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

MINERAL COMMODITY SUMMARIES 2014

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

MINERAL COMMODITY SUMMARIES 2014

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
Manganese
Mercury
Mica
Molybdenum
Nickel
Niobium
Nitrogen
Peat
Perlite
Phosphate Rock
Platinum
Potash
Pumice
Quartz Crystal
Rare Earths
Rhenium
Rubidium
Salt
Sand and Gravel
Scandium
Selenium
Silicon
Silver
Soda Ash
Stone
Strontium
Sulfur
Talc
Tantalum
Tellurium
Thallium
Thorium
Tin
Titanium
Tungsten
Vanadium
Vermiculite
Wollastonite
Yttrium
Zeolites
Zinc
Zirconium

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

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Information about the U.S. Geological Survey, its programs, staff, and products is available from the Internet at <http://www.usgs.gov> or by calling (888) ASK–USGS [(888) 275–8747].

This publication has been prepared by the National Minerals Information Center. Information about the Center and its products is available from the Internet at <http://minerals.usgs.gov/minerals> or by writing to Director, National Minerals Information Center, 988 National Center, Reston, VA 20192.

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 2014 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 2013 mineral production data for the world. More than 90 individual minerals and materials are covered by two-page synopses.

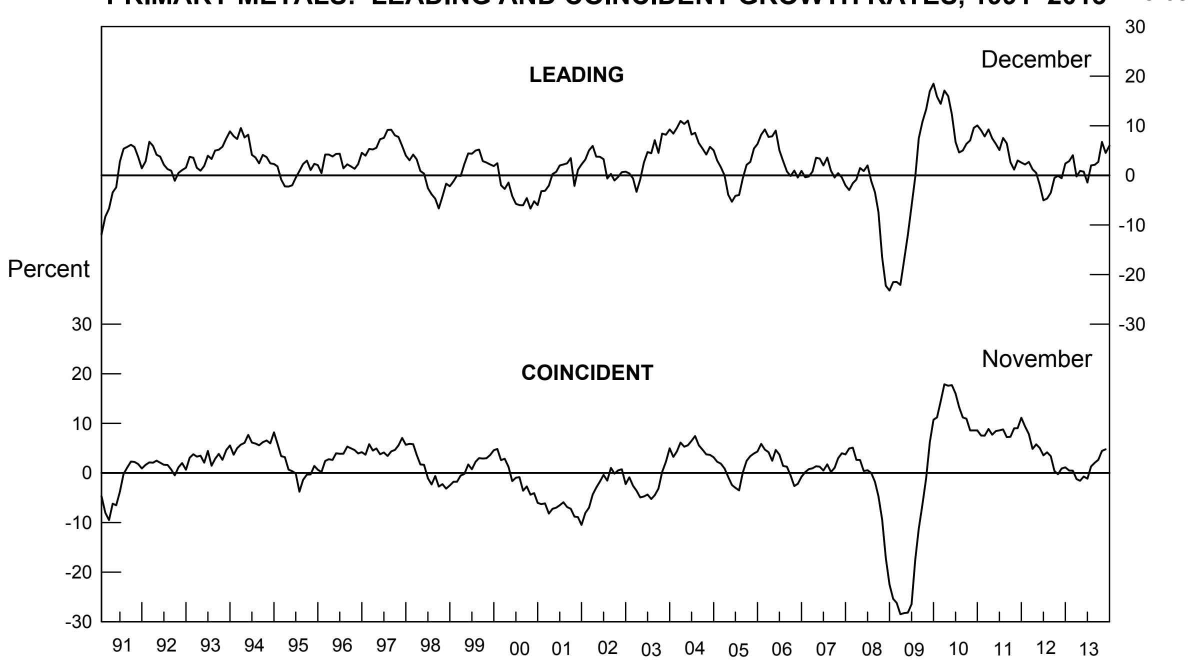
For mineral commodities for which there is a Government stockpile, detailed information concerning the stockpile status is included in the two-page synopsis.

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.

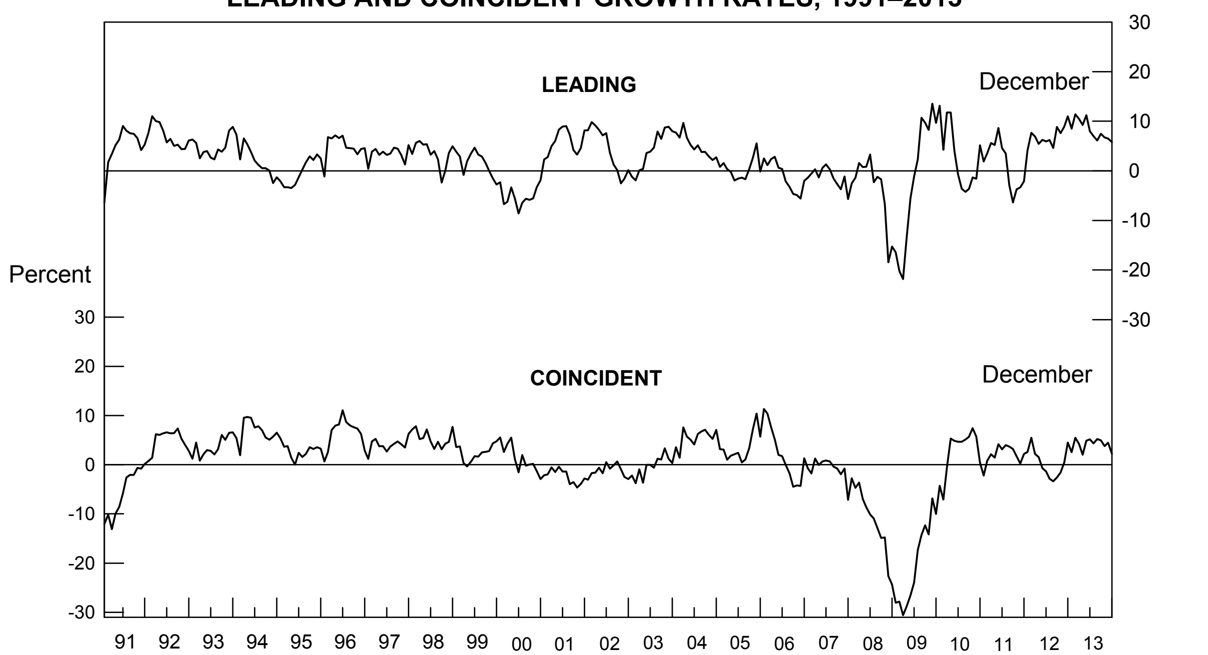
The USGS continually strives to improve the value of its publications to users. Constructive comments and suggestions by readers of the MCS 2014 are welcomed.

GROWTH RATES OF LEADING AND COINCIDENT INDEXES FOR MINERAL PRODUCTS

PRIMARY METALS: LEADING AND COINCIDENT GROWTH RATES, 1991–2013



NONMETALLIC MINERAL PRODUCTS: LEADING AND COINCIDENT GROWTH RATES, 1991–2013

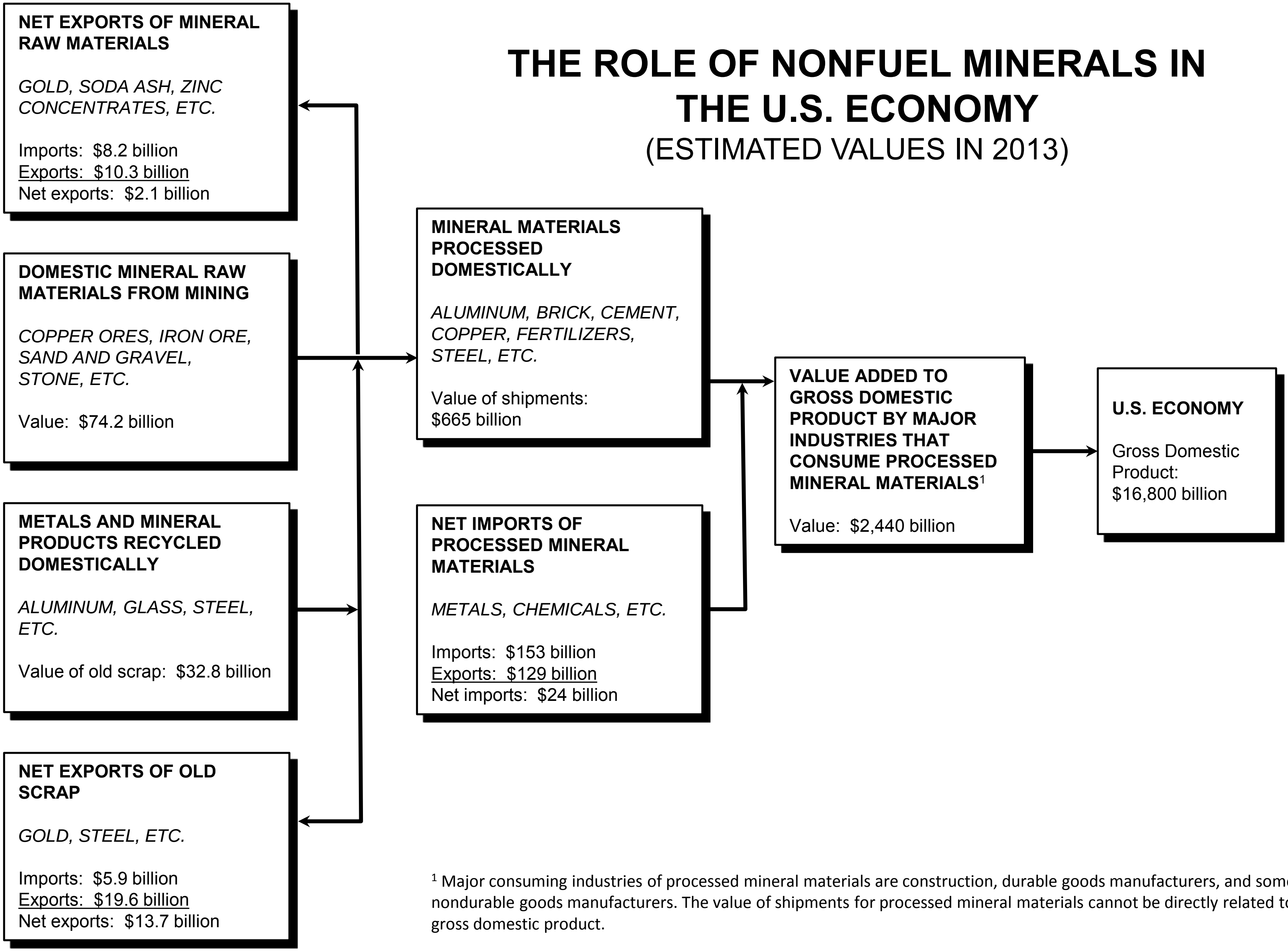


The leading indexes historically give signals several months in advance of major changes in the corresponding coincident index, which measures current industry activity. The growth rates, which can be viewed as trends, are expressed as compound annual rates based on the ratio of the current month's index 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 2013)



[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 the U.S. Department of Commerce.

2013 U.S. NET IMPORT RELIANCE[1]

Commodity	Percent	Major import sources (2009–12)[2]
ARSENIC	100	Morocco, China, Belgium
ASBESTOS	100	Canada, Brazil
BAUXITE AND ALUMINA	100	Jamaica, Brazil, Guinea, Australia
CESIUM	100	Canada
FLUORSPAR	100	Mexico, China, South Africa, Mongolia
GRAPHITE (natural)	100	China, Mexico, Canada, Brazil
INDIUM	100	Canada, China, Japan, Belgium
MANGANESE	100	South Africa, Gabon, Australia, Georgia
MICA, sheet (natural)	100	China, Brazil, Belgium, India
NIOBIUM (columbium)	100	Brazil, Canada
QUARTZ CRYSTAL (industrial)	100	China, Japan, and Russia
RUBIDIUM	100	Canada
SCANDIUM	100	China
STRONTIUM	100	Mexico, Germany, China
TANTALUM	100	China, Germany, Kazakhstan, Russia
THALLIUM	100	Germany, Russia
THORIUM	100	India, France
VANADIUM	100	Canada, Czech Rep., Rep. of Korea, Austria
YTTRIUM	100	China, Japan, Austria, France
GALLIUM	99	Germany, United Kingdom, China, Canada
GEMSTONES	99	Israel, India, Belgium, South Africa
BISMUTH	91	China, Belgium, United Kingdom
IODINE	91	Chile, Japan
DIAMOND (dust grit, and powder)	88	China, Ireland, Rep. of Korea, Romania
ANTIMONY	85	China, Mexico, Belgium, Bolivia
GERMANIUM	85	China, Belgium, Russia, Germany
POTASH	82	Canada, Russia, Israel, Chile
RHENIUM	80	Chile, Poland, Germany
STONE (dimension)	80	China, Brazil, Italy, Turkey
PLATINUM	79	Germany, South Africa, United Kingdom, Canada
TITANIUM MINERAL CONCENTRATES	79	South Africa, Australia, Canada, Mozambique
COBALT	76	China, Norway, Russia, Finland
GARNET (industrial)	76	Australia, India, China
BARITE	75	China, India, Morocco
ZINC	74	Canada, Mexico, Peru
TIN	73	Peru, Bolivia, Indonesia, Malaysia
SILICON CARBIDE (crude)	72	China, South Africa, Netherlands, Romania
PEAT	66	Canada
PALLADIUM	60	Russia, South Africa, United Kingdom, Norway
SILVER	58	Mexico, Canada, Poland, Peru
CHROMIUM	50	South Africa, Kazakhstan, Russia, Mexico
NICKEL	48	Canada, Russia, Australia, Norway
MAGNESIUM COMPOUNDS	47	China, Brazil, Canada, Australia
TITANIUM (sponge)	45	Japan, Kazakhstan, China
TUNGSTEN	41	China, Bolivia, Germany, Portugal
SILICON	40	Russia, Brazil, Canada, South Africa
COPPER	36	Chile, Canada, Peru, Mexico
MICA, scrap and flake (natural)	36	Canada, China, India, Finland
NITROGEN (fixed)—AMMONIA	36	Trinidad and Tobago, Canada, Russia, Ukraine
VERMICULITE	30	South Africa, China, Brazil
ALUMINUM	28	Canada, Russia, China, Mexico
LEAD	25	Canada, Mexico
MAGNESIUM METAL	25	Israel, Canada, China
SALT	22	Canada, Chile, Mexico, The Bahamas
PERLITE	20	Greece
SULFUR	18	Canada, Mexico, Venezuela
IRON and STEEL	13	Canada, Mexico, Rep. of Korea, Brazil
TALC	12	China, Canada, Pakistan, Japan
BERYLLIUM	11	Russia, Kazakhstan, China, Japan
GYPSUM	9	Canada, Mexico, Spain
IRON and STEEL SLAG	8	Canada, Japan, Italy, South Africa
CEMENT	7	Canada, Rep. of Korea, China, Mexico
PUMICE	5	Greece, Iceland, Mexico, Montserrat

[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, phosphate rock). 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 2013, the estimated value of mineral production decreased in the United States after 3 consecutive years of increases. Production increased for most industrial mineral commodities mined in the United States, and overall, prices remained stable. Production of most metals was relatively stable compared with that of 2012, but lower metal prices resulted in an overall reduction in the value of mineral production in the United States. 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. Following the reduction in construction activity that began with the 2008–09 recession and continued through 2011, the construction industry began to show signs of recovery in 2012, and that trend continued in 2013, with increased production and consumption of cement, construction sand and gravel, crushed stone, and gypsum, mineral commodities that are used almost exclusively in construction.

The figure on page 4 shows that the primary metals industry and the nonmetallic minerals products industry are fundamentally 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 signal 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. The primary metals leading index growth rate started 2013 at just over 2.0% and increased to nearly 3.0% by yearend. Although domestic metal consumption boosted the U.S. primary metals industry, slow global economic growth restrained the metals industry. Metals consumption from the manufacturing sector rose during the year, and moderate metals demand is likely in 2014. An increase in construction projects also raised metals demand in 2013. The nonmetallic mineral products industry also benefited from the increase in construction spending in 2013, with more than half of its output going to the construction sector. However, residential construction indicators, such as housing starts and building permits, suggest that housing industry activity will be less robust in 2014. The nonmetallic mineral products leading index growth rate ended 2013 pointing to slow growth in the nonmetallic mineral products industry in 2014.

As shown in the figure on page 5, the estimated value of mineral raw materials produced at mines in the United States in 2013 was $74.3 billion, a slight decrease from $75.8 billion in 2012. Net exports of mineral raw materials and old scrap contributed an additional $15.8 billion to the U.S. economy. Domestic raw materials and domestically recycled materials were used to process mineral materials worth $665 billion. These mineral materials, including aluminum, brick, copper, fertilizers, and steel, and net imports of processed materials (worth about $24 billion) were, in turn, consumed by downstream industries with a value added of an estimated $2.44 trillion in 2013.

The estimated value of U.S. metal mine production in 2013 was $32.0 billion, about 8% less than that of 2012. Principal contributors to the total value of metal mine production in 2013 were gold (32%), copper (29%), iron ore (17%), molybdenum (10%), and zinc (5%). Average prices for most domestically mined metals decreased in 2013. The yearly average price of gold decreased for the first time since 2001. The estimated value of U.S. industrial minerals mine production in 2013 was $42.3 billion, about 3% more than that of 2012. The value of industrial minerals mine production in 2013 was dominated by crushed stone (28%), cement (16%), and construction sand and gravel (16%). In general, industrial minerals prices were relatively stable, with modest price variations.

Mine production of 14 mineral commodities was worth more than $1 billion each in the United States in 2013. These were, in decreasing order of value, crushed stone, gold, copper, cement, construction sand and gravel, iron ore (shipped), molybdenum concentrates, phosphate rock, industrial sand and gravel, lime, soda ash, salt, zinc, and clays (all types).

