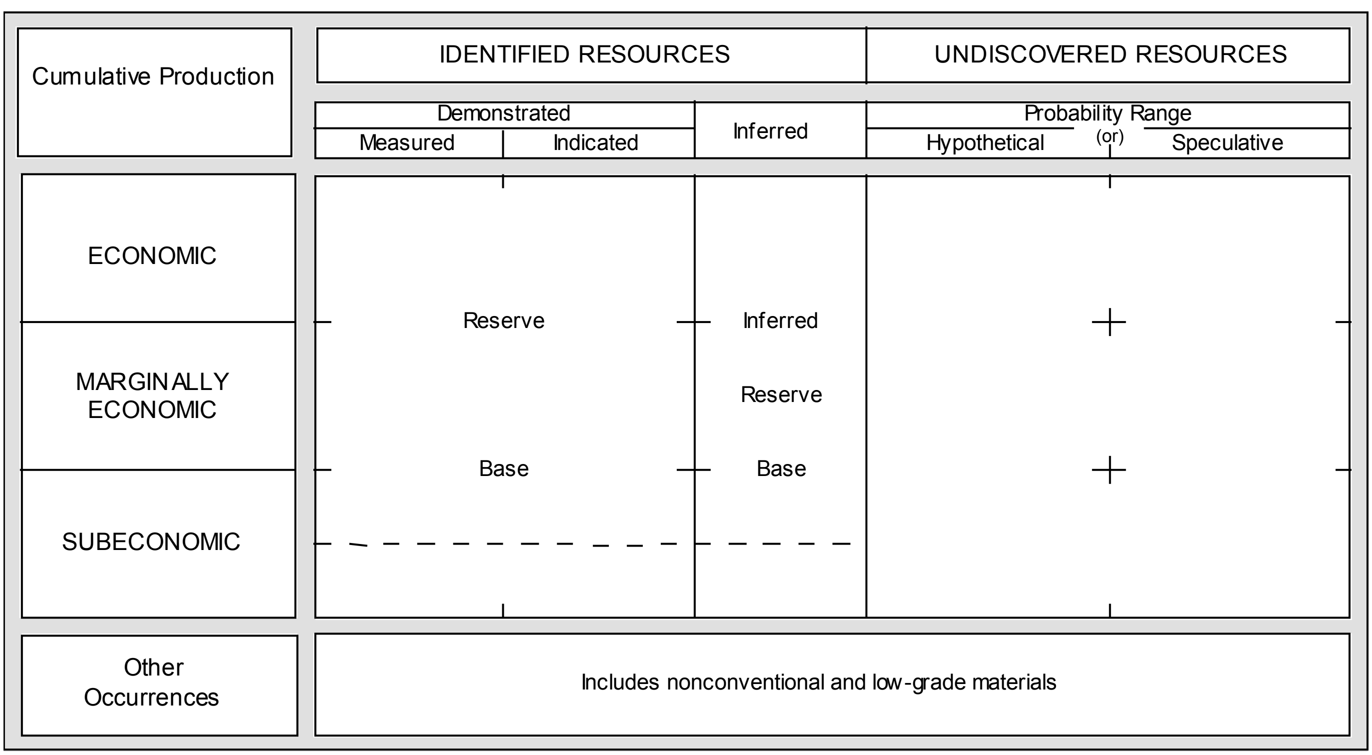


FIGURE 2.—*Reserve Base* and *Inferred Reserve Base* Classification Categories



Part B—Sources of Reserves Data

National information on reserves for most mineral commodities found in this report, including those for the United States, is derived from a variety of sources. The ideal source of such information would be comprehensive evaluations that apply the same criteria to deposits in different geographic areas and report the results by country. In the absence of such evaluations, national reserve estimates compiled by countries for selected mineral commodities are a primary source of national reserves information. Lacking national assessment information by governments, sources such as academic articles, company reports, presentations by company representatives, and trade journal articles, or a combination of these, serve as the basis for national information on reserves reported in the mineral commodity sections of this publication.