The figure on page 6 illustrates the reliance of the United States on foreign sources for raw and processed mineral materials. In 2013, the supply for more than one-half of U.S. apparent consumption of the 40 mineral commodities shown in the figure came from imports, and the United States was 100% import reliant for 19 of those. 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 2013, 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 2013, 12 States each produced more than $2 billion worth of nonfuel mineral commodities. These States were, in descending order of value—Nevada, Arizona, Minnesota, Florida, Texas, Alaska, Utah, California, Wyoming, Missouri, Michigan, and Colorado. 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 environmentally sound stewardship for strategic and critical materials in the U.S. National Defense Stockpile (NDS). DLA Strategic Materials stores 24 commodities at 5 locations in the United States. In fiscal year 2013, DLA Strategic Materials sold $108 million of excess mineral materials from the NDS. At the end of the fiscal year, mineral materials valued at $1.3 billion remained in the NDS. Of the remaining material, some was being

TABLE 1.—U.S. MINERAL INDUSTRY TRENDS

	2009	2010	2011	2012	2013[e]
Total mine production (million dollars):					
Metals	21,800	30,400	36,000	34,700	31,900
Industrial minerals	37,000	37,500	38,800	41,100	42,300
Coal	35,700	38,600	44,900	40,600	39,800
Employment (thousands of production workers):					
Coal mining	71	70	78	76	73
Metal mining	28	29	[1]98	[1]103	[1]105
Industrial minerals, except fuels	73	71	[2]NA	[2]NA	[2]NA
Chemicals and allied products	479	474	480	491	491
Stone, clay, and glass products	303	283	278	272	272
Primary metal industries	273	275	301	317	306
Average weekly earnings of production workers (dollars):					
Coal mining	1,250	1,365	1,404	1,348	1,354
Metal mining	1,096	[2]NA	[2]NA	[2]NA	[2]NA
Industrial minerals, except fuels	807	[2]NA	[2]NA	[2]NA	[2]NA
Chemicals and allied products	841	888	911	910	921
Stone, clay, and glass products	706	727	767	766	783
Primary metal industries	819	880	889	908	964

[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

	2009	2010	2011	2012	2013[e]
Gross domestic product (billion dollars)	14,418	14,958	15,534	16,245	16,803
Industrial production (2007=100):					
Total index	86	91	94	97	100
Manufacturing:	82	87	90	94	96
Nonmetallic mineral products	67	69	70	71	73
Primary metals:	74	91	97	99	99
Iron and steel	69	89	98	101	101
Aluminum	76	92	98	102	102
Nonferrous metals (except aluminum)	94	112	114	111	111
Chemicals	83	86	86	86	87
Mining:	96	101	107	114	119
Coal	93	94	95	88	86
Oil and gas extraction	106	110	116	127	138
Metals	90	96	98	97	97
Nonmetallic minerals	72	73	74	78	80
Capacity utilization (percent):					
Total industry:	69	74	76	78	78
Mining:	80	84	87	88	89
Metals	68	74	74	70	70
Nonmetallic minerals	66	70	74	79	81
Housing starts (thousands)	554	586	612	783	928
Light vehicle sales (thousands)[1]	7,550	8,620	9,760	11,200	12,200
Highway construction, value, put in place (billion dollars)	82	82	80	80	81

[e]Estimated.

[1]Excludes imports.

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

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 chapters 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 2013[p, 1]

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	$990,000	26	1.33	Cement (portland), stone (crushed), lime, sand and gravel (construction), cement (masonry).
Alaska	3,420,000	6	4.60	Gold, zinc, lead, silver, sand and gravel (construction).
Arizona	7,540,000	2	10.16	Copper, molybdenum concentrates, sand and gravel (construction), cement (portland), stone (crushed).
Arkansas	1,020,000	22	1.37	Cement (portland), bromine, stone (crushed), sand and gravel (industrial), sand and gravel (construction).
California	3,110,000	8	4.19	Boron minerals, cement (portland), sand and gravel (construction), stone (crushed), gold.
Colorado	2,110,000	12	2.84	Molybdenum concentrates, gold, sand and gravel (construction), cement (portland), stone (crushed).
Connecticut[2]	171,000	43	0.23	Stone (crushed), sand and gravel (construction), clays (common), gemstones (natural).
Delaware[2]	15,400	50	0.02	Magnesium compounds, sand and gravel (construction), stone (crushed), gemstones (natural).
Florida	3,840,000	4	5.17	Phosphate rock, stone (crushed), cement (portland), zirconium concentrates, sand and gravel (construction).
Georgia	1,500,000	14	2.02	Clays (kaolin), stone (crushed), clays (fuller's earth), cement (portland), sand and gravel (construction).
Hawaii	102,000	47	0.14	Stone (crushed), sand and gravel (construction), gemstones (natural).
Idaho	991,000	25	1.34	Molybdenum concentrates, phosphate rock, sand and gravel (construction), silver, stone (crushed).
Illinois	1,220,000	17	1.64	Sand and gravel (industrial), stone (crushed), sand and gravel (construction), cement (portland), tripoli.
Indiana	821,000	29	1.11	Stone (crushed), cement (portland), sand and gravel (construction), lime, cement (masonry).
Iowa	670,000	32	0.90	Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial), lime.
Kansas	1,150,000	19	1.55	Helium (Grade–A), cement (portland), salt, stone (crushed), sand and gravel (construction).
Kentucky	1,010,000	23	1.36	Stone (crushed), lime, cement (portland), sand and gravel (construction), clays (common).
Louisiana[2]	395,000	35	0.53	Salt, sand and gravel (construction), stone (crushed), sand and gravel (industrial), lime.
Maine	131,000	45	0.18	Sand and gravel (construction), stone (crushed), cement (portland), stone (dimension), cement (masonry).
Maryland[2]	255,000	40	0.34	Cement (portland), stone (crushed), sand and gravel (construction), cement (masonry), stone (dimension).
Massachusetts[2]	232,000	42	0.31	Stone (crushed), sand and gravel (construction), stone (dimension), lime, clays (common).
Michigan	2,190,000	11	2.95	Iron ore (usable shipped), cement (portland), sand and gravel (construction), stone (crushed), salt.
Minnesota[2]	4,650,000	3	6.27	Iron ore (usable shipped), sand and gravel (construction), sand and gravel (industrial), stone (crushed), stone (dimension).
Mississippi	161,000	44	0.22	Sand and gravel (construction), stone (crushed), clays (fuller's earth), clays (ball), clays (bentonite).
Missouri	2,440,000	10	3.29	Stone (crushed), cement (portland), lead, lime, sand and gravel (construction).
Montana	1,350,000	16	1.82	Palladium metal, copper, molybdenum concentrates, platinum metal, gold.

See footnotes at end of table.

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 2013[p, 1]—Continued

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Nebraska	307,000	39	0.41	Cement (portland), stone (crushed), sand and gravel (construction), sand and gravel (industrial), lime.
Nevada	9,040,000	1	12.18	Gold, copper, silver, lime, sand and gravel (construction).
New Hampshire	102,000	48	0.14	Sand and gravel (construction), stone (crushed), stone (dimension), gemstones (natural).
New Jersey[2]	462,000	34	0.62	Stone (crushed), sand and gravel (construction), sand and gravel (industrial), greensand marl, peat.
New Mexico	1,540,000	13	2.07	Copper, potash, sand and gravel (construction), molybdenum concentrates, cement (portland).
New York	1,210,000	18	1.63	Salt, stone (crushed), sand and gravel (construction), cement (portland), wollastonite.
North Carolina	1,030,000	21	1.39	Stone (crushed), phosphate rock, sand and gravel (construction), sand and gravel (industrial), feldspar.
North Dakota[2]	244,000	41	0.33	Sand and gravel (construction), lime, stone (crushed), clays (common), sand and gravel (industrial).
Ohio[2]	1,000,000	24	1.35	Stone (crushed), sand and gravel (construction), salt, lime, cement (portland).
Oklahoma	755,000	30	1.02	Stone (crushed), cement (portland), sand and gravel (industrial), sand and gravel (construction), iodine.
Oregon	328,000	36	0.44	Stone (crushed), sand and gravel (construction), cement (portland), diatomite, perlite (crude).
Pennsylvania[2]	1,360,000	15	1.83	Stone (crushed), cement (portland), lime, sand and gravel (construction), sand and gravel (industrial).
Rhode Island[2]	30,300	49	0.04	Sand and gravel (construction), stone (crushed), sand and gravel (industrial), gemstones (natural).
South Carolina[2]	538,000	33	0.73	Cement (portland), stone (crushed), sand and gravel (construction), cement (masonry), sand and gravel (industrial).
South Dakota	320,000	37	0.43	Sand and gravel (construction), gold, cement (portland), stone (crushed), lime.
Tennessee	941,000	27	1.27	Stone (crushed), zinc, cement (portland), sand and gravel (construction), clays (ball).
Texas	3,740,000	5	5.03	Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial), lime.
Utah	3,310,000	7	4.46	Copper, magnesium metal, gold, potash, molybdenum concentrates.
Vermont[2]	118,000	46	0.16	Stone (crushed), sand and gravel (construction), stone (dimension), talc (crude), gemstones (natural).
Virginia	1,110,000	20	1.49	Stone (crushed), zirconium concentrates, cement (portland), lime, sand and gravel (construction).
Washington	743,000	31	1.00	Sand and gravel (construction), gold, stone (crushed), cement (portland), diatomite.
West Virginia	313,000	38	0.42	Stone (crushed), cement (portland), lime, sand and gravel (industrial), cement (masonry).
Wisconsin[2]	935,000	28	1.26	Sand and gravel (industrial), sand and gravel (construction), stone (crushed), lime, stone (dimension).
Wyoming	2,460,000	9	3.31	Soda ash, clays (bentonite), helium (Grade–A), sand and gravel (construction), cement (portland).
Undistributed	827,000	XX	1.11	
Total	74,200,000	XX	100.00	

[p]Preliminary. XX Not applicable.

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

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

MAJOR METAL-PRODUCING AREAS

MAJOR INDUSTRIAL MINERAL-PRODUCING AREAS—PART I

SYMBOLS

Ba	Barite
B	Borates
Br	Bromine
Dia	Diatomite
Fl	Fluorspar
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

SYMBOLS

BC	Ball clay
Bent	Bentonite
Clay	Common clay
DS	Dimension stone
FC	Fire clay
Fel	Feldspar
Ful	Fuller's earth
IOP	Iron oxide pigments
IS	Industrial sand
Ka	Kaolin
Li	Lithium carbonate
Per	Perlite
Pum	Pumice and pumicite

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 $25.9 million. Bonded and coated abrasive products accounted for most abrasive uses of fused aluminum oxide and silicon carbide.

Salient Statistics—United States:	2009	2010	2011	2012	2013[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	64,200	185,000	223,000	231,000	228,000
Silicon carbide	78,000	143,000	129,000	100,000	108,000
Exports (U.S.):					
Fused aluminum oxide	12,300	20,000	19,900	19,100	23,500
Silicon carbide	20,700	23,100	27,800	20,000	17,700
Consumption, apparent (U.S.):					
Fused aluminum oxide	NA	NA	NA	NA	NA
Silicon carbide	92,300	155,000	136,000	115,000	125,000
Price, value of imports, dollars per ton (U.S.):					
Fused aluminum oxide, regular	608	555	627	560	643
Fused aluminum oxide, high-purity	1,170	1,300	1,360	1,080	721
Silicon carbide	557	793	1,260	877	1,080
Net import reliance[2] as a percentage of apparent consumption (U.S.):					
Fused aluminum oxide	NA	NA	NA	NA	NA
Silicon carbide	62	77	74	70	72

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

Import Sources (2009–12): Fused aluminum oxide, crude: China, 76%; Venezuela, 14%; Canada, 7%; and other, 3%. Fused aluminum oxide, grain: Brazil, 21%; Germany, 20%; Austria, 15%; Canada, 12%; and other, 32%. Silicon carbide, crude: China, 58%; South Africa, 17%; Netherlands, 7%; Romania, 7%; and other, 11%. Silicon carbide, grain: China, 44%; Brazil, 24%; Russia, 8%; Norway, 7%; and other, 17%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 2013, China was the world's leading producer of abrasive fused aluminum oxide and abrasive silicon carbide, with production 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 2013, these manufacturing sectors included the aerospace, automotive, furniture, housing, and steel industries, all of which experienced increased production. The U.S. abrasive markets also are influenced by economic and technological trends.

World Production Capacity:

	Fused aluminum oxide		Silicon carbide	
	2012	2013[e]	2012	2013[e]
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 2013, 5 companies operated 10 primary aluminum smelters; 3 smelters were closed temporarily for the entire year. Based on published market prices, the value of primary metal production was $4.07 billion. Aluminum consumption was centered in the East Central United States. Transportation accounted for an estimated 36% of domestic consumption; the remainder was used in packaging, 23%; building, 14%; electrical, 9%; machinery, 8%; consumer durables, 7%; and other, 3%.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production:					
Primary	1,727	1,726	1,986	2,070	1,950
Secondary (from old scrap)	1,260	1,250	1,470	1,440	1,650
Imports for consumption (crude and semimanufactures)	3,680	3,610	3,710	3,760	4,360
Exports, total	2,710	3,040	3,420	3,480	3,350
Consumption, apparent[2]	3,320	3,460	3,570	3,950	5,020
Price, ingot, average U.S. market (spot), cents per pound	79.4	104.4	116.1	101.0	94.7
Stocks:					
Aluminum industry, yearend	937	1,010	1,060	1,140	1,050
LME, U.S. warehouses, yearend[3]	2,200	2,230	2,360	2,120	1,800
Employment, number[4]	33,800	29,200	30,300	31,500	30,500
Net import reliance[5] as a percentage of apparent consumption	10	14	3	11	28

Recycling: In 2013, aluminum recovered from purchased scrap in the United States was about 3.27 million tons, of which about 56% came from new (manufacturing) scrap and 44% from old scrap (discarded aluminum products). Aluminum recovered from old scrap was equivalent to about 37% of apparent consumption.

Import Sources (2009–12): Canada, 61%; Russia, 7%; China, 5%; Mexico, 4%; and other, 23%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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: In February 2013, the owner of the 270,000-ton-per-year Hannibal, OH, smelter filed for chapter 11 bankruptcy protection, citing high power prices, low aluminum prices, high debt levels, and legacy costs. In August, two of the six potlines were shut down after a request for a lower rate for power was denied, leaving only 90,000 tons per year of capacity operating. The remaining capacity was shut down in October. In June, the Sebree, KY, smelter was sold as part of a corporate restructuring. Expansion of the smelter to 210,000 tons per year from 196,000 tons per year was still expected to be completed by yearend 2014. The expansion project had been delayed from 2012 owing to declining aluminum prices and uncertainty about demand for aluminum. In June, construction of an 85,000-ton-per-year potline began at a smelter in Massena, NY, that would replace a 40,000-ton-per-year potline subsequently shut down in August. By mid-November of 2013, domestic smelters operated at about 67% of rated or engineered capacity.

The monthly average U.S. market price for primary ingot quoted by Platts Metals Week started the year at $1.031 per pound but declined to $0.976 per pound in March. The monthly average price then trended downward to $0.918 per pound in July, before increasing to $0.923 per pound in August. The price then decreased to $0.892 per pound in September and then increased to $0.916 per pound in October. Prices on the London Metal Exchange (LME) followed the trend of U.S. market prices.

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ALUMINUM

Reliance upon imports of aluminum by U.S. manufacturers increased in 2013 as primary production declined and net imports increased. Canada, Russia, and the United Arab Emirates accounted for about 73% of total U.S. imports. Total aluminum exports (crude, semimanufactures, and scrap) from the United States decreased by 4% in 2013 compared with those in 2012, and total imports of aluminum were 14% higher than the amount imported in 2012. Imports of crude aluminum (metal and alloys) in 2013 were 22% higher than the amount imported in 2012. China, Mexico, Canada, and the Republic of Korea, in descending order, received approximately 83% of total United States exports. Scrap sent to China accounted for 37% of total aluminum exports.

World primary aluminum production increased by about 3% in 2013 compared with production in 2012. New capacity in China accounted for most of the increased production. World inventories of metal held by producers, as reported by the International Aluminium Institute, declined gradually to about 2.2 million tons at the end of August from about 2.3 million tons at yearend 2012. Despite a decline in U.S. LME inventories, global inventories of primary aluminum metal held by the LME increased during the year to 5.4 million tons in mid-October from 5.2 million tons at yearend 2012.

World Smelter Production and Capacity:

	Production		Yearend capacity	
	2012	2013[e]	2012	2013[e]
United States	2,070	1,950	2,720	2,680
Argentina	450	460	455	455
Australia	1,860	1,750	1,980	1,770
Bahrain	890	900	970	970
Brazil	1,440	1,330	1,700	1,700
Canada	2,780	2,900	3,020	2,880
China	20,300	21,500	26,900	30,200
Germany	410	400	620	620
Iceland	820	825	810	830
India	1,700	1,700	1,860	2,700
Mozambique	564	560	570	570
Norway	1,150	1,200	1,230	1,230
Qatar	604	600	610	610
Russia	3,850	3,950	4,450	4,450
South Africa	665	820	900	900
United Arab Emirates	1,820	1,800	1,850	2,350
Other countries	4,540	4,650	6,400	6,960
World total (rounded)	45,900	47,300	57,000	61,900

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 determine 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 and heat-exchange applications.

[e]Estimated.
[1]See also Bauxite and Alumina.
[2]Defined as 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 2013. Primary antimony metal and oxide was produced by one company in Montana, using imported feedstock. The estimated domestic distribution of primary antimony consumption was as follows: metal products, including antimonial lead and ammunition, 35%; nonmetal products, including ceramics and glass and rubber products, 35%; and flame retardants, 30%.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production:					
Mine (recoverable antimony)	—	—	—	—	—
Smelter:					
Primary	W	W	W	W	W
Secondary	3,020	3,520	3,230	3,730	3,500
Imports for consumption, ores and concentrates, oxide, and metal	20,200	26,200	23,500	22,600	25,000
Exports of metal, alloys, oxide, and waste and scrap[1]	2,100	2,540	4,170	4,710	4,500
Consumption, apparent[2]	21,200	27,000	22,700	21,700	24,000
Price, metal, average, cents per pound[3]	236	401	650	565	465
Stocks, yearend	1,420	1,560	1,430	1,430	1,400
Employment, plant, number (yearend)[e]	27	27	24	24	24
Net import reliance[4] as a percentage of apparent consumption	86	87	86	83	85

Recycling: Traditionally, the bulk of secondary antimony has been recovered at secondary lead smelters as antimonial lead, most of which was generated by, and then consumed by, the lead-acid battery industry.

Import Sources (2009–12): Metal: China, 74%; Mexico, 10%; India, 7%; and other, 9%. Ore and concentrate: Italy, 60%; China, 20%; Bolivia, 13%; and other, 7%. Oxide: China, 70%; Belgium, 9%; Bolivia, 9%; Mexico, 8%; and other, 4%. Total: China, 71%; Mexico, 9%; Belgium, 8%; Bolivia, 5%; and other, 7%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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.

Events, Trends, and Issues: In 2013, domestic antimony production was derived mostly from the recycling of 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 processed imported concentrates and oxides to make antimony products, and during the first 3 quarters of 2013 produced 336 tons of antimony metal.[5] The company that operated the smelter was substantially increasing its antinomy production capacity in Mexico by acquiring and expanding historically productive antimony mines and reaching supply agreements to acquire feedstock for its expanding mills and smelter. The company expected to produce about 300 tons of antimony metal at its smelter in Mexico in 2013, about 78% more than that in 2012, and planned to further increase production in 2014.

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ANTIMONY

In late 2012, an antimony mine in central Newfoundland, Canada, that had been the leading antimony producer in North America, was shut down owing to ore depletion. In late 2013, a Canadian exploration company acquired a number of claims near the closed mine and intended to complete a soil geochemical survey and prospecting program to determine if further development would be economically feasible.

China was the leading antimony producer in the world. The Chinese Government considered antimony to be one of the protected and strategic minerals, and mine production of antimony was controlled. In 2013, the Ministry of Land and Resources (MLR) allocated a total production quota of 98,000 tons (metal content) of mined antimony, compared with 74,400 tons in 2012. However, estimates of Chinese antimony mine production, as reported by the state-run China Nonferrous Metals Industry Association (CNIA), were greater than the official quotas. The MLR has refused any exploration or new mining applications related to antimony since 2009. Owing to the mining restrictions and increased smelting capacity, China's imports of antimony concentrates have increased substantially since 2009.

During the first 10 months of 2013, exports of antimony metal and antimony oxide from China decreased by 32% and 22% respectively compared with those in 2012, reportedly owing to decreased foreign demand. China's antimony metal production capacity was estimated to be 200,000 tons per year, but capacity utilization was thought to be relatively low. Late in 2013, 15 antimony smelters in China's Hunan Province announced plans to merge into a single company by early 2014, reportedly to consolidate production capacity. In November, the China State Reserve Bureau purchased 10,500 tons of antimony for the national stockpile, an increase from 4,500 tons in 2012. An official antimony industry association, a subsidiary of the CNIA, was expected to be established in 2014. One of the goals of the association was to help Chinese antimony producers develop more value-added downstream products instead of selling primary materials. In China, the flame retardant sector was the leading consumer of antimony and accounted for about 50% of the total, followed by battery alloys, plastic stabilizers, and glass.

The price of antimony trended downward during the first three quarters of 2013 and then increased during the fourth quarter. The antimony price started the year averaging $5.00 per pound in January, declined to $4.30 per pound in July, and increased to an average of $4.70 per pound in November.

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:

	Mine production		Reserves[6]
	2012	2013[e]	
United States	—	—	—
Bolivia	4,000	5,000	310,000
China	145,000	130,000	950,000
Russia (recoverable)	6,500	6,500	350,000
South Africa	3,800	4,200	27,000
Tajikistan	2,000	4,700	50,000
Other countries	13,000	13,000	150,000
World total (rounded)	174,000	163,000	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, Mexico, Russia, South Africa, and Tajikistan. 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]U.S. Antimony Corp., 2013, Antimony, gold and silver, zeolite production information: Thompson Falls, MT, U.S. Antimony Corp. (Accessed December 20, 2013, at http://www.usantimony.com/2013_production.htm.)
[6]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 U.S. 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 2013 was estimated to be about $6 million.

Salient Statistics—United States:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Imports for consumption:					
Metal	438	769	628	883	525
Trioxide	4,660	4,530	4,990	5,740	6,250
Exports, metal[1]	354	481	705	439	1,750
Estimated consumption[2]	5,100	5,300	5,620	6,620	6,780
Value, cents per pound, average[3]					
Metal (China)	121	72	74	75	73
Trioxide (Morocco)	20	20	22	24	26
Net import reliance[4] 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, although no arsenic was recovered from them during recycling to recover other contained metals. No arsenic was recovered domestically from arsenic-containing residues and dusts generated at nonferrous smelters in the United States.

Import Sources (2009–12): Metal: China, 87%; Japan, 12%; and other, 1%. Arsenic trioxide: Morocco, 67%; China, 20%; Belgium, 12%; and other, 1%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–13**
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.

Events, Trends, and Issues: Human health and environmental concerns continued to reduce the demand for arsenic compounds. A voluntary ban on the use of CCA wood preservatives in most residential applications, effective yearend 2003, significantly reduced demand in wood preservative applications. Owing to the residential ban, imports of arsenic trioxide declined to an average of 6,500 tons per year gross weight during 2008 to 2012, from an average of almost 28,000 tons per year during 1999 to 2003. Effective January 1, 2013, Maryland, a major poultry-producing State, prohibited the sale and use of poultry feed additives that contained arsenic. The principal producer of roxarsone, the organic arsenic compound added to poultry feed to kill parasites and promote growth, had already suspended its sales in the United States in July 2011. Concern over the adverse effects of arsenic from natural and anthropogenic sources in the human food chain has led to numerous studies of arsenic in fruit juices and rice. In September, the U.S. Food and Drug Administration released the results of a sampling study of arsenic contained in rice, a crop that is grown in water and that is susceptible to arsenic uptake. The FDA recommended that consumers vary their grain intake pending a study on the risks that arsenic in rice pose.

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ARSENIC

Given that arsenic metal has not been produced domestically since 1985, it is likely that only a small portion of the material reported by the U.S. Census Bureau as arsenic metal exports was pure arsenic metal, and most of the material that has been reported under this category reflects the gross weight of compounds, alloys, and residues containing arsenic. Reported arsenic metal exports from 2005 to 2008 were at extremely high levels, and were likely to have also included arsenic acid and CCA that became available for export following the phaseout of the residential use of CCA preserved wood. Therefore, the estimated consumption reported under salient U.S. statistics has been revised to reflect only imports of arsenic products.

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 2013, GaAs demand increased, still driven mainly by cellular handsets and other high-speed wireless applications, owing to rapid growth of feature-rich, application-intensive, third- and fourth-generation “smartphones.” See the “Gallium” chapter for details.

World Production and Reserves:

	Production (arsenic trioxide)		Reserves[5]
	2012	2013[e]	
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	26,000	25,000	
Morocco	8,000	7,000	
Russia	1,500	1,500	
Other countries[6]	200	200	
World total (rounded)	46,700	45,000	

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]Most of the materials reported to the U.S. Census Bureau as arsenic metal exports are arsenic-containing compounds and metal.
[2]Estimated to be the same as imports. Previously reported to be equal to net imports.
[3]Calculated from U.S. Census Bureau import data.
[4]Defined as imports.
[5]See Appendix C for resource/reserve definitions and information concerning data sources.
[6]Includes Bolivia, Japan, and Portugal. Mexico and Peru were significant producers of arsenic trioxide, but have reported no production in recent years.

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 950 tons, based on asbestos imports through July 2013. The chloralkali industry accounted for an estimated 67% of U.S. consumption; roofing products, 30%; and unknown applications, 3%.

Salient Statistics—United States:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Production (sales), mine	—	—	—	—	—
Imports for consumption	869	1,040	1,180	1,610	870
Exports[1]	59	171	169	47	25
Consumption, estimated	869	1,040	1,180	1,020	950
Price, average value, dollars per ton[2]	787	786	931	1,570	1,300
Net import reliance[3] as a percentage of estimated consumption	100	100	100	100	100

Recycling: None.

Import Sources (2009–12): Canada, 58%; Brazil, 41%; and other, 1%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12–31–13**
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 decreased by 46% and estimated consumption of asbestos decreased by 7% in 2013. The large decline in imports resulted from increased imports and a buildup of inventories in 2012 and a drawdown of stocks during 2013. All asbestos imported and used in the United States was chrysotile, solely sourced from Brazil in 2013. The average unit value of imports declined in 2013. Based on current trends, annual U.S. asbestos consumption is likely to be between 900 and 1,000 tons for the near future.

World Mine Production and Reserves: Reserves from Brazil were revised based on new information from the Instituto Brasileiro de Mineração.

	Mine production		Reserves[4]
	2012	2013[e]	
United States	—	—	Small
Brazil	307,000	300,000	11,000,000
China	420,000	400,000	Large
Kazakhstan	241,000	240,000	Large
Russia	1,000,000	1,000,000	Large
Other countries	300	300	Moderate
World total (rounded)	1,970,000	1,940,000	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 in asbestos-based products is more limited than long-fiber asbestos.

Substitutes: Numerous materials substitute for asbestos. 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 about 660,000 tons in 2013 valued at an estimated $78 million. Most of the production came from four major mines in Nevada; a significantly smaller sales volume came from a single mine in Georgia. In 2013, an estimated 2.6 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 fluids used in the drilling of oil and natural gas wells. The majority of Nevada crude barite was ground in Nevada and Wyoming and then sold primarily to exploration companies drilling in Colorado, New Mexico, North Dakota, Utah, and Wyoming. Crude barite was shipped to a Canadian grinding mill in Lethbridge, Alberta, which supplied 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 also is 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:	2009	2010	2011	2012	2013[e]
Sold or used, mine	396	662	710	666	660
Imports for consumption	1,430	2,110	2,320	2,920	2,130
Exports	49	109	98	151	190
Consumption, apparent[1] (crude and ground)	1,780	2,660	2,930	3,430	2,600
Consumption[2] (ground and crushed)	2,410	2,570	2,910	3,310	2,700
Estimated price, average value, dollars per ton, f.o.b. mine	80	77	86	112	115
Employment, mine and mill, number[e]	400	420	450	470	480
Net import reliance[3] as a percentage of apparent consumption	78	75	76	81	75

Recycling: None.

Import Sources (2009–12): China, 86%; India, 8%; Morocco, 3%; and other, 3%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
Ground barite	2511.10.1000	Free.
Crude barite	2511.10.5000	$1.25 per metric ton.
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: Because oil and gas drilling is the dominant use of barite in the United States, the count of operating drill rigs exploring for oil and gas is a good barometer of barite consumption or industry stockpiling. During 2013, the number of drill rigs operating in the United States was fairly constant, varying between 1,738 and 1,782. This was essentially unchanged from yearend 2012, but substantially below the peak of 2,031 reached in 2008. Estimated 2013 barite imports decreased by more than 25% compared with those of 2012, which was an indication of reduced demand and the result of possible stockpiling in 2012.

Barite mining projects, in various stages of development, were underway in Kazakhstan, Liberia, Mexico, Nigeria, Zimbabwe, and possibly in other countries. The dependency on a few major exporting countries and rising prices led to increased interest in developing new sources of barite. As a result, diversification in global barite supplies will likely increase.

Compared with those at yearend 2011, Chinese and Moroccan barite prices decreased in 2012 while Indian barite prices increased. The October published price range for Chinese unground barite, specific gravity 4.20, free on board (f.o.b.) China, was $120 to $140 per ton, a decrease of about $15 per ton. The price range for Moroccan unground barite, f.o.b. Morocco, was $105 to $130 per ton, a decrease of $28 per ton. The price range for Indian unground barite, f.o.b. Chennai, was $145 to $155 per ton, an increase of about $8 per ton.

World Mine Production and Reserves: Production estimates for individual countries were made using country-specific data where available; other estimates were made based on trade data and general knowledge of end-use markets. Reserves data for India, Kazakhstan, and Turkey were revised based on Government or industry information.

	Mine production		Reserves[4]
	2012	2013[e]	
United States	666	660	15,000
China	4,200	3,800	100,000
Germany	55	55	1,000
India	1,700	1,500	34,000
Iran	330	330	NA
Kazakhstan	250	250	85,000
Mexico	140	125	7,000
Morocco	1,000	850	10,000
Pakistan	52	50	1,000
Peru	76	75	NA
Russia	63	65	12,000
Thailand	70	70	18,000
Turkey	260	260	35,000
Vietnam	85	90	NA
Other countries	250	300	35,000
World total (rounded)	9,200	8,500	350,000

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.

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 consumed, 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, proppants, and refractories.

Salient Statistics—United States:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Production, bauxite, mine	NA	NA	NA	NA	NA
Imports of bauxite for consumption[2]	7,770	9,310	10,200	11,000	10,400
Imports of alumina[3]	1,860	1,720	2,160	1,790	2,170
Exports of bauxite[2]	45	54	76	42	19
Exports of alumina[3]	946	1,520	1,660	1,680	1,450
Consumption, apparent, bauxite and alumina (in aluminum equivalents)[4]	2,480	2,580	2,250	2,890	2,720
Price, bauxite, average value U.S. imports (f.a.s.) dollars per ton	28	27	30	28	28
Stocks, bauxite, industry, yearend[2]	1,780	95	272	440	540
Net import reliance,[5] bauxite and alumina, as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2009–12):[6] Bauxite: Jamaica, 45%; Guinea, 24%; Brazil, 21%; Guyana, 4%; and other, 6%. Alumina: Australia, 33%; Suriname, 31%; Brazil, 14%; Jamaica, 10%; and other, 12%. Total: Jamaica, 30%; Brazil, 18%; Guinea, 18%; Australia, 11%; and other, 23%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–13**
Bauxite, calcined (refractory grade)	2606.00.0030	Free.
Bauxite, calcined (other)	2606.00.0060	Free.
Bauxite, crude dry (metallurgical grade)	2606.00.0090	Free.
Alumina	2818.20.0000	Free.
Aluminum hydroxide	2818.30.0000	Free.

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

Government Stockpile: None

Events, Trends, and Issues: The average price (free alongside ship) for U.S. imports for consumption of metallurgical-grade alumina through August was $368 per ton, 3% less than the average price during the same period in 2012. During the first 8 months of the year, the price ranged between $351 per ton to $533 per ton. According to production data from the International Aluminium Institute, world alumina production through September 2013 increased by 5% compared with that of the same period in 2012. Bauxite production increased slightly in 2013 compared with production in 2012.

In February 2013, the owner of the 540,000-ton-per-year Burnside, LA, alumina refinery filed for chapter 11 bankruptcy protection, citing high power prices, low aluminum prices, high debt levels, and legacy costs. In August, the company shut down 360,000 tons per year of capacity at the refinery. It also shut down two of the six potlines at its 270,000-ton-per-year Hannibal, OH, smelter in August, in addition to the two potlines that were shut down in August 2012, leaving only 90,000 tons per year of capacity operating, which was subsequently shut down in October. In October, the owner entered into an agreement to sell the refinery, pending approval of the bankruptcy court.

Production from a 1.4-million-ton-per-year alumina refinery in Lanjigarh, India, was restarted in July at about 60% of its capacity. A shortage of bauxite was cited when the refinery shut down in December 2012. The refinery used bauxite purchased from other parts of India while the owner sought permits to mine nearby bauxite deposits.

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BAUXITE AND ALUMINA

Several companies were planning to build alumina refineries in Indonesia in response to a law restricting exportation of unprocessed mineral ores. A 20% tax on exports of unprocessed mineral ores was implemented in 2012, and exports would be banned after 2014. Many of the companies planning to build refineries in Indonesia were based in China, where the Government was encouraging companies to invest in power-intensive industries in other countries.

World Bauxite Mine Production and Reserves: The reserve estimates for India and several other countries have been revised based on new information available through Government reports and other sources.

	Mine production		Reserves[7]
	2012	2013[e]	
United States	NA	NA	20,000
Australia	76,300	77,000	6,000,000
Brazil	34,000	34,200	2,600,000
China	47,000	47,000	830,000
Greece	2,100	2,000	600,000
Guinea	17,800	17,000	7,400,000
Guyana	2,210	2,250	850,000
India	19,000	19,000	540,000
Indonesia	29,000	30,000	1,000,000
Jamaica	9,340	9,500	2,000,000
Kazakhstan	5,170	5,100	160,000
Russia	5,720	5,200	200,000
Suriname	3,400	3,400	580,000
Venezuela	2,000	2,500	320,000
Vietnam	100	100	2,100,000
Other countries	5,020	5,000	2,400,000
World total (rounded)	258,000	259,000	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 determine 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 yet 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.

[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 2009–12. For 2009–12, the U.S. net import reliance as a percentage of apparent consumption ranged from being a net exporter 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 250 tons was valued at about $114 million, based on the estimated unit value for beryllium in imported beryllium-copper master alloy. Based on sales revenues, 32% of beryllium alloy strip and bulk products was estimated to be used in industrial components and commercial aerospace applications, 20% in consumer electronics applications, 14% in automotive electronics applications, 12% in energy applications, 12% in telecommunications infrastructure applications, 8% in appliance applications, and 2% in defense and medical applications. Based on sales revenues, 52% of beryllium metal and beryllium composite products was estimated to be used in defense and science applications, 26% in industrial components and commercial aerospace applications, 8% in medical applications, 7% in telecommunications infrastructure applications, and the remaining 7% in other applications.

Salient Statistics—United States:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Production, mine shipments[e]	120	180	235	225	220
Imports for consumption[1]	24	271	92	100	61
Exports[2]	23	39	21	55	38
Government stockpile releases[3]	19	29	22	([4])	9
Consumption:					
Apparent[5]	170	456	333	265	250
Reported, ore	150	200	250	220	230
Unit value, annual average, beryllium-copper master alloy, dollars per pound contained beryllium[6]	154	228	203	204	209
Stocks, ore, consumer, yearend	30	15	10	15	20
Net import reliance[7] as a percentage of apparent consumption	29	61	29	15	11

Recycling: Beryllium was recovered from new scrap generated during the manufacture of beryllium products and from old scrap. Detailed data on the quantities of beryllium recycled are not available but may represent as much as 20% to 25% of apparent consumption. The leading U.S. beryllium producer established a comprehensive recycling program for all of its beryllium products, and indicated a 40% recovery rate of its beryllium alloy new and old scrap. Beryllium manufactured from recycled sources requires only 20% of the energy as that of beryllium manufactured from virgin sources.

Import Sources (2009–12):[1] Russia, 42%; Kazakhstan, 25%; China, 9%; Japan, 6%; and other, 18%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12–31–13**
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. The disposal limit for beryllium materials in the fiscal year 2014 Annual Materials Plan was beryllium metal, 16 tons of contained beryllium.