A national estimate may be assembled from the following: historically reported reserve information carried for years without alteration because no new information is available, historically reported reserves reduced by the amount of historical production, and company reported reserves. International minerals availability studies conducted by the U.S. Bureau of Mines before 1996 and estimates of identified resources by an international collaborative effort (the International Strategic Minerals Inventory) are the bases for some reserve estimates. The USGS collects information about the quantity and quality of mineral resources but does not directly measure reserves, and companies or governments do not directly report reserves to the USGS. Reassessment of reserves is a continuing process, and the intensity of this process differs for mineral commodities, countries, and time period.

Some countries have specific definitions for reserve data, and reserves for each country are assessed separately, based on reported data and definitions. An attempt is made to make reserves consistent among countries for a mineral commodity and its byproducts. For example, the Australasian Joint Ore Reserves Committee (JORC) established the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (the JORC Code) that sets out minimum standards, recommendations, and guidelines for public reporting in Australasia of exploration results, mineral resources, and ore reserves. Companies listed on the Australian Securities Exchange and the New Zealand Stock Exchange are required to report publicly on ore reserves and mineral resources under their control, using the JORC Code (http://www.jorc.org/).

Data reported for individual deposits by mining companies are compiled in Geoscience Australia's national mineral resources database and used in the preparation of the annual national assessments of Australia's mineral resources. Because of its specific use in the JORC Code, the term "reserves" is not used in the national inventory, where the highest category is "Economic Demonstrated Resources" (EDR). In essence, EDR combines the JORC Code categories proved reserves and probable reserves, plus measured resources and indicated resources. This is considered to provide a reasonable and objective estimate of what is likely to be available for mining in the long term. Accessible Economic Demonstrated Resources represent the resources within the EDR category that are accessible for mining. Reserves for Australia in Mineral Commodity Summaries 2013 are Accessible EDR. For more information, see Australia's Identified Mineral Resources 2011 (https://www.ga.gov.au/image_cache/GA20563.pdf).

In Canada, the Canadian Institute of Mining, Metallurgy, and Petroleum (CIM) provides standards for the classification of mineral resources and mineral reserves estimates into various categories. The category to which a resource or reserve estimate is assigned depends on the level of confidence in the geologic information available on the mineral deposit, the quality and quantity of data available on the deposit, the level of detail of the technical and economic information that has been generated about the deposit, and the interpretation of the data and information. For more information on the CIM definition standards, see http://web.cim.org/UserFiles/File/CIM_DEFINITON_STANDARDS_Nov_2010.pdf.

Russian reserves for most minerals, which had been withheld, have been released with increasing frequency within the past few years and can appear in a number of sources, although no systematic list of Russian reserves is published. Russian reserve data for various minerals appear at times in journal articles, such as those in the journal Mineral'nye Resursy Rossii [Mineral Resources of Russia (MRR)], which is published by the Russian Ministry of Natural Resources. Russian reserve data are often published according to the Soviet reserves classification system, which is still used in many countries of the former Soviet Union but also at times published according to the JORC system based on analyses made by Western firms. It is sometimes not clear if the reserves are being reported in ore or mineral content. It is also in many cases not clear which definition of reserves is being used, as the system inherited from the former Soviet Union has a number of ways in which the term reserves is defined, and these definitions qualify the percentage of reserves that are included. For example, the Soviet reserves classification system, besides the categories A, B, C1, and C2, which represent progressively detailed knowledge of a mineral deposit based on exploration data, has other subcategories cross-imposed upon the system. Under the broad category reserves (zapasy), there are subcategories that include balance reserves (economic reserves or balansovye zapasy) and outside the balance reserves (uneconomic reserves or zabalansovye zapasy), as well as categories that include explored, industrial, and proven reserves, and the reserve totals can vary significantly depending on the specific definition of reserves being reported.

APPENDIX D

Country Specialists Directory

Minerals information country specialists at the U.S. Geological Survey collect and analyze information on the mineral industries of more than 170 nations throughout the world. The specialists are available to answer minerals-related questions concerning individual countries.