Stockpile Status—9–30–13[8]

Material	**Uncommitted inventory**	**Authorized for disposal**	**Disposal plan FY 2013**	**Disposals FY 2013**
Beryllium metal:				
Hot-pressed powder	73	28	—	9
Vacuum-cast	6	6	16	—

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BERYLLIUM

Events, Trends, and Issues: Market conditions were relatively unchanged for beryllium-based products in 2013. During the first 9 months of 2013, the leading U.S. beryllium producer reported the volume of shipments of strip and bulk beryllium-copper alloy products to be 4% higher and 6% lower, respectively, than those during the first 9 months of 2012. Sales of beryllium-copper alloy products for key large markets, including industrial components/commercial aerospace and consumer electronics, remained relatively unchanged from sales in the first 9 months of 2012, while the smaller automotive electronics market and beryllium hydroxide sales were greater. Sales of beryllium-copper alloy products for the remaining smaller markets, including energy and appliances, were lower. Overall, beryllium metal and beryllium composite sales decreased slightly during the first 9 months of 2013 from those in the same period of 2012, with the largest markets, defense and science, affected by reduced Government defense budgets.

The leading U.S. beryllium producer announced plans to significantly increase beryllium hydroxide production capacity at its operation in Delta, UT. The producer anticipated a worldwide decline of stockpiled beryllium within 3 years.

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.

World Mine Production and Reserves:

	Mine production[e]		Reserves[9]
	2012	2013	
United States	225	220	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 15,000 tons of contained beryllium. World beryllium reserves are not available.
China	20	20	
Mozambique	2	2	
Other countries	1	1	
World total (rounded)	250	240	

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 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. — Zero.
[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.

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 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. In 2013 the value of reported consumption of bismuth was approximately $17 million.

Chemical production accounted for about two thirds of domestic bismuth consumption, principally in pharmaceutical applications. Bismuth use in pharmaceuticals included bismuth salicylate (the active ingredient in over-the-counter stomach remedies) and other bismuth medicinal compounds used to treat burns, intestinal disorders, and stomach ulcers in humans and animals. Other applications of bismuth chemicals and compounds included uses in superconductors and pearlescent pigments for cosmetics and paints. Bismuth has a wide variety of metallurgical applications, including use as a nontoxic replacement for lead in brass, free-machining steels, and solders. Bismuth is used as an additive to enhance metallurgical quality in the foundry industry, as a triggering mechanism for fire sprinklers, and in holding devices for grinding optical lenses.

Salient Statistics—United States:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Production:					
Refinery	—	—	—	—	—
Secondary (old scrap)	60	80	80	80	80
Imports for consumption, metal	1,250	1,620	1,750	1,700	1,700
Exports, metal, alloys, and scrap	397	1,040	628	764	850
Consumption:					
Reported[e]	812	636	696	899	900
Apparent	1,010	660	1,200	1,020	930
Price, average, domestic dealer, dollars per pound	7.84	8.76	11.47	10.10	8.70
Stocks, yearend, consumer	134	133	138	134	130
Net import reliance[1] as a percentage of apparent consumption	94	88	93	92	91

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

Import Sources (2009–12): China, 55%; Belgium, 37%; United Kingdom, 3%; Korea, 2% and other, 3%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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: 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 opened for bismuth as a metallurgical additive to lead-free pipe fittings and fixtures, and bismuth use in water meters and fixtures 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 new application is the use of a bismuth-tellurium oxide alloy film paste for use in the manufacture of semiconductor devices. Bismuth also was used domestically in the manufacture of ceramic glazes, crystal ware, and pigments, and as an additive to free-machining steels and malleable iron castings. Researchers in the European Union, Japan, and the United States continued to investigate the use of bismuth in lead-free solders. Research examining liquid lead-bismuth coolants for use in nuclear reactors was also ongoing. Work was proceeding toward developing a bismuth-containing metal-polymer bullet.

In Peru, the La Oroya Metallurgical complex, which was shuttered in 2009 owing to financial and environmental problems, was undergoing restructuring in lieu of liquidation. Zinc production was reported to have begun in July 2012 and the lead smelter reportedly resumed operations during the first half of 2013. Although prior to the shutdown the La Oroya complex had been a significant producer of bismuth, it was uncertain whether bismuth production had resumed. Canadian production dropped significantly, owing to ore depletion and closure of the Bathurst Mine (lead-zinc) in northern New Brunswick.

The price of bismuth, which had trended downward during 2012, started 2013 at $8.40 per pound, decreased to a low of $7.68 per pound in August, and ended November at $9.30 per pound. The estimated average price of bismuth in 2013 was about 14% less than that in 2012. Industry analysts attributed the lower price to decreased world demand.

World Mine Production and Reserves:

	Mine production		Reserves[2]
	2012	2013[e]	
United States	—	—	—
Bolivia	50	10	10,000
Canada	121	50	5,000
China	7,000	6,500	240,000
Mexico	940	940	10,000
Other countries	77	90	50,000
World total (rounded)	8,200	7,600	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 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 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 unless otherwise noted)

Domestic Production and Use: Two companies in southern California produced borates in 2013, 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 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 2013, the glass and ceramics industries remained the leading domestic users of boron products, consuming an estimated 80% of total borates consumption. Boron also was used as a component in abrasives, cleaning products, insecticides, and in the production of semiconductors.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production	W	W	W	W	W
Imports for consumption, gross weight:					
Borax	([1])	([1])	2	2	2
Boric acid	36	50	57	55	60
Colemanite	31	50	20	28	30
Ulexite	28	1	5	12	10
Exports, gross weight:					
Boric acid	171	264	235	190	190
Refined sodium borates	417	423	492	456	460
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	540	485	579	569	570
Employment, number	1,310	1,220	1,180	1,180	1,190
Net import reliance[2] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (2009–12): Borates: Turkey, 78%; China, 4%; Argentina, 3%; Austria, 3%; and other, 12%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 borate minerals—colemanite, kernite, tincal, and ulexite—make up 90% of the borate minerals used by industry worldwide. Although borates were used in more than 300 applications, more than three-quarters of the world's supply is consumed in ceramics, detergents, fertilizer, and glass.

Consumption of borates is expected to increase in 2013 and the coming years, spurred by demand in the Asian and South American agricultural, ceramic, and glass markets. World consumption of borates was projected to reach 2.0 million tons of B_2O_3 by 2014, compared with 1.5 million 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[3]		Reserves[4]
	2012	2013[e]	
United States	W	W	40,000
Argentina	650	700	2,000
Bolivia	130	130	NA
Chile	444	450	35,000
China	160	160	32,000
Kazakhstan	30	30	NA
Peru	104	200	4,000
Russia	400	250	40,000
Turkey	2,500	3,000	60,000
World total (rounded)	[5]4,420	[5]4,900	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]Less than ½ unit.
[2]Defined as imports – exports.
[3]Gross weight of ore in thousand metric tons.
[4]See Appendix C for resource/reserve definitions and information concerning data sources.
[5]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 also is 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:	2009	2010	2011	2012	2013[e]
Production	W	W	W	W	W
Imports for consumption, elemental bromine and compounds[1]	36,000	45,400	47,300	53,100	46,000
Exports, elemental bromine and compounds	6,130	8,150	7,150	6,430	5,000
Consumption, apparent	W	W	W	W	W
Employment, number[e]	1,000	950	950	950	950
Net import reliance[2] as a percentage of apparent consumption	<25	<25	<25	<25	<25

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 (2009–12): Israel, 79%; China, 11%; Germany, 5%; and other, 5%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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, especially Israel and Jordan, strengthened their positions as world producers of elemental bromine. In March 2013, a project in Jordan was completed to double capacity to 100,000 tons per year at the joint-venture bromine operation of a United States bromine company and a Jordanian company. China also is a significant bromine producer; environmental restrictions to protect farmland, limits to plant expansions, and shutdowns of unlicensed bromine operations have stabilized production levels in China. Although companies did not announce prices for bromine and bromine compounds in 2013, prices were thought to have remained relatively stable.

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, although the company in Jordan reports bromine production capacity of about 100,000 tons.

The leading use of bromine is in flame retardants; this use, however, 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 by 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: Because revised data indicated that bromine had not been produced in Spain since 1999, the country was removed from this table, although large bromine reserves may exist there.

	Production		Reserves[3]
	2012	2013[e]	
United States	W	W	11,000,000
Azerbaijan	3,500	3,500	300,000
China	100,000	100,000	NA
Germany	1,500	1,500	NA
India	1,500	1,500	NA
Israel	174,000	180,000	NA
Japan	20,000	20,000	NA
Jordan	200,000	250,000	NA
Turkmenistan	150	480	700,000
Ukraine	4,100	4,100	NA
World total (rounded)	[4]505,000	[4]560,000	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.
[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: Three companies in the United States produced refined cadmium in 2013. One company, operating in Tennessee, recovered primary cadmium as a byproduct of zinc leaching from roasted sulfide concentrates. The other two companies, operating in Ohio and 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, NiCd batteries, pigments, and plastic stabilizers.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production, refinery[1]	633	637	W	W	W
Imports for consumption:					
Metal	117	216	201	170	300
Alloys	5	5	9	21	200
Scrap	—	([2])	([2])	1	—
Exports:					
Metal	276	75	63	253	160
Alloys	249	231	204	378	210
Scrap	137	—	5	—	20
Consumption of metal, apparent	199	477	W	W	W
Price, metal, annual average,[3] dollars per kilogram	2.87	3.90	2.76	2.03	1.95
Stocks, yearend, producer and distributor	27	102	W	W	W
Net import reliance[4] as a percentage of apparent consumption	E	E	E	E	<25%

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 available.

Import Sources (2009–12): Metal:[5] Australia, 24%; Mexico, 19%; Canada, 14%; Germany, 11%; and other, 32%.

Tariff: Item	Number	Normal Trade Relations[6] 12–31–13
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: Most of the world's primary cadmium metal was produced in Asia. Leading producers were China, the Republic of Korea, and Japan. Secondary production accounted for about 20% of global production.

Cadmium was primarily consumed in China, Belgium, and Japan. Cadmium for NiCd batteries accounted for more than 80% of global consumption, and 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 share of cadmium consumed globally for NiCd battery production has been increasing, while the shares for the traditional end uses of cadmium—specifically coatings, pigments, and stabilizers—have gradually decreased owing to environmental and health concerns.

The U.S. market price for 99.95%-purity cadmium remained stable during the first quarter of 2013, averaging $1.83 per kilogram for the months of January through March. Subsequently, prices rose, averaging $1.88 per kilogram in April and reaching $1.98 per kilogram in July, where they remained through September.

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CADMIUM

In February, a major global aircraft manufacturer announced that it no longer planned to equip its new aircraft with lithium-ion (Li-ion) batteries and instead would revert back to the use of NiCd batteries. The announcement was made after the U.S. Federal Aviation Administration grounded an aircraft in January following two fire incidents originating from Li-ion batteries. Another company modified its Li-ion battery technology to avoid further incidents.

In October, the European Union (EU) amended Directive 2006/66/EC to prohibit the use of NiCd batteries in cordless power tools. The original directive prohibited the inclusion of NiCd batteries in electronic devices for sale within the EU, with the exception of cordless power tools, emergency systems, and medical equipment. The revision to end the exemption on power tools was to take effect on January 31, 2016.

World Refinery Production and Reserves:

	Refinery production		Reserves[7]
	2012	2013[e]	
United States	W	W	32,000
Australia	380	380	NA
Bulgaria	420	420	NA
Canada	1,100	800	23,000
China	7,300	7,400	92,000
India	620	630	35,000
Japan	1,800	1,900	—
Kazakhstan	1,300	1,400	30,000
Korea, Republic of	3,000	3,900	—
Mexico	1,624	1,630	47,000
Netherlands	560	560	—
Peru	684	685	55,000
Poland	530	400	16,000
Russia	700	850	44,000
Other countries	880	850	130,000
World total (rounded)	[8]20,900	[8]21,800	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 cadmium, which shares certain similar chemical properties with zinc and often substitutes 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: Li-ion and nickel-metal hydride batteries are replacing NiCd batteries in some applications. However, the higher cost of these alternatives 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]Less than ½ unit.
[3]Average New York dealer price for 99.95% purity in 5-short-ton lots. Source: Platts Metals Week.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]Imports for consumption of unwrought metal and metal powders (Tariff no. 8107.20.0000).
[6]No tariff for Australia, Canada, Mexico, and Peru for items shown.
[7]See Appendix C for resource/reserve definitions and information concerning data sources.
[8]Does not include production in Italy, North Korea, and the United States.

CEMENT

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2013, domestic production of cement totaled about 75.1 million tons of portland cement and 2.1 million tons of masonry cement; output was from 98 plants in 34 States. Cement also was produced at two plants in Puerto Rico. Production continued to be very low compared with the record level of 99 million tons in 2005, and reflected continued full-time idle status at several plants, underutilized capacity at many others, and plant closures. Cement sales improved markedly in 2013, but were still about 44 million tons below the record volumes in 2005. The overall value of sales was about $7.6 billion. Most of the sales of cement were to make concrete, worth at least $45 billion. As in recent years, about 70% of cement sales went to ready-mixed concrete producers, 11% to concrete product manufacturers, 9% to contractors (mainly road paving), 4% each to oil and gas well drillers and to building materials dealers, and 2% to other users. Texas, California, Missouri, Florida, and Michigan were, in descending order, the five leading cement-producing States and accounted for 47% U.S. production.

Salient Statistics—United States:[1]	2009	2010	2011	2012	2013[e]
Production:					
Portland and masonry cement[2]	63,907	66,447	67,895	74,151	77,200
Clinker	56,116	59,802	61,241	67,173	69,300
Shipments to final customers, includes exports	71,489	71,169	73,402	79,951	83,600
Imports of hydraulic cement for consumption	6,211	6,013	5,812	6,107	6,300
Imports of clinker for consumption	556	613	606	786	840
Exports of hydraulic cement and clinker	884	1,178	1,414	1,749	1,300
Consumption, apparent[3]	71,500	71,200	72,200	77,900	82,100
Price, average mill value, dollars per ton	99.00	92.00	89.50	89.50	91.00
Stocks, cement, yearend	6,080	6,180	6,270	6,920	7,000
Employment, mine and mill, number[e]	13,000	12,000	11,500	10,500	10,300
Net import reliance[4] as a percentage of apparent consumption	8	8	7	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 construction aggregate.

Import Sources (2009–12):[5] Canada, 51%; Republic of Korea, 17%; China, 8%; Mexico, 5%; and other, 19%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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: Sales of cement improved significantly in 2013 owing to higher spending levels for new residential construction and for nonresidential buildings. Public sector construction remained below the already low levels of 2012. Continued high numbers of home foreclosures and high levels of unemployment constrained spending levels despite higher housing prices and assessments and associated improvements in property tax revenues to the States. Imports of cement were slightly higher during the year. Although increasing, cement production remained well below capacity at almost all plants, and most multikiln plants continued to operate only one kiln in 2013. Following the 2012 closure of one active integrated plant, one active grinding plant, and the announced closure of two already idle integrated plants and one idle grinding plant, no plant closures were announced in 2013 and no new plants opened during the year. Whereas three plants changed ownership in 2012, no such sales were announced in 2013.

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CEMENT

The manufacture of clinker for cement releases a great deal of carbon dioxide. The results of the second mandatory reporting survey (2011) of the cement industry's greenhouse gas emissions were released by the U.S. Environmental Protection Agency in early 2013 and revealed that most U.S. cement plants not already so equipped had installed continuous emissions monitoring systems during the previous year. 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, but widespread use of limestone addition was not evident in 2013. 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 granted 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]	
	2012	2013[e]	2012	2013
United States (includes Puerto Rico)	74,900	77,800	106,000	105,000
Brazil	68,800	70,000	57,000	60,000
China	2,210,000	2,300,000	1,800,000	1,900,000
Egypt	46,100	46,000	46,000	46,000
Germany	32,400	34,000	31,000	31,000
India	270,000	280,000	270,000	280,000
Indonesia	32,000	35,000	47,500	50,000
Iran	70,000	75,000	75,000	80,000
Italy	33,000	29,000	46,000	46,000
Japan	51,300	53,000	55,000	55,000
Korea, Republic of	48,000	49,000	50,000	50,000
Mexico	35,400	36,000	42,000	42,000
Pakistan	32,000	32,000	42,500	42,000
Russia	61,500	65,000	80,000	80,000
Saudi Arabia	50,000	50,000	55,000	55,000
Thailand	37,000	35,000	50,000	50,000
Turkey	63,900	70,000	66,900	67,000
Vietnam	60,000	65,000	68,000	70,000
Other countries (rounded)	524,000	597,000	312,000	291,000
World total (rounded)	3,800,000	4,000,000	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.

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. 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, and as 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 2013, one company offered 1-gram ampoules of 99.8% (metal basis) cesium for $57.40 each and 99.98% (metal basis) cesium for $70.60, an increase of 3.4% and 3.5%, respectively, from those of 2012. The price for 50 grams of 99.8% (metals basis) cesium was $708.00, and 100 grams of 99.98% (metal basis) cesium was priced at $1,942.00, an increase of 3.5% from those of 2012 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. No data are available on the amount used or recovered.

Import Sources (2009–12): Canada is the chief source of pollucite concentrate imported by the United States.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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, which in turn would increase prices. Commercially useful quantities of inexpensive cesium are available as a byproduct of lithium production. 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.

Increases in radioactive cesium were measured in October as construction and repair continued outside of Fukushima No. 1 nuclear plant in Japan. Areas inside the silt fence containment area, an artificial bay designed to prevent movement of contaminated sea water, were exposed to contaminated soil and water as cleanup crews attempted to solidify soil around the facility to prevent contaminated groundwater from flowing into the bay.

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; exploration of those deposits was scheduled to begin in November of 2013. Zimbabwe produced cesium in small quantities as a byproduct of lithium operations.

	Reserves[1]
Canada	99,000,000
Zimbabwe	64,000,000
Other countries	NA
World total (rounded)	160,000,000

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 2013, 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. Stainless steels and superalloys require chromium. The value of chromium material consumption in 2012 was $952 million as measured by the value of net imports, excluding stainless steel, and was expected to be about $780 million in 2013.

Salient Statistics—United States:[1]	**2009**	**2010**	**2011**	**2012**	**2013**[e]
Production:					
Mine	—	—	—	NA	NA
Recycling[2]	141	144	147	146	236
Imports for consumption	273	499	531	554	459
Exports	280	274	232	234	224
Government stockpile releases	25	15	4	4	4
Consumption:					
Reported (includes recycling)	369	396	400	402	493
Apparent[3] (includes recycling)	160	384	450	470	471
Unit value, average annual import (dollars per metric ton):					
Chromite ore (gross quantity)	227	212	355	392	360
Ferrochromium (chromium content)	2,085	2,564	2,603	2,362	2,195
Chromium metal (gross quantity)	9,896	11,322	14,090	13,333	11,379
Stocks, yearend, held by U.S. consumers	7	7	8	8	8
Net import reliance[4] as a percentage of apparent consumption	12	63	67	69	50

Recycling: In 2013, recycled chromium (contained in reported stainless steel scrap receipts) accounted for 50% of apparent consumption.

Import Sources (2009–12): Chromite mineral: South Africa, 100%. Chromium-containing scrap: Canada, 61%; Mexico, 34%; and other, 5%. Chromium primary metal: South Africa, 29%; Kazakhstan, 20%; Russia, 12%; China, 5%; and other 34%. Total imports: South Africa, 36%; Kazakhstan, 16%; Russia, 10%; Mexico, 5%; and other, 33%.

Tariff:[5] **Item**	**Number**	**Normal Trade Relations 12–31–13**
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 FY 2014, the DLA Strategic Materials announced maximum disposal limits for chromium materials of 88,050 t of ferrochromium and 454 t of chromium metal.

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CHROMIUM

Stockpile Status—9–30–13[6]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2013	Disposals FY 2013	Average chromium content
Ferrochromium:					
High-carbon	88.6	—	[7]90.7	*8.92	71.4%
Low-carbon	45.6	—	([7])	*5.24	71.4%
Chromium metal	4.09	—	0.454	—	100%

<u>Events, Trends, and Issues</u>: China is the leading chromium-consuming country and the leading stainless steel producer. Chromium is consumed in the form of ferrochromium to produce stainless steel. China produced 17 to 18 million metric tons of stainless steel and produced 3 million metric tons of high-carbon ferrochromium, the leading chromium ferroalloy used to make stainless steel. Anticipating a 500,000 ton-per-year-increase in stainless steel production, China's ferrochromium industry increased production capacity by 1.5 million metric tons. China's chromite ore imports were expected to increase to support increased ferrochromium production as were its ferrochromium imports to supplement that domestically produced for stainless steel production. South Africa was the leading chromite ore and ferrochromium producer upon whom world stainless steel producers depend directly or indirectly for chromium supply. South Africa's electrical power generating group declared an emergency because of the country's constrained electrical power supply. The power group negotiated short-term buyback deals with ferrochromium producers.

<u>World Mine Production and Reserves</u>:

	Mine production[8]		Reserves[9]
	2012	2013[e]	(shipping grade)[10]
United States	NA	NA	620
India	3,900	3,900	54,000
Kazakhstan	4,000	4,000	230,000
South Africa	11,000	11,000	200,000
Other countries	6,700	7,100	NA
World total (rounded)	25,600	26,000	>480,000

<u>World Resources</u>: 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.

<u>Substitutes</u>: 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.
*Corrections posted on

CLAYS

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2013, 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 61% of the tonnage and 85% of the value for all types of clay sold or used in the United States. In 2013, sales or use was estimated to be 25.9 million tons valued at $1.58 billion. Uses for specific clays were estimated to be as follows: ball clay—44% floor and wall tile, 18% sanitaryware, and 38% other uses; bentonite—33% absorbents, 20% drilling mud, 11% iron ore pelletizing, 13% foundry sand bond, and 23% other uses; common clay—45% brick, 23% lightweight aggregate, 24% cement, and 8% other uses; fire clay—40% heavy clay products and 60% refractory products and other uses; fuller's earth—72% absorbent uses and 28% other uses; and kaolin—48% paper and 52% other uses.

Salient Statistics—United States:[1]	2009	2010	2011	2012	2013[e]
Production (sold or used):					
Ball clay	831	912	886	973	1,000
Bentonite	3,650	4,600	4,990	4,980	4,950
Common clay	12,500	11,900	11,700	11,700	11,800
Fire clay	320	216	215	183	185
Fuller's earth[2]	2,010	2,050	1,950	1,980	2,040
Kaolin	5,290	5,950	5,950	5,980	5,950
Total[2, 3]	24,500	25,600	25,700	25,800	25,900
Imports for consumption:					
Artificially activated clay and earth	27	28	31	31	20
Kaolin	281	510	549	472	310
Other	17	17	13	21	60
Total[3]	325	555	593	524	390
Exports:					
Ball clay	35	45	49	74	65
Bentonite	709	953	1,020	1,040	950
Fire clay[4]	328	404	371	289	290
Fuller's earth	90	100	102	105	100
Kaolin	2,290	2,470	2,490	2,450	2,500
Clays, not elsewhere classified	374	382	209	213	300
Total[3]	3,830	4,360	4,240	4,170	4,200
Consumption, apparent	21,000	21,800	22,100	22,200	22,100
Price, average, dollars per ton:					
Ball clay	45	46	46	46	47
Bentonite	57	58	61	62	65
Common clay	13	12	12	10	10
Fire clay	37	28	29	27	27
Fuller's earth	103	98	100	92	92
Kaolin	135	137	143	146	151
Employment, number:					
Mine	875	828	810	900	820
Mill	4,540	4,400	4,200	4,350	4,350
Net import reliance[5] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (2009–12): Brazil, 83%; Canada, 6%; Mexico, 4%; and other, 7%.

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CLAYS

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 was likely to result in slightly increased sales of common clay for heavy clay products and ball clay for ceramic tile and sanitaryware manufacture. Bentonite sales declined slightly because sales to most markets, except pet litter, appeared to have declined. Fuller's earth saw slight gains, mainly because of sales increases for pet litters and fluid purification applications. Kaolin production decreased slightly because refractory markets declined slightly and paper markets remained unchanged.

World Mine Production and Reserves:[6] Global reserves are large and distributed throughout many countries, but country-specific data are not available.

	Mine production					
	Bentonite		Fuller's earth		Kaolin	
	2012	2013[e]	2012	2013[e]	2012	2013[e]
United States (sales)	4,980	4,950	[2]1,980	[2]2,040	5,980	5,950
Brazil (beneficiated)	567	570	—	—	1,950	2,050
Czech Republic (crude)	221	220	—	—	3,320	3,300
Germany (sales)	375	350	—	—	4,900	4,500
Greece (crude)	800	1,200	—	—	—	—
Italy	110	100	3	3	640	640
Mexico	54	50	108	100	163	160
Spain	115	110	591	590	303	300
Turkey	400	400	—	—	1,200	2,000
Ukraine (crude)	210	210	—	—	1,300	1,600
United Kingdom (sales)	—	—	—	—	900	900
Uzbekistan (crude)	15	15	—	—	7,000	7,000
Other countries	2,100	2,100	299	270	8,540	8,600
World total (rounded)	9,950	10,300	[2]2,980	[2]3,000	36,200	37,000

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 48% of the cobalt consumed in the United States was used in superalloys, mainly in aircraft gas turbine engines; 9% in cemented carbides for cutting and wear-resistant applications; 16% in various other metallic applications; and 27% in a variety of chemical applications. The total estimated value of cobalt consumed in 2013 was $250 million.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production:					
Mine	—	—	—	—	—
Secondary	1,790	2,000	2,210	2,160	2,200
Imports for consumption	7,680	11,100	10,600	11,100	10,800
Exports	2,440	2,640	3,390	3,760	3,700
Shipments from Government stockpile excesses[1]	180	-8	—	—	—
Consumption:					
Reported (includes secondary)	7,470	8,030	9,100	8,420	8,400
Apparent[2] (includes secondary)	7,580	10,300	9,230	9,520	9,300
Price, average, dollars per pound:					
Spot, cathode[3]	17.86	20.85	17.99	14.07	12.90
London Metal Exchange (LME), cash	XX	XX	16.01	13.06	12.30
Stocks, yearend:					
Industry	780	880	1,040	970	1,000
LME, U.S. warehouse	XX	23	43	51	50
Net import reliance[4] as a percentage of apparent consumption	76	81	76	77	76

Recycling: In 2013, cobalt contained in purchased scrap represented an estimated 26% of cobalt reported consumption.

Import Sources (2009–12): Cobalt contained in metal, oxide, and salts: China, 21%; Norway, 13%; Russia, 11%; Finland, 9%; and other, 46%.

Tariff: Item	Number	Normal Trade Relations[5] 12–31–13
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—9–30–13[6]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2013	Disposals FY 2013
Cobalt	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 add to supply. China was the world's leading producer of refined cobalt and the leading supplier of cobalt imports to the United States. Much of China's production was from cobalt-rich ore and partially refined cobalt imported from Congo (Kinshasa). In recent years, China has been drawing down significant stocks of cobalt feed that had accumulated from 2009 through 2011.

During the first 6 months of 2013, world availability of refined cobalt (as measured by production) was 11% higher than that of the same period in 2012. China showed a large increase in production and an operation in Madagascar that began production during the second half of 2012 ramped up production.

Worldwide cobalt inventories in London Metal Exchange (LME) warehouses increased to 527 tons in late November 2013 from 429 tons at yearend 2012.

World Mine Production and Reserves: Reserves for Australia were revised based on Government information. Reserves for Canada, Morocco, New Caledonia, and the United States were revised based on company reports.

	Mine production		Reserves[7]
	2012	2013[e]	
United States	—	—	36,000
Australia	5,880	6,500	[8]1,000,000
Brazil	3,900	3,900	89,000
Canada	6,630	8,000	260,000
China	7,000	7,100	80,000
Congo (Kinshasa)	51,000	57,000	3,400,000
Cuba	4,900	4,300	500,000
Morocco	1,800	2,100	18,000
New Caledonia[9]	2,620	3,300	200,000
Russia	6,300	6,700	250,000
Zambia	4,200	5,200	270,000
Other countries	8,820	13,000	1,100,000
World total (rounded)	103,000	120,000	7,200,000

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 terrestrial cobalt resources are about 25 million tons. The vast majority of these resources are in sediment-hosted stratiform copper deposits in Congo (Kinshasa) and Zambia; nickel-bearing laterite deposits in Australia and nearby island countries and Cuba; and magmatic nickel-copper sulfide deposits hosted in mafic and ultramafic rocks in Australia, Canada, Russia, and the United States. More than 120 million tons of cobalt resources have been identified in manganese nodules and crusts on the floor of the Atlantic, Indian, and Pacific Oceans.

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, 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 Daily (formerly 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 520,000 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 2013 increased by 4% to about 1.22 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 Idaho and Missouri. Twenty-seven 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 2013. 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, 44%; electric and electronic products, 20%; transportation equipment, 17%; consumer and general products, 12%; and industrial machinery and equipment, 7%.[1]

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production:					
Mine	1,180	1,110	1,110	1,170	1,220
Refinery:					
Primary	1,110	1,060	992	962	960
Secondary	46	38	37	39	54
Copper from all old scrap	138	143	153	163	170
Imports for consumption:					
Ores and concentrates	(2)	1	15	6	(2)
Refined	664	605	670	630	770
General imports, refined	645	583	649	628	760
Exports:					
Ores and concentrates	151	137	252	301	350
Refined	81	78	40	159	95
Consumption:					
Reported, refined	1,650	1,760	1,760	1,760	1,800
Apparent, unmanufactured[3]	1,580	1,760	1,730	1,770	1,770
Price, average, cents per pound:					
Domestic producer, cathode	241.2	348.3	405.9	367.3	340
London Metal Exchange, high-grade	233.6	341.7	399.8	360.6	332
Stocks, yearend, refined, held by U.S. producers, consumers, and metal exchanges	434	384	409	236	270
Employment, mine and mill, thousands	8.3	9.5	10.6	11.5	12.0
Net import reliance[4] as a percentage of apparent consumption	21	32	34	36	36

Recycling: Old scrap, converted to refined metal and alloys, provided 170,000 tons of copper, equivalent to 9% of apparent consumption. Purchased new scrap, derived from fabricating operations, yielded 640,000 tons of contained copper. Of the total copper recovered from scrap (including aluminum- and nickel-based scrap), brass mills recovered 74%; miscellaneous manufacturers, foundries, and chemical plants, 11%; ingot makers,10%; and copper smelters and refiners, 5%. Copper in all old and new, refined or remelted scrap contributed about 32% of the U.S. copper supply.

Import Sources (2009–12): Unmanufactured: Chile, 54%; Canada, 24%; Peru, 11%; Mexico, 9%; and other, 2%. Refined copper accounted for 85% of unwrought copper imports.

Tariff: Item	Number	Normal Trade Relations[5] 12–31–13
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: The COMEX spot copper price began 2013 at $3.72 per pound of copper, rose to $3.78 per pound in February, and declined to a low of $3.03 per pound in June before averaging $3.28 per pound in October. Copper prices on average trended downward during the year in large part owing to slower economic growth

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COPPER

in China and expectations that the U.S. Federal Reserve would begin cutting its bond purchases during 2013. At the end of September, domestic stocks were 17% greater than those at yearend 2012. The International Copper Study Group (ICSG)[6] projected that global refined copper production in 2013 would exceed demand by about 390,000 tons. Global production of refined copper was projected to increase by 3.9% and consumption was projected to remain essentially unchanged.

U.S. mine production increased by about 4% in 2013, mainly owing to a significant increase in production in Utah, but smaller production increases occurred in all other copper-producing states. In April, a rock slide at the Bingham Canyon Mine in Utah temporarily halted production. Despite the interruption, Bingham Canyon Mine production was expected to increase during 2013. Total U.S. refined production was estimated to remain essentially unchanged. In 2014, domestic mine and refined production of copper were expected to increase significantly, and according to ICSG projections, global refined copper output was expected to exceed demand owing to more modest demand growth in China and a 5.5% growth in global refined production.

World Mine Production and Reserves: Reserves for Peru were revised based on new company and Government information.

	Mine production		Reserves[7]
	2012	2013[e]	
United States	1,170	1,220	39,000
Australia	958	990	[8]87,000
Canada	579	630	10,000
Chile	5,430	5,700	190,000
China	1,630	1,650	30,000
Congo (Kinshasa)	600	900	20,000
Indonesia	360	380	28,000
Kazakhstan	424	440	7,000
Mexico	440	480	38,000
Peru	1,300	1,300	70,000
Poland	427	430	26,000
Russia	883	930	30,000
Zambia	690	830	20,000
Other countries	2,000	2,000	90,000
World total (rounded)	16,900	17,900	690,000

World Resources: A 1998 USGS assessment estimated 550 million tons of copper contained in identified and undiscovered resources in the United States.[9] A USGS global assessment of porphyry copper deposits, the most significant source of mined copper, indicated that known resources contain about 1.8 billion tons of copper, some of which has already been extracted, and undiscovered resources contain an estimated 3.1 billion tons.[10] (For a listing of USGS regional copper resource assessments, go to: http://minerals.usgs.gov/global.) 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 2012 by the Copper Development Association, Inc., 2013.
[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, 2013, Forecast 2013–2014: Lisbon, Portugal, International Copper Study Group press release, October 2, 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 24 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]Hammarstrom, J.M., and others, 2013, Undiscovered porphyry copper resources–A global assessment [abs.]: The Geological Society of America Annual Meeting and Exposition, 125th, Denver, Colo., October 27–30, 2013, Paper no. 236-2. (Also available at https://gsa.confex.com/gsa/2013AM/webprogram/Paper226200.html.)

DIAMOND (INDUSTRIAL)

(Data in million carats unless otherwise noted)

Domestic Production and Use: In 2013, 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 37.3 million carats. The following industry sectors were the major consumers of industrial diamond: computer chip production, construction, machinery manufacturing, mining services (drilling for mineral, natural gas, and oil 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:	2009	2010	2011	2012	2013[e]
Bort, grit, and dust and powder; natural and synthetic:					
Production:					
Manufactured diamond[e]	38.3	39.3	41.5	43.7	44
Secondary	33.5	33.4	34.7	36.5	37
Imports for consumption	246	596	726	1,180	703
Exports[1]	67	113	148	154	135
Consumption, apparent	251	556	654	1,110	649
Price, value of imports, dollars per carat	0.17	0.14	0.13	0.13	0.11
Net import reliance[2] as a percentage of apparent consumption	71	87	88	93	88
Stones, natural and synthetic:					
Production:					
Manufactured diamond[e]	52.7	53.7	56.7	59.7	60
Secondary	0.46	0.46	0.31	0.33	0.33
Imports for consumption[3]	1.4	1.72	2.46	2.33	1.83
Exports[1]	—	—	—	—	—
Sales from Government stockpile excesses	—	—	—	—	—
Consumption, apparent	54.6	55.9	59.4	62.3	62
Price, value of imports, dollars per carat	13.31	18.78	19.67	15.30	16.90
Net import reliance[2] as a percentage of apparent consumption	3	3	4	4	3

Recycling: In 2013, the amount of diamond bort, grit, and dust and powder recycled was estimated to be 36.5 million carats. Lower prices of newly produced industrial diamond appear to be reducing the number and scale of diamond stone recycling operations. In 2013, it was estimated that 325,000 carats of diamond stone was recycled.

Import Sources (2009–12): Bort, grit, and dust and powder; natural and synthetic: China, 77%; Ireland, 11%; Republic of Korea, 4%; Romania, 3%; and other, 5%. Stones, primarily natural: Botswana, 36%; South Africa, 21%; India, 20%; Namibia, 7%; and other, 16%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 2013, 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] Reserves for Australia were revised based on new Government information.

	Mine production		Reserves[5]
	2012	2013[e]	
United States	—	—	NA
Australia	8	11	270
Botswana	20	22	130
Congo (Kinshasa)	17	17	150
Russia	15	15	40
South Africa	4	4	70
Other countries	11	11	90
World total (rounded)	75	80	750

World Resources: Natural diamond resources have been discovered in more than 35 countries. Natural diamond accounts for about 3% of all industrial diamond used; 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 2013; 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 2013, production of diatomite was estimated at 770,000 tons with an estimated processed value of $220 million, f.o.b. plant. Six companies produced diatomite at 10 mining areas and 9 processing facilities in California, Nevada, Oregon, and Washington. Diatomite is frequently used in filter aids, 56%; cement, 15%; fillers, 14%; absorbents, 13%; and less than 2% for other applications, including specialized pharmaceutical and biomedical uses. The unit value of diatomite varied widely in 2013, from approximately $7.00 per ton for use as a lightweight aggregate in portland cement concrete to more than $400 per ton for limited specialty markets, including art supplies, cosmetics, and DNA extraction.

Salient Statistics—United States:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Production[1]	575	595	813	735	770
Imports for consumption	1	1	2	3	1
Exports	88	86	106	96	102
Consumption, apparent	488	510	709	642	669
Price, average value, dollars per ton, f.o.b. plant	255	299	269	286	286
Stocks, producer, yearend[e]	40	40	40	40	40
Employment, mine and plant, number[e]	670	660	660	660	660
Net import reliance[2] as a percentage of apparent consumption	E	E	E	E	E

Recycling: None.