Africa and the Middle East

Algeria	Mowafa Taib
Angola	Omayra Bermúdez-Lugo
Bahrain	Mowafa Taib
Benin	Omayra Bermúdez-Lugo
Botswana	Harold R. Newman
Burkina Faso	Omayra Bermúdez-Lugo
Burundi	Thomas R. Yager
Cameroon	Harold R. Newman
Cape Verde	Harold R. Newman
Central African Republic	Omayra Bermúdez-Lugo
Chad	Philip M. Mobbs
Comoros	Harold R. Newman
Congo (Brazzaville)	Philip M. Mobbs
Congo (Kinshasa)	Thomas R. Yager
Côte d'Ivoire	Omayra Bermúdez-Lugo
Djibouti	Thomas R. Yager
Egypt	Mowafa Taib
Equatorial Guinea	Philip M. Mobbs
Eritrea	Harold R. Newman
Ethiopia	Thomas R. Yager
Gabon	Omayra Bermúdez-Lugo
The Gambia	Omayra Bermúdez-Lugo
Ghana	Omayra Bermúdez-Lugo
Guinea	Omayra Bermúdez-Lugo
Guinea-Bissau	Omayra Bermúdez-Lugo
Iran	Philip M. Mobbs
Iraq	Mowafa Taib
Israel	Thomas R. Yager
Jordan	Mowafa Taib
Kenya	Thomas R. Yager
Kuwait	Philip M. Mobbs
Lebanon	Mowafa Taib
Lesotho	Harold R. Newman
Liberia	Omayra Bermúdez-Lugo
Libya	Mowafa Taib
Madagascar	Thomas R. Yager
Malawi	Thomas R. Yager
Mali	Omayra Bermúdez-Lugo
Mauritania	Mowafa Taib
Mauritius	Harold R. Newman
Morocco & Western Sahara	Harold R. Newman
Mozambique	Thomas R. Yager
Namibia	Omayra Bermúdez-Lugo
Niger	Omayra Bermúdez-Lugo
Nigeria	Philip M. Mobbs
Oman	Mowafa Taib
Qatar	Mowafa Taib
Reunion	Harold R. Newman
Rwanda	Thomas R. Yager
São Tomé & Principe	Omayra Bermúdez-Lugo
Saudi Arabia	Philip M. Mobbs
Senegal	Omayra Bermúdez-Lugo
Seychelles	Harold R. Newman
Sierra Leone	Omayra Bermúdez-Lugo
Somalia	Thomas R. Yager
South Africa	Thomas R. Yager
South Sudan	Thomas R. Yager
Sudan	Thomas R. Yager
Swaziland	Harold R. Newman
Syria	Mowafa Taib
Tanzania	Thomas R. Yager
Togo	Omayra Bermúdez-Lugo
Tunisia	Mowafa Taib
Turkey	Philip M. Mobbs
Uganda	Harold R. Newman
United Arab Emirates	Mowafa Taib
Yemen	Mowafa Taib
Zambia	Philip M. Mobbs
Zimbabwe	Philip M. Mobbs

Asia and the Pacific

Afghanistan	Chin S. Kuo
Australia	Pui-Kwan Tse
Bangladesh	Yolanda Fong-Sam
Bhutan	Lin Shi
Brunei	Pui-Kwan Tse
Burma (Myanmar)	Yolanda Fong-Sam
Cambodia	Yolanda Fong-Sam
China	Pui-Kwan Tse
East Timor	Pui-Kwan Tse
Fiji	Lin Shi
India	Chin S. Kuo
Indonesia	Chin S. Kuo
Japan	Chin S. Kuo
Korea, North	Lin Shi
Korea, Republic of	Lin Shi
Laos	Yolanda Fong-Sam
Malaysia	Pui-Kwan Tse
Mongolia	Susan Wacaster
Nauru	Pui-Kwan Tse
Nepal	Lin Shi
New Caledonia	Susan Wacaster
New Zealand	Pui-Kwan Tse
Pakistan	Chin S. Kuo
Papua New Guinea	Susan Wacaster
Philippines	Yolanda Fong-Sam
Singapore	Pui-Kwan Tse
Solomon Islands	Chin S. Kuo
Sri Lanka	Chin S. Kuo
Taiwan	Pui-Kwan Tse
Thailand	Lin Shi
Tonga	Chin S. Kuo
Vanuatu	Chin S. Kuo
Vietnam	Yolanda Fong-Sam