Import Sources (2009–12): Mexico, 35%; France, 31%; Italy, 11%; and others, 23%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–13**
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 2013 increased 5% compared with that of 2012. Apparent domestic consumption increased 4% in 2013; exports increased by 6%. 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]
	2012	2013[e]	
United States[1]	735	770	250,000
Argentina	55	60	NA
China	420	420	110,000
Denmark[4] (processed)	338	325	NA
France	75	75	NA
Japan	100	100	NA
Mexico	85	85	NA
Peru	81	80	NA
Spain	50	50	NA
Other countries	181	180	NA
World total (rounded)	2,120	2,150	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 2013 was valued at about $37.7 million. The three leading producers accounted for about 87% of production, with four other companies supplying the remainder. Producing States were North Carolina, Idaho, Virginia, 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 was shipped 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:	2009	2010	2011	2012	2013[e]
Production, marketable[e]	550	500	590	525	490
Imports for consumption	2	2	2	2	4
Exports	8	17	17	13	17
Consumption, apparent[e]	544	485	575	514	477
Price, average value, marketable production, dollars per ton	65	61	62	68	77
Employment, mine, preparation plant, and office, number[e]	350	340	380	360	340
Net import reliance[1] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Feldspar is not recycled by producers; however, glass container producers use cullet (recycled glass), thereby reducing feldspar consumption.

Import Sources (2009–12): Mexico, 72%; Germany, 26%; United Kingdom 1%; and China, 1%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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.

Recovery from the global economic recession in 2008 and 2009 continued to be slow during 2013. Consumption of flat glass in residential construction continued to slowly increase. Housing starts and completions each rose by more than 20% in the first half of 2013 compared with those of the same period in 2012; increases were expected to continue into 2014. Spending on private and public nonresidential construction, which had increased by 6% in the first 10 months of 2012 compared with those of the same period in 2011, decreased slightly in the first 10 months of 2013. Automotive glass consumption continued to increase with a nearly 5% increase in production in the first 10 months of 2013 compared with those of the same period in 2012.

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FELDSPAR

Fiberglass consumption for thermal insulation was expected to expand in line with housing and commercial building construction in the United States through 2014; the slight slowdown in spending on private and public nonresidential construction in 2013 was expected to reverse with spending increases expected in 2014. Domestic feldspar consumption has been gradually shifting from ceramics toward glass markets. A 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 remained sluggish because of the continued slow rebound of the housing market from the economic recession, some closures of plants, and increased imports. Sanitaryware production continued to expand in China, Mexico, the Middle East, South America, and South East Asia.

World Mine Production and Reserves: Reserves for Brazil, the Czech Republic, India, Poland, and Turkey were revised based on new Government information.

	Mine production		Reserves[2]
	2012	2013[e]	
United States[e]	525	490	NA
Argentina	215	215	NA
Brazil	330	334	320,000
Bulgaria	80	80	NA
China	2,100	2,100	NA
Czech Republic	445	440	24,500
Egypt	400	400	5,000
France	650	650	NA
Germany	205	200	NA
India	500	520	44,000
Iran	500	650	NA
Italy	4,700	4,700	NA
Japan	600	600	NA
Korea, Republic of	400	360	NA
Malaysia	400	450	NA
Mexico	380	380	NA
Poland	510	510	14,200
Portugal	113	125	11,000
Saudi Arabia	50	100	NA
South Africa	94	100	NA
Spain	510	600	NA
Thailand	1,100	1,100	NA
Turkey	7,100	7,000	240,000
Venezuela	200	200	NA
Other countries	620	650	NA
World total (rounded)	22,700	23,000	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.
[2]See Appendix C for resource/reserve definitions and information concerning data sources.

FLUORSPAR

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2013, fluorspar (calcium fluoride) production began 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 2013, an estimated 76,000 tons of fluorosilicic acid (equivalent to about 134,000 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:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Production:					
Finished, all grades	NA	NA	NA	NA	NA
Fluorspar equivalent from phosphate rock	114	128	124	130	134
Imports for consumption:					
Acid grade	417	442	560	464	500
Metallurgical grade	58	97	167	156	125
Total fluorspar imports	475	539	727	620	625
Fluorspar equivalent from hydrofluoric acid plus cryolite	175	209	209	209	194
Exports	14	18	24	24	18
Consumption:					
Apparent[1]	473	492	672	525	585
Reported	400	446	454	416	440
Stocks, yearend, consumer and dealer[2]	103	131	162	234	256
Employment, mine, number[e]	--	4	11	5	6
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 (2009–12): Mexico, 73%; China, 15%; South Africa, 8%; Mongolia, 3%; and other, 1%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12–31–13**
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: Fluorspar production began at the Klondike II Mine in Livingston County, KY. Initial mining activities simply involved stockpiling of ore. Plans were to process the ore through a heavy media separation plant, which was expected to be sufficient to upgrade the ore to acid grade. Planned output included acid-grade and metallurgical-grade fluorspar, with the latter possibly including briquettes.

Exploration and development work continued at fluorspar projects in Canada, Mongolia, South Africa, the United States, and Vietnam. The status of the projects varied from exploration drilling to mine startups.

Russia's major fluorspar mine in Russia's far eastern Primorye territory was mothballed because of low-quality ores and the need to modernize the mine. The shutdown was expected to last an extended period, potentially into 2016. The mine was licensed to develop the Pogranichnoye and Voznesenskoye fluorspar deposits, which according to the Russian reserve classification system contained 22 million metric tons of reserves.

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FLUORSPAR

Fluorspar prices decreased in 2013 as a result of a slowdown in downstream global fluorochemicals markets. As of October 2013, the price of Chinese acid-grade fluorspar, wet filtercake, free on board China, had decreased by 25% compared with the yearend 2012 price. During the same time period, Mexican high-arsenic acid-grade prices decreased by 17%. In addition, substantial price decreases were reported for various Chinese metallurgical grades of fluorspar.

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 the United States has been revised on information from company sources. Previously published reserve estimates for Namibia and Spain were based on out-of-date data; current reserve data were not available.

	Mine production		Reserves[4, 5]
	2012	2013[e]	
United States	NA	NA	4,000
Brazil	25	26	1,000
China	4,400	4,300	24,000
Kazakhstan	65	50	NA
Kenya	110	48	2,000
Mexico	1,200	1,240	32,000
Mongolia	471	350	22,000
Morocco	78	75	NA
Namibia	80	85	NA
Russia	100	80	NA
South Africa	225	180	41,000
Spain	117	110	NA
Other countries	200	180	110,000
World total (rounded)	7,070	6,700	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 (crude, unrefined) gallium was recovered in 2013. Globally, primary gallium is recovered as a byproduct of processing bauxite and zinc ores. One company in Utah recovered and refined gallium from imported primary gallium metal and new scrap. Imports of gallium, which supplied most of U.S. gallium consumption, were valued at about $16 million. Gallium arsenide (GaAs) and gallium nitride (GaN) used in electronic components accounted for approximately 99% of domestic gallium consumption. About 68% of the gallium consumed was used in integrated circuits (ICs). Optoelectronic devices, which include laser diodes, light-emitting diodes (LEDs), photodetectors, and solar cells, accounted for nearly all of the remaining gallium consumption. Optoelectronic devices were used in aerospace applications, consumer goods, industrial equipment, medical equipment, and telecommunications equipment. Uses of ICs included defense applications, high-performance computers, and telecommunications equipment.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production, primary	—	—	—	—	—
Imports for consumption	35,900	59,200	85,700	58,200	31,000
Exports	NA	NA	NA	NA	NA
Consumption, reported	24,900	33,500	35,300	34,400	34,000
Price, yearend, dollars per kilogram[1]	449	600	688	529	511
Stocks, consumer, yearend	4,100	4,970	6,850	6,220	4,700
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-based devices were reprocessed.

Import Sources (2009–12): Germany, 34%; United Kingdom, 26%; China, 21%; Canada, 6%; and other, 13%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 remained unchanged throughout 2013. The price for low-grade (99.99%-pure) gallium in Asia averaged $280 per kilogram from January through September. Prices had declined rapidly from mid-2011 to yearend 2012 owing to significant increases in gallium production and declining demand from LED producers. Chinese gallium production capacity expanded tremendously in 2011 and 2012 on the expectation of a strong LED-based backlighting market, which failed to materialize.

Global demand for GaAs- and GaN-based products increased in 2013. GaAs demand, while still driven mainly by cellular telephones and other high-speed wireless applications, increased owing to growth of feature-rich, application-intensive, third- and fourth-generation “smartphones,” which employ up to 10 times the amount of GaAs as standard cellular handsets. Smartphones accounted for approximately 40% of all cellular telephone sales in 2013. 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 an average annual growth rate of nearly 11%, increasing to $650 million by 2017 from $390 million in 2012. The GaAs device market was anticipated to increase at an average rate of 3.2% per year to $6.1 billion by 2016 from $5.2 billion in 2011.

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 annual growth rate of nearly 29%, to reach $178 million in 2015.

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GALLIUM

During the last several years, significant expansion of worldwide LED manufacturing capacity took place, much of it owing to government instituted incentives to increase LED production, and LED prices declined. With the rate of adoption of LEDs in television backlighting slowing, the LED industry was expected to focus on general lighting applications for the rest of the decade. The highest growth rate in the lighting industry was forecast to be in LED-based tubes that could replace fluorescent tubes used in commercial applications, as well as LED-based street lights and LED luminaires of varying sizes. More than 100 billion GaN LEDs were expected to ship in 2013, more than triple the number shipped in 2009.

Sustained high energy prices continued to spark interest in solar energy in 2013. Scientists in Switzerland achieved a record 20.4% efficiency for a copper-indium-gallium diselenide (CIGS) thin-film solar cell on a flexible polymer substrate. CIGS technology, however, has been slow to enter the commercial market owing to a complicated manufacturing process that has kept the cost of production of CIGS panels high. Decreased prices of silicon-based solar cells led to lower consumption of the more expensive CIGS cells. A large oversupply of CIGS modules caused prices to decline by 20% in 2011 and remain low throughout 2012 and 2013.

World Production and Reserves:[3] In 2013, world primary gallium production was estimated to be 280 metric tons, 27% less than the 2012 world primary production of 383 tons. Reports and trade data indicated that many primary gallium producers reduced output owing to the large surplus of primary gallium produced in 2012. 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 in 2013 was estimated to be about 200 tons, about 30% less than primary production. 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 2013 was estimated to be 470 tons; refinery capacity, 300 tons; and secondary capacity, 200 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.

World Resources: The average gallium content of 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. Gallium contained in world resources of bauxite is estimated to exceed 1 million metric tons, and a considerable quantity could be contained in world zinc resources. However, only a small percentage of the gallium in bauxite and zinc resources is potentially 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 no effective substitutes exist 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 2013 by four firms—one in Idaho, one in Montana, and two in New York. The estimated value of crude garnet production was about $8.6 million, while refined material sold or used had an estimated value of $7.1 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:	2009	2010	2011	2012	2013[e]
Production (crude)	45,600	52,600	56,400	46,900	47,000
Production (refined, sold or used)	22,100	28,900	33,700	25,800	26,000
Imports for consumption[e]	71,100	79,700	116,000	166,000	160,000
Exports[e]	13,200	11,700	14,500	14,600	15,000
Consumption, apparent[e, 2]	104,000	121,000	158,000	199,000	192,000
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	64	76	76

Recycling: Small amounts of garnet reportedly are recycled.

Import Sources (2009–12):[e] Australia, 45%; India, 43%; China, 10%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 2013, domestic U.S. production of crude garnet concentrates was essentially the same as the production in 2012. U.S. garnet consumption decreased slightly compared with that of 2012. The United States consumed about 11% of global garnet production. In 2013, imports were estimated to have decreased by 4% compared with those of 2012, and exports were estimated to have increased slightly from those of 2012. The 2013 estimated domestic sales or use of refined garnet was essentially the same as the sales in 2012. In 2013, 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:

	Mine production		Reserves[5]
	2012	2013[e]	
United States	46,900	47,000	5,000,000
Australia	263,000	260,000	Moderate to Large
China	510,000	510,000	Moderate to Large
India	800,000	800,000	6,700,000
Other countries	50,000	83,000	6,500,000
World total (rounded)	1,670,000	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. 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 remained almost the same in 2013 as that of 2012. 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 of production value, Arizona, North Carolina, Oregon, California, Utah, 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, North Carolina, South 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:	2009	2010	2011	2012	2013[e]
Production:[2]					
Natural[3]	9.3	10.0	11.0	11.3	11
Laboratory-created (synthetic)	27.2	30.8	31.9	31.2	31
Imports for consumption	13,600	19,600	23,500	21,000	24,700
Exports, including reexports[4]	10,500	14,100	18,200	16,900	19,800
Consumption, apparent	3,080	5,510	5,360	4,070	4,930
Price	Variable, depending on size, type, and quality				
Employment, mine, number[e]	1,000	1,100	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 (2009–12 by value): Israel, 41%; India, 24%; Belgium, 19%; South Africa, 5%; and other, 11%. Diamond imports accounted for 95% of the total value of gem imports.

Tariff:

Item	Number	Normal Trade Relations 12–31–13
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 2013, the U.S. market for gem-quality diamonds was estimated to be about $23.2 billion, accounting for more than 35% of world demand. The domestic market for natural, nondiamond gemstones was estimated to be about $1.5 billion. The United States is expected to continue dominating global gemstone consumption.

World Gem Diamond Mine Production[6] and Reserves:

	Mine production		Reserves[7]
	2012	2013[e]	
Angola	7,500	7,900	World reserves of diamond-bearing deposits are substantial. No reserve data are available for other gemstones.
Australia	92	70	
Botswana	14,400	14,000	
Brazil	46	30	
Canada	10,500	10,800	
Central African Republic	293	200	
Congo (Brazzaville)	21,500	21,500	
Congo (Kinshasa)	10	10	
Guinea	213	200	
Guyana	44	52	
Lesotho	479	480	
Namibia	1,630	1,500	
Russia	20,700	20,700	
Sierra Leone	325	300	
South Africa	2,830	2,800	
Tanzania	108	170	
Zimbabwe	11,000	11,000	
Other countries	51	50	
World total (rounded)	91,700	91,800	

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 processing of imported germanium compounds or recycling 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 contained in concentrates produced at a zinc mine in Alaska was exported to Canada for processing. During the third quarter of 2012, a producer began to recover an intermediate germanium concentrate from concentrates at a zinc mine and smelter complex in Tennessee. The company continued to work on increasing germanium concentrate production efficiency during 2013.

A germanium refinery in Utica, NY, produced germanium tetrachloride for optical fiber production. Another refinery in Quapaw, OK, produced refined germanium and compounds from scrap and imported materials for the production of fiber optics, infrared devices, and substrates for electronic devices. The worldwide end-use pattern of germanium was estimated to be: infrared optics, 30%; fiber optics, 20%; polymerization catalysts, 20%; electronics and solar applications, 15%; and other uses (such as phosphors, metallurgy, and chemotherapy), 15%. The domestic end use distribution was different and was estimated to be: fiber-optic systems, 40%; infrared optics, 30%; electronics and solar applications, 20%; and other uses, 10%. Germanium was not used in polymerization catalysts in the United States. In 2013, domestic consumption of germanium for fiber-optic systems increased compared with that in 2012 but use in infrared optics declined. The estimated value of germanium metal consumed in 2013, based on the annual average U.S. producer price, was about $71 million.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production, refinery[e]	4,600	3,000	3,000	W	W
Total imports[1]	60,200	44,700	38,500	48,500	45,000
Total exports[1]	21,200	8,000	5,900	15,300	12,000
Shipments from Government stockpile excesses	68	—	—	—	—
Consumption, estimated	44,000	40,000	36,000	38,000	38,000
Price, producer, yearend, dollars per kilogram:					
Zone refined	940	1,200	1,450	1,640	1,875
Dioxide, electronic grade	580	720	1,250	1,360	1,340
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant,[2] number[e]	70	100	100	100	100
Net import reliance[3] as a percentage of estimated consumption	90	90	90	85	85

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 (2009–12):[4] China, 60%; Belgium, 15%; Russia, 15%; Germany, 5%; and other, 5%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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: In fiscal year 2012, the Defense Logistics Agency, DLA Strategic Materials awarded two contracts to convert 3,000 kg of the germanium ingots held in the stockpile to epitaxial wafers for use as substrates required by National Security Space Strategy photovoltaic solar cell applications. As of late 2013, the germanium had not been upgraded. The DLA did not allocate any germanium for sale in the fiscal year 2013 Annual Materials Plan.

Stockpile Status—9–30–13[5]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2013	Disposals FY 2013
Germanium	16,362	*—	—	—

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GERMANIUM

Events, Trends, and Issues: Germanium dioxide prices were relatively stable during the first three quarters of 2013, remaining close to 2012 levels, and nearly double those in 2010. Germanium metal began the year at about $1,640 per kilogram, increased to $1,800 per kilogram in May, and was about $1,875 per kilogram by late September. At current price levels, some consumers were finding it cheaper to purchase germanium metal instead of dioxide owing to the lower unit cost of the germanium contained in metal. This, and Chinese stockpiling activities, may have contributed to germanium metal price increases.

China remained the leading global consumer and producer of germanium in 2013. The industry has become relatively concentrated with a handful of leading manufacturers in China accounting for most of the production. Recent reports indicated that total refined germanium production capacity in China was as much as 200 metric tons per year, and in 2013, producers operated at about 55% of capacity. Chinese National and Provincial governments have encouraged producers to integrate operations and focus on producing value-added products. China's trade policies during recent years, such as a 5% export tax placed on germanium dioxide, have been aimed at reducing exports of minor metals and encouraging the export of downstream products such as infrared devices. Chinese consumption of germanium in infrared devices reportedly increased significantly in 2013 as its military spending soared. In 2012, China's State Reserve Bureau purchased 20 metric tons of germanium metal for its national stockpile and was expected to purchase a similar quantity, or slightly more, for the stockpile by yearend 2013.

Outside of China, germanium consumption patterns reflected declines in defense spending. Leading domestic and European producers reported declines in sales of germanium lenses for use in infrared optics in 2013 compared with 2012. Consumption of germanium substrates for use in terrestrial solar cells declined in 2013 as did use in light-emitting diodes. Conversely, germanium consumption for use in solar cells for satellites and in fiber optics increased in 2013. The continued global expansion of fiber-optic networks was expected to be a growth area for germanium. The sustained high germanium prices caused some consumers to seek less expensive substitutes. In Japan, germanium dioxide consumption for use in polymerization catalysts declined, with imports decreasing to 8 metric tons in the first half of 2013 from 13 metric tons during the same period of 2012.

World Refinery Production and Reserves:

	Refinery production[e]		Reserves[6]
	2012	2013	
United States	W	W	NA
China	105,000	110,000	NA
Russia	5,000	5,000	NA
Other countries	40,000	40,000	NA
World total	[7]150,000	[7]155,000	NA

World Resources: The available resources of germanium are associated with certain zinc and lead-zinc-copper sulfide ores. Substantial U.S. reserves of recoverable germanium are contained in zinc deposits in Alaska and Tennessee. Based on an analysis of zinc concentrates, U.S. reserves of zinc may contain as much as 2,500 metric tons of germanium. Because zinc concentrates are shipped globally and blended at smelters, however, the recoverable germanium in zinc reserves cannot be determined. On a global scale, as little as 3% of the germanium contained in zinc concentrates is recovered. Significant amounts of germanium are contained in ash and flue dust generated in the combustion of certain coals for power generation.

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. W Withheld to avoid disclosing company proprietary data. — 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.

[7]Excludes U.S. production.

*Correction posted on March 27, 2014.

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, 3% 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. Domestic gold mine production in 2013 was estimated to be about 227 tons, 3% less than in 2012, and the value of mine production in 2013 was estimated to be about $10.2 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 the New York, NY, and Providence, RI, areas, with lesser concentrations in California, Florida, and Texas. Estimated domestic uses were electrical and electronics, 38%; jewelry, 36%; official coins, 19%; dental, 5%; other, 2%.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production:					
Mine	223	231	234	235	227
Refinery:					
Primary	170	175	220	222	200
Secondary (new and old scrap)	189	198	263	215	200
Imports for consumption[2]	320	604	507	332	310
Exports[2]	381	383	474	692	760
Consumption, reported	173	180	168	147	160
Stocks, yearend, Treasury[3]	8,140	8,140	8,140	8,140	8,140
Price, dollars per troy ounce[4]	975	1,228	1,572	1,673	1,400
Employment, mine and mill, number[5]	9,650	10,300	11,100	12,700	13,000
Net import reliance[6] as a percentage of apparent consumption	([7])	([7])	([7])	([7])	([7])

Recycling: In 2013, 200 tons of new and old scrap was recycled, more than the reported consumption.

Import Sources (2009–12):[2] Mexico, 57%; Canada, 17%; Colombia, 10%; Peru, 4%; and other, 12%.

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: The estimated gold price in 2013 was 16% lower than the price in 2012. This was the first time the annual average gold price has decreased since 2001. Engelhard's daily price of gold began the year at $1,697.28 per troy ounce, the highest level of the year, and then trended downward until the price reached a low of $1,194.68 per troy ounce on June 28. The price rebounded and trended upward through late August when the price started trending downward, ending November at $1,245.00 per troy ounce. Many believe that the gold price decreased owing to the lack of confidence in gold as an investment.

The decrease in domestic mine production was attributed to lower ore grades at the three leading producers in Nevada. These decreases were partly offset by one mine in Alaska that had higher ore grades and two mines in Nevada that increased the tonnage of ore processed.

In 2013, worldwide gold production was 3% more than that in 2012 owing to increases in production from Brazil, Canada, China, the Dominican Republic, and Russia, which more than offset production decreases in Peru, Tanzania, South Africa, and the United States. Gold production in China continued to increase, and the country remained the leading gold-producing nation, followed by Australia, the United States, Russia, Peru, and South Africa. Throughout the world, high-cost mines, expansion projects, and development projects were placed on hold because of the drop in the price of gold.

Domestic and global jewelry consumption increased because of the low price of gold and improved economic environment. Gold used in other industrial uses was relatively unchanged.

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GOLD

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

	Mine production		Reserves[8]
	2012	2013[e]	
United States	235	227	3,000
Australia	250	255	9,900
Brazil	65	75	2,400
Canada	104	120	920
Chile	50	55	3,900
China	403	420	1,900
Ghana	87	85	2,000
Indonesia	59	60	3,000
Mexico	97	100	1,400
Papua New Guinea	53	62	1,200
Peru	161	150	1,900
Russia	218	220	5,000
South Africa	160	145	6,000
Uzbekistan	93	93	1,700
Other countries	655	700	10,000
World total (rounded)	2,690	2,770	54,000

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.[9] 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.
[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: 0 (2009), 0 (2010), -4 (2011), 0 (2012), and 5 (2013, 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 2013, the price was estimated by the USGS based on monthly data from January through November.
[5]Data from Mine Safety and Health Administration.
[6]Defined as imports – exports + adjustments for Government and industry stock changes.
[7]In recent years, the United States has been a net exporter; however, large unreported investor stock changes preclude calculation of a meaningful net import reliance.
[8]See Appendix C for resource/reserve definitions and information concerning data sources.
[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.

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 2013, 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 2013 were, in decreasing order by tonnage, refractory applications, steelmaking, brake linings, foundry operations, batteries, and lubricants. These uses consumed 70% of the total natural graphite used during 2013.

Salient Statistics—United States:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Production, mine	—	—	—	—	—
Imports for consumption	33	65	72	57	60
Exports	11	6	6	6	8
Consumption, apparent[1]	22	60	66	50	51
Price, imports (average dollars per ton at foreign ports):					
Flake	694	720	1,180	1,370	1,360
Lump and chip (Sri Lankan)	1,410	1,700	1,820	1,960	1,720
Amorphous	249	257	301	339	433
Net import reliance[1] 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 (2009–12): China, 48%; Mexico, 25%; Canada, 17%; Brazil, 6%; and other, 4%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–13**
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 steadily increased throughout 2012 and into 2013. 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 and Vietnam provided all the amorphous graphite, and Sri Lanka provided all the lump and chippy dust variety. China, Canada, and Madagascar were, in descending order of tonnage, the major suppliers of crystalline flake and flake dust graphite.

During 2013, China produced the majority of the world's graphite. Graphite production increased in China, Madagascar, and Sri Lanka from that of 2012, while production decreased in Brazil from 2012 production levels.

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: The reserve data for Brazil were revised based on information reported by Associação Brasileira do Alumínio, 2012–2013; Instituto Brasileiro de Mineração, 2012–2013; and Summário Mineral 2011–2012.

	Mine production		Reserves[2]
	2012	2013[e]	
United States	—	—	—
Brazil	110	105	58,000
Canada	25	25	([3])
China	800	810	55,000
India	160	160	11,000
Korea, North	30	30	([3])
Madagascar	4	10	940
Mexico	8	8	3,100
Norway	2	2	([3])
Russia	14	14	([3])
Sri Lanka	4	5	([3])
Turkey	5	5	([3])
Ukraine	6	6	([3])
Zimbabwe	6	6	([3])
Other countries	2	2	([3])
World total (rounded)	1,170	1,190	130,000

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]See Appendix C for resource/reserve definitions and information concerning data sources.
[3]Included with "World total."

GYPSUM

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2013, domestic production of crude gypsum was estimated to be 16.3 million tons with a value of about $130 million. The leading crude gypsum-producing States were, in descending order, Texas, Oklahoma, Nevada, California, and Indiana, which together accounted for 62% of total output. Overall, 47 companies produced or processed gypsum in the United States at 118 mines and plants in 17 States. Approximately 90% of domestic consumption, which totaled approximately 27 million tons, was accounted for by manufacturers of wallboard and plaster products. Approximately 1.6 million tons of gypsum used in cement production and agricultural applications and small amounts of high-purity gypsum in a wide range of industrial processes accounted for the remaining tonnage. At the beginning of 2013, the production capacity of operating wallboard plants in the United States was about 33 billion square feet[1] per year.

Salient Statistics—United States:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Production:					
Crude	11,500	10,200	10,500	15,800	16,300
Synthetic[2]	8,120	10,700	11,800	11,800	12,300
Calcined[3]	13,400	12,400	11,900	12,800	13,200
Wallboard products sold (million square feet[1])	18,300	17,100	17,200	18,900	19,500
Imports, crude, including anhydrite	4,220	3,330	3,330	3,250	3,200
Exports, crude, not ground or calcined	156	360	316	408	290
Consumption, apparent[4]	23,700	23,900	25,300	30,400	31,500
Price:					
Average crude, f.o.b. mine, dollars per metric ton	7.40[r]	6.90	8.20[r]	7.70	8.00
Average calcined, f.o.b. plant, dollars per metric ton	35.30[r]	29.70	28.70[r]	28.70	29.00
Employment, mine and calcining plant, number[e]	4,500	4,500	4,500	4,500	4,500
Net import reliance[5] as a percentage of apparent consumption	17	12	12	9	9

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 (2009–12): Canada, 51%; Mexico, 36%; and Spain, 13%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
Gypsum; anhydrite	2520.10.0000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: U.S. gypsum production increased 3% compared with that of 2012 because the housing and construction markets increased in activity. Apparent consumption increased by 4% compared with that of 2012. The world's leading gypsum producer, China, produced about three times the amount produced in the United States. Iran, ranked third in world production, supplied much of the gypsum needed for construction in the Middle East. Spain, the leading European producer, ranked fifth 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. Should additional cultures utilize wallboard within their respective construction sectors, 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 decreased slightly compared with those of 2012. Exports, although very low compared with imports and often subject to wide fluctuations, decreased by 29%.

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GYPSUM

World Mine Production and Reserves:

	Mine production		Reserves[6]
	2012	2013[e]	
United States	15,800	16,300	700,000
Algeria	1,700	1,700	NA
Argentina	1,400	1,300	NA
Australia	2,500	3,000	NA
Brazil	3,230	3,200	230,000
Canada	2,550	1,900	450,000
China	48,000	50,000	NA
France	2,300	2,300	NA
Germany	1,950	1,900	NA
India	2,750	3,600	69,000
Iran	13,000	14,000	NA
Italy	4,130	4,100	NA
Japan	5,500	5,500	NA
Mexico	4,690	5,000	NA
Oman	1,900	1,900	NA
Poland	1,200	1,400	55,000
Russia	3,150	6,000	NA
Saudi Arabia	2,500	2,500	NA
Spain	7,100	7,100	NA
Thailand	9,000	9,000	NA
Turkey	2,100	2,000	NA
United Kingdom	1,700	1,700	NA
Other countries	13,500	14,400	NA
World total (rounded)	152,000	160,000	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; 83 countries produced gypsum in 2013.

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 2013, synthetic gypsum accounted for approximately 43% of the total domestic gypsum supply.

[e]Estimated. NA Not available.

[1]The standard unit used in the U.S. wallboard industry is square feet; multiply square feet by 9.29×10^{-2} to convert to square meters. Source: The Gypsum Association.

[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 2013 by private industry was about $930 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 2013 domestic consumption of helium was 47 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:	2009	2010	2011	2012	2013[e]
Helium extracted from natural gas[2]	78	75	71	73	77
Withdrawn from storage[3]	40	53	59	60	52
Grade-A helium sales	118	128	130	133	129
Imports for consumption	—	—	—	—	—
Exports[4]	71	77	82	85	82
Consumption, apparent[4, 5]	47	51	48	48	47
Net import reliance[6] as a percentage of apparent consumption	E	E	E	E	E

Price: In fiscal year (FY) 2013, the price for crude helium to Government users was $2.44 per cubic meter ($67.75 per thousand cubic feet) and to nongovernment users was $3.03 per cubic meter ($84.00 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 $7.21 per cubic meter ($200 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 (2009–12): None.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 2013, privately owned companies purchased about 4.1 million cubic meters (149 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 2013, the BLM's Amarillo Field Office, Helium Operations (AMFO), accepted about 11.9 million cubic meters (430 million cubic feet) of private helium for storage and redelivered nearly 64.3 million cubic meters (2,320 million cubic feet). As of September 30, 2013, about 52.0 million cubic meters (1,440 million cubic feet) of privately owned helium remained in storage at Cliffside Field.

Stockpile Status—9–30–13[7]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2013	Disposals FY 2013
Helium	305.5	305.5	64.1	56.1

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HELIUM

Events, Trends, and Issues: In 2013, BLM continued to use a pricing mechanism based on the requirements of the Helium Privatization Act of 1996. During 2013, BLM helium prices to nongovernment buyers increased to $3.03 per cubic meter ($84.00 per thousand cubic feet) of gas delivered. 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 2013, 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 2014 and may become greater as the storage reservoir production declines. Just before the end of the fiscal year, Congress passed the Helium Stewardship Act, which continued authorization of the Helium Program through at least 2021. The Act contains changes in how the BLM sells helium and the timing of those sales.

World Production and Reserves:

	Production		Reserves[9]
	2012	2013[e]	
United States (extracted from natural gas)	73	77	3,900
United States (from Cliffside Field)	60	52	([10])
Algeria	15	15	1,800
Australia	4	4	NA
Canada	NA	NA	NA
China	NA	NA	NA
Poland	3	3	25
Qatar	13	15	NA
Russia	6	5	1,700
Other countries	NA	NA	NA
World total (rounded)	174	171	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 Grade-A helium – exports.

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

[7]See Appendix B for definitions.

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

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

[10]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 2013. Two companies, one in New York and the other in Rhode Island, produced high-purity indium metal and indium products from lower grade imported indium metal. Several additional firms produced high-purity indium shapes, alloys, indium tin oxide (ITO), and other indium compounds from imported indium. Production of ITO continued to account for most of global indium consumption. ITO thin-film coatings were primarily used for electrical conductive purposes in a variety of flat-panel displays—most commonly liquid crystal displays (LCDs). Other indium end uses included solders and alloys, compounds, electrical components and semiconductors, and research. The estimated value of primary indium metal consumed domestically in 2013, based on the annual average New York dealer price, was about $62 million.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production, refinery	—	—	—	—	—
Imports for consumption[1]	105	117	146	109	90
Exports	NA	NA	NA	NA	NA
Consumption, estimated	100	100	100	100	100
Price, annual average, dollars per kilogram:					
U.S. producer[2]	500	565	720	650	620
New York dealer[3]	382	552	685	540	570
99.99% c.i.f. Japan[4]	348	546	680	510	580
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 scrap in Japan and the Republic of Korea.

Import Sources (2009–12):[1] Canada, 24%; China, 23%; Japan, 13%; Belgium, 11%; and other, 29%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
Unwrought indium, including powders	8112.92.3000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: Although U.S. producer and dealer prices on average were significantly higher than the price in Japan during 2012, the average prices all converged during 2013. The estimated annual average New York dealer price of indium was $570 per kilogram, 6% more than that of 2012. The New York dealer price range for indium began the year at $485 to $500 per kilogram and generally increased through the year, averaging $560 to $585 per kilogram in the third quarter. In early November, the price ranged from $690 to $715 per kilogram. The U.S. producer price for indium began the year at $580 per kilogram and increased to $680 per kilogram in August, where it remained through November.

Imports of indium into Japan and the Republic of Korea, the two leading consumers of indium, increased during the first 8 months of 2013 compared with imports during the same period of 2012. Reports indicated that demand for ITO increased during the year from that in 2012 owing to a rise in demand for flat-panel displays in developing countries, especially in China. In addition to increasing demand for ITO in LCD displays, two leading flat-panel makers announced intentions to replace amorphous silicon with indium-gallium-zinc-oxide (IGZO) as the thin-film transistor in displays used in some consumer electronics, including organic light-emitting diode (OLED) televisions, smartphones, and tablets.

During the first 8 months of 2013, China imported 97 tons of unwrought and wrought indium, more than five times the amount imported during the corresponding period of 2012. Although indium consumption in China was reported to have remained unchanged in 2013, net imports rose owing to increased investment demand. Inventories of indium at the Fanya Nonferrous Metals Exchange at the end of September were 1,565 tons, an increase of 955 tons from those at the end of January.

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INDIUM

World Refinery Production and Reserves: Estimated refinery production data for China and the Republic of Korea were revised owing to new country and company information.

	Refinery production		Reserves[6]
	2012	2013[e]	
United States	—	—	Quantitative estimates of reserves are not available.
Belgium	30	30	
Canada	62	65	
China	405	410	
Japan	71	71	
Korea, Republic of	165	150	
Peru	11	10	
Russia	13	13	
Other countries	25	25	
World total (rounded)	782	770	

World Resources: 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 in trace amounts in other base-metal sulfides—particularly chalcopyrite and stannite—most deposits of these metals are subeconomic for indium.

Substitutes: Indium's recent price volatility and various supply concerns associated with the metal have spurred the development of ITO substitutes. Antimony tin oxide coatings have been developed as an alternative to ITO coatings in LCDs and have been successfully annealed to LCD glass. Carbon nanotube coatings 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. 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: Metal Bulletin, 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.
[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 2013 by two companies operating in Oklahoma, and one company in Montana. Production in 2013 was estimated to have slightly increased from that of 2012. To avoid disclosing company proprietary data, U.S. iodine production in 2013 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 capacity utilization. The average cost, insurance, and freight value of iodine imports in 2013 was estimated to be $43.00 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, 13 plants reported consumption of iodine in 2012. Iodine and iodine compounds reported were ethyl and methyl iodide, 50%; potassium iodide, 13%; povidine-iodine, 8%; crude iodine, ethylenediamine dihydroiodide, and hydriodic acid, 4% each; resublimed iodine, 2%; sodium iodide, 1%; and other inorganic compounds, 14%.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production	W	W	W	W	W
Imports for consumption, crude content	5,190	5,710	6,590	5,960	5,650
Exports	1,160	1,070	900	1,040	1,180
Consumption:					
Apparent	W	W	W	W	W
Reported	4,550	4,640	4,740	4,880	4,900
Price, average c.i.f. value, dollars per kilogram, crude	25.55	24.39	38.13	41.97	43.00
Employment, number[e]	30	30	30	30	30
Net import reliance[1] as a percentage of reported consumption	89	100	100	100	91

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

Import Sources (2009–12): Chile, 86%; Japan, 13%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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: Historically high iodine prices continued into 2013; however, by the end of the first quarter of 2013, prices began to slightly decrease. Strong demand for iodine continued, driven by the liquid crystal display (LCD) and x-ray contrast media industries. Some companies that minimized their use of iodine and iodine compounds in 2011 and 2012 owing to the uncertainty of supply, have come back into the market. With a continued 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 63% of world production in 2012, having two of the leading iodine producers in the world. The Chilean producers were operating near capacity and were expected to continue to expand production in response to changes in demand and to capitalize on price increases.

World Mine Production and Reserves:

	Mine production		Reserves[2]
	2012	2013[e]	
United States	W	W	250,000
Azerbaijan	350	350	170,000
Chile	17,500	18,000	1,800,000
China	NA	NA	4,000
Indonesia	75	75	100,000
Japan	9,300	9,400	5,000,000
Russia	300	170	120,000
Turkmenistan	480	480	170,000
Uzbekistan	2	2	NA
World total (rounded)	[3]28,000	[3]28,500	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: No comparable substitutes exist 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.

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 2013 with an estimated valued of about $116 billion. Pig iron was produced by 5 companies operating integrated steel mills in 13 locations. About 61 companies produce raw steel at about 110 minimills. Combined production capability was about 125 million tons. Indiana accounted for 26% of total raw steel production, followed by Ohio, 12%; Michigan, 6%; and Pennsylvania, 6%. The distribution of steel shipments was estimated to be warehouses and steel service centers, 25%; construction, 18%; transportation (predominantly automotive), 16%; cans and containers, 3%; and other, 38%.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Pig iron production[2]	19.0	26.8	30.2	32	31
Steel production	59.4	80.5	86.4	89	87
Basic oxygen furnaces, percent	38.2	38.7	39.7	41	40
Electric arc furnaces, percent	61.8	61.3	60.3	59	60
Continuously cast steel, percent	97.5	97.4	98.0	99	99
Shipments:					
Steel mill products	56.4	75.7	83.3	87	87
Steel castings[e, 3]	0.4	0.4	0.4	0.4	0.4
Iron castings[e, 3]	4.0	4.0	4.0	4.0	4.0
Imports of steel mill products	14.7	21.7	25.9	30.4	29
Exports of steel mill products	8.4	11.0	12.2	12.5	12
Apparent steel consumption[4]	63	80	90	98	100
Producer price index for steel mill products (1982=100)[5]	165.2	191.7	216.2	208.0	195
Steel mill product stocks at service centers yearend[6]	5.6	7.0	7.6	7.3	7
Total employment, average, number					
Blast furnaces and steel mills	135,000	137,000	148,000	154,000	154,000
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	11	6	7	11	13

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

Import Sources (2009–12): Canada, 22%; Mexico, 10%; the Republic of Korea, 10%; Brazil, 9%, and other, 49%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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) forecast of global GDP growth for 2013, 2014, and 2015 was 2.2%, 3.0%, and 3.3%, respectively, after 2.5% in 2012. The U.S. Federal Reserve's projections for the U.S. 2014 GDP growth rate was between 3.0% and 3.5% and between 2.9% and 3.6% for 2015.

According to the Institute of Supply Management (ISM), economic activity in the domestic manufacturing sector expanded in October 2013 for the fifth consecutive month, and the overall U.S. economy grew for the 53rd consecutive month. The ISM manufacturing Purchasing Managers Index January through October 2013 corresponded to a 3.5% increase in real GDP.

MEPS International Inc. forecast total world steel production in 2014 to be 3.1% more than that in 2013. MEPS also forecast changes in steel production in 2014 in South America, Europe and the Commonwealth of Independent States, Africa and the Middle East, North America, and Asia of 19%, 13%, 7%, 4%, and -3%, respectively, relative to those of 2013.

A concern among the World's steelmakers is worldwide overcapacity. Steel demand decreased during the financial crisis of 2008, but capacity growth did not slow to match decreasing consumption growth rates. Since 2008, steelmaking capacity has exceeded apparent steel use, primarily as a result of China's rapid economic expansion and increasing steelmaking capacity. China's excess capacity and production has resulted in an inflow of steel products into the United States and other steelmaking countries that also have excess capacity. Also, demand by China's steelmakers has caused unprecedented increases of prices of iron ore and metallurgical coal that have hurt other steelmaking companies and their customers worldwide. The short-term outlook is that steelmaking capacity, globally and especially in China, will continue to exceed steel demand growth, steel prices will remain stable, and production costs will not decrease significantly.

World Production:

	Pig iron		Raw steel	
	2012	2013[e]	2012	2013[e]
United States	32	31	89	87
Brazil	27	26	35	35
China	658	720	717	783
Germany	27	27	43	42
India	48	50	78	80
Japan	81	84	107	110
Korea, Republic of	40	39	70	65
Russia	49	50	69	69
Taiwan	12	14	21	23
Turkey	*9	9	36	34
Ukraine	29	29	33	33
Other countries	*98	91	252	219
World total (rounded)	1,110	1,170	1,550	1,580

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.
*Corrrections posted on January 17, 2015.

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 $29.5 billion in 2013, slightly more than that of 2012. U.S. apparent steel consumption, an indicator of economic growth, increased to about 110 million tons in 2013. Manufacturers of pig iron, raw steel, and steel castings accounted for about 89% 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 11% 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 2013, raw steel production was about 89 million tons, up slightly from that of 2012; annual steel mill capability utilization was about 76% compared with 78% for 2012. Net shipments of steel mill products were about 87 million tons, the same as that in 2012.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production:					
Home scrap	10	10	10	10	9
Purchased scrap[2]	70	66	72	70	77
Imports for consumption[3]	3	4	4	4	4
Exports[3]	22	21	24	21	21
Consumption, reported	54	60	63	63	63
Price, average, dollars per metric ton delivered, No. 1 Heavy Melting composite price, Iron Age Average, Pittsburgh, Philadelphia, Chicago	208	319	392	365	339
Stocks, consumer, yearend	3.1	3.3	4.0	4.2	4.2
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 2012, the latest year for which statistics were available, was about 93%. In 2012, the automotive recycling industry recycled more than 18 million tons of steel from end-of-life vehicles through more than 300 car shredders, the equivalent of nearly 18 million automobiles. More than 12,500 vehicle dismantlers throughout North America resell parts.

The recycling rates for appliances and steel cans in 2012 were 90% and 71%, respectively; this was the latest year for which statistics were available. Recycling rates for construction materials in 2012 were, as in 2011, 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 57% post-consumer (old, obsolete) scrap, 22% prompt scrap (produced in steel-product manufacturing plants), and 21% home scrap (recirculating scrap from current operations).

Import Sources (2009–12): Canada, 78%; Mexico, 9%; United Kingdom, 4%; Sweden, 4%; and other, 5%.

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IRON AND STEEL SCRAP

Tariff: Item	**Number**	**Normal Trade Relations 12–31–13**
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: During 2013, hot-rolled steel prices decreased steadily from $698 per ton in January to a low of $635 per ton in May and then increased to $750 per ton in December. Prices of hot-rolled steel ended the year slightly lower than those in 2012. 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 194 in September 2013. Steel mill production capability utilization peaked at 80.9% in April 2012 from 40.8% in April 2009, decreased to a low for the year of 68% in October 2012, and then rose to 78.3% in February 2013. World steel consumption was expected to increase by 2.9% in 2013 and 3.4% in 2014, following 5.6% annual growth in 2012, according to the World Steel Association.

Scrap prices fluctuated during the first 8 months of 2013, between about $322 and $360 per ton. Composite prices published by Scrap Price Bulletin for No. 1 Heavy Melting steel scrap delivered to purchasers in Chicago, IL, Philadelphia, PA, and Pittsburgh, PA, averaged about $339 per ton during the first 8 months of 2013. As reported by Scrap Price Bulletin, the average price for nickel-bearing stainless steel scrap delivered to purchasers in Pittsburgh was about $1,511 per ton during the first 11 months of 2013, which was about 14% lower than the 2012 average price of $1,762 per ton. Exports of ferrous scrap decreased in 2013 to an estimated 19 million tons from 21 million tons during 2012, mainly to Turkey, Taiwan, the Republic of Korea, and China, in descending order of export tonnage. The value of exported scrap decreased from $9.4 billion in 2012 to an estimated $7.9 billion in 2013.

The 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. In the pre-2008 period of high ferrous scrap demand, the number of new scrap dealers increased and existing scrap dealers expanded operations. The number of shredders operating in the U.S. increased to 300 in 2013. The 2013 market faced overcapacity in domestic scrap metal generation and processing that contributed to lower prices. Complicating factors included a relatively stagnant economic recovery and scrap production from foreign competitors such as China. Scrap production trends suggest that the supply of shredded scrap relative to other grades is likely to continue to increase as mills adapt to use more of it. Electric arc furnace (EAF) production may increase as production by integrated mills decreases. Optimization practices have improved efficiency in EAF and integrated mills. Shredded scrap may eventually be the predominant grade globally.

The United States will likely continue exporting valuable ferrous scrap for at least another decade, and Turkey and the Republic of Korea will likely remain large importers of scrap at least through 2020. China may reduce its dependence on scrap imports; it may not become a net exporter of scrap before 2020.

World Mine Production and Reserves: Not applicable.

World Resources: Not applicable.

Substitutes: About 4.5 million tons of direct-reduced iron was used in the United States in 2013 as a substitute for iron and steel scrap, up from 3.6 million tons in 2012.

[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 2012.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.

IRON AND STEEL SLAG

(Data in million metric tons unless otherwise noted)

Domestic Production and Use: Ferrous slags are produced during iron- and steelmaking and, after cooling and processing, 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 18 to 25 million tons in 2013. Domestic slag sales[1] in 2013 amounted to an estimated 17 million tons, valued at about $290 million (f.o.b. plant). Iron (blast furnace) slag accounted for about 45% of the tonnage sold and had a value of about $225 million; nearly 85% of this value was from sales of 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 2013 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:	2009	2010	2011	2012	2013[e]
Production, marketed[1, 3]	12.5	15.8	15.4	16.1	17.0
Imports for consumption[4]	1.3	1.4	1.6	1.2	1.3
Exports	([5])	0.1	([5])	([5])	([5])
Consumption, apparent[4, 6]	12.5	15.8	15.5	16.2	17.1
Price average value, dollars per ton, f.o.b. plant	19.00	17.00	17.00	17.00	17.00
Employment, number[e]	2,000	2,100	2,000	1,800	1,800
Net import reliance[7] as a percentage of apparent consumption	10	8	9	7	8

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 (2009–12): 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 2011–12. Based on official data, the principal country sources for 2009–12 were Canada, 40%; Japan, 40%; Italy, 7%; South Africa, 6%; and other, 7%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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: The availability of blast furnace slag is becoming problematic in the United States because of a decline in the number of active U.S. blast furnaces in recent years, the lack of construction of new furnaces, and the depletion of old slag piles. At yearend 2013, granulation cooling was available at only three active blast furnaces. Pelletized blast furnace slag was in very limited supply (one site only), but it was uncertain if any additional pelletizing capacity was being planned. Production of steel slag from basic oxygen and electric arc furnaces increased, but the long-term supply of steel slag was expected to become increasingly reliant on the electric arc furnaces. 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, demand for GGBFS has trended more in line with those of cement, but, although increasingly popular as a cementitious additive, sales volumes can be constrained by restricted supply. 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. Recent draft regulations to restrict emissions (especially of mercury) from U.S. cement plants and to potentially 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. However, not all potential exporting countries produce high-quality granulated slag, and for some of them that do, the amount of slag available for export to the United States is limited by the number of operational furnaces and increasing local and international demand for the 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 2013 was on the order of 260 to 320 million tons, and steel slag about 170 to 250 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, and in this respect also compete with portland cement itself. 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.
[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 2009–13.
[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.

IRON ORE[1]

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

Domestic Production and Use: In 2013, mines in Michigan and Minnesota shipped 99% of the usable ore produced in the United States, with an estimated value of $5.0 billion. Eleven iron ore mines (10 open pits and 1 reclamation 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 the majority of production. The United States was estimated to have produced and consumed 2% of the world's iron ore output.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production, usable	26.7	49.9	54.7	54.0	52
Shipments	27.6	50.6	55.6	52.9	54
Imports for consumption	3.9	6.4	5.3	5.1	2.9
Exports	3.9	10.0	11.1	11.2	9.9
Consumption:					
Reported (ore and total agglomerate)[3]	31.0	42.3	46.3	46.9	44
Apparent[4]	25.7	47.9	49.1	48.1	45
Price,[5] U.S. dollars per metric ton	92.76	98.79	99.45	98.16	98.75
Stocks, mine, dock, and consuming plant, yearend, excluding byproduct ore	5.06	3.47	3.26	3.11	3.0
Employment, mine, concentrating and pelletizing plant, quarterly average, number	3,530	4,780	5,270	5,420	5,290
Net import reliance[6] as a percentage of apparent consumption (iron in ore)	E	E	E	E	E

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

Import Sources (2009–12): Canada, 74%; Brazil, 14%; and other, 12%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 2013 than that in 2012 owing to reduced consumption for steel production. Two production lines were idled at the Northshore Mine in Minnesota; the Empire Mine in Michigan was idled from April until September owing to reduced demand. A storage dome at a direct-reduced-iron (DRI) plant under construction in Louisiana collapsed, delaying production until 2014. A planned taconite mine in Minnesota was delayed until 2015 owing to lack of required funds.

An intent-to-mine notice was filed with the Wisconsin Department of Natural Resources in June, along with a bulk-sampling plan to be conducted in the Penokee Range in Ashland County, WI. A 3-million-ton-per-year pelletizing plant was under construction in Reynolds, IN, and was expected to be completed in the fourth quarter of 2014. A company announced plans to construct an iron nugget plant in Jamestown, ND, to produce 100,000 tons of iron nuggets using concentrates from Minnesota.

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IRON ORE

Drought conditions in the Great Lakes region led to reduced carrying capacities for freighters transporting iron ore. The Port of Long Beach, CA, began exporting iron ore concentrates from a mine in Cedar City, UT, to China in March. In the second quarter of 2013, a private company began a 4-year process to transport a 5-million-ton stockpile of iron ore concentrates in Mobile, AL, to steel manufacturers in China.

Uncertainty regarding declining demand from Chinese steel manufacturers and announcements of production-capacity increases at major Australian mines resulted in a 31% decrease in prices for iron fines sold in European and Asian markets in the first half of 2013. Cancellations and delays of proposed iron mine expansion plans in Australia, in addition to higher than expected consumption from China, led to price rebounding in the third quarter.

World Mine Production and Reserves: Mine production for China is based on crude ore, rather than usable ore, which is reported for the other countries. Iron ore reserves for Brazil and India have been revised based on new information from those countries.

	Mine production		Reserves[7]	
	2012	2013[e]	Crude ore	Iron content
United States	54	52	6,900	2,100
Australia	521	530	35,000	17,000
Brazil	398	398	31,000	16,000
Canada	39	40	6,300	2,300
China	1,310	1,320	23,000	7,200
India	144	150	8,100	5,200
Iran	37	37	2,500	1,400
Kazakhstan	26	25	2,500	900
Russia	105	102	25,000	14,000
South Africa	63	67	1,000	650
Sweden	23	26	3,500	2,200
Ukraine	82	80	[8]6,500	[8]2,300
Venezuela	27	30	4,000	2,400
Other countries	96	88	14,000	7,100
World total (rounded)	2,930	2,950	170,000	81,000

World Resources: U.S. resources are estimated to be about 27 billion tons of iron contained within 110 billion tons of iron 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, iron nuggets, DRI, or sinter. At some blast furnace operations, ferrous scrap may constitute as much as 7% of the blast furnace feedstock. Scrap, DRI, and iron nuggets are extensively used for steelmaking in electric arc furnaces and in iron and steel foundries, but scrap availability can be limited. Technological advancements have been 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]Defined as production + imports – exports + adjustments for industry stocks.
[5]Estimated from reported value of ore at mines.
[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]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, which was withheld by the U.S. Geological Survey to avoid disclosing company proprietary data, decreased slightly in 2013 from that of 2012. Six companies, including the three producers of natural IOPs, processed and sold finished natural and synthetic IOPs. Sales by those companies were virtually unchanged in 2013 from those of 2012, 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 animal food, industrial chemicals, magnetic ink and tape, and other uses.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production, mine	W	W	W	W	W
Production, finished natural and synthetic IOP	50,800	54,700	48,000	48,400	48,000
Imports for consumption	106,000	151,000	158,000	151,000	165,000
Exports, pigment grade	5,640	8,750	8,660	8,950	8,000
Consumption, apparent[1]	151,000	197,000	197,000	190,000	205,000
Price, average value, dollars per kilogram[2]	1.46	1.48	1.54	1.60	1.54
Employment, mine and mill	58	60	58	58	55
Net import reliance[3] as a percentage of apparent consumption	>50%	>50%	>50%	>50%	>50%

Recycling: None.

Import Sources (2009–12): Natural: Cyprus, 57%; Spain, 13%; France, 12%; and other, 18%. Synthetic: China, 51%; Germany, 23%; Brazil, 7%; and other, 19%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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.

Events, Trends, and Issues: In 2013, domestic production and sales of natural IOPs decreased slightly after slight increases in 2011 and 2012. In Europe, consumption declined, mostly owing to continued sluggishness in the region's construction industry; moderate to strong growth continued in Asia. Domestically, residential construction, in which IOPs are commonly used to color concrete block and brick, ready-mixed concrete, and roofing tiles, increased in the first half of 2013. Housing starts and completions each rose by more than 20% compared with those of the same period in 2012 and increases were expected to continue in 2014. Spending on residential construction increased by 16% during the first 10 months of 2013 compared with the same period in 2012. Increased home construction could lead to an increase in IOP consumption in this sector. Spending on nonresidential construction, however, which accounted for about 60% of construction expenditures, decreased slightly in the first 10 months of 2013 compared with the same period in 2012.

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IRON OXIDE PIGMENTS

Exports of pigment-grade IOPs decreased during the first 10 months of 2013 compared to those of the same period in 2012, mostly owing to a decrease in exports to China. Exports of other grades of IOPs and hydroxides significantly increased, mostly owing to a substantial increase in exports to China and smaller increases to Australia, Brazil, Chile, and Thailand. Total exports of natural and synthetic IOPs trended higher during the first 10 months of 2013 compared to those of the same period in 2012.

Three leading producers of finished natural and synthetic IOPs began construction of synthetic IOP production plants in Augusta, GA; Anhui, China; and Ningbo, China. The completion of the $115 million advanced technology facility in Georgia—the first new IOP production plant built in the United States in nearly 35 years—was expected by the end of 2014 with operations beginning in February 2015. The plants in China, one owned by a Hong Kong-based company and the other owned by a German chemical company, had similar timelines for completion and startup.

World Mine Production and Reserves:

	Mine