Europe and Central Eurasia

Albania	Mark Brininstool
Armenia[1]	Elena Safirova
Austria[2]	Steven T. Anderson
Azerbaijan[1]	Elena Safirova

Europe and Central Eurasia—continued

Belarus[1]	Elena Safirova
Belgium[2]	Alberto A. Perez
Bosnia and Herzegovina	Mark Brininstool
Bulgaria[2]	Mark Brininstool
Croatia	Harold R. Newman
Cyprus[2]	Harold R. Newman
Czech Republic[2]	Steven T. Anderson
Denmark, Faroe Islands, and Greenland[2]	Harold R. Newman
Estonia[2]	Alberto A. Perez
Finland[2]	Alberto A. Perez
France[2]	Alberto A. Perez
Georgia	Elena Safirova
Germany[2]	Steven T. Anderson
Greece[2]	Harold R. Newman
Hungary[2]	Steven T. Anderson
Iceland	Harold R. Newman
Ireland[2]	Alberto A. Perez
Italy[2]	Alberto A. Perez
Kazakhstan[1]	Mark Brininstool
Kosovo	Mark Brininstool
Kyrgyzstan[1]	Elena Safirova
Latvia[2]	Alberto A. Perez
Lithuania[2]	Alberto A. Perez
Luxembourg[2]	Alberto A. Perez
Macedonia	Mark Brininstool
Malta[2]	Harold R. Newman
Moldova[1]	Elena Safirova
Montenegro	Harold R. Newman
Netherlands[2]	Alberto A. Perez
Norway	Harold R. Newman
Poland[2]	Mark Brininstool
Portugal[2]	Alfredo C. Gurmendi
Romania[2]	Alberto A. Perez
Russia[1]	Elena Safirova
Serbia	Mark Brininstool
Slovakia[2]	Harold R. Newman
Slovenia[2]	Harold R. Newman
Spain[2]	Alfredo C. Gurmendi
Sweden[2]	Alberto A. Perez
Switzerland	Harold R. Newman
Tajikistan[1]	Elena Safirova
Turkmenistan[1]	Elena Safirova
Ukraine[1]	Mark Brininstool
United Kingdom[2]	Alberto A. Perez
Uzbekistan[1]	Elena Safirova

North America, Central America, and the Caribbean

Belize	Susan Wacaster
Canada	Philip M. Mobbs
Costa Rica	Susan Wacaster
Cuba	Susan Wacaster
Dominican Republic	Susan Wacaster
El Salvador	Susan Wacaster
Guatemala	Susan Wacaster
Haiti	Susan Wacaster
Honduras	Susan Wacaster
Jamaica	Susan Wacaster
Mexico	Alberto A. Perez
Nicaragua	Susan Wacaster
Panama	Susan Wacaster
Trinidad and Tobago	Susan Wacaster

South America

Argentina	Susan Wacaster
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Brazil	Alfredo C. Gurmendi
Chile	Steven T. Anderson
Colombia	Susan Wacaster
Ecuador	Susan Wacaster
French Guiana	Alfredo C. Gurmendi
Guyana	Alfredo C. Gurmendi
Paraguay	Alfredo C. Gurmendi
Peru	Alfredo C. Gurmendi
Suriname	Alfredo C. Gurmendi
Uruguay	Alfredo C. Gurmendi
Venezuela	Alfredo C. Gurmendi

[1]Member of Commonwealth of Independent States.
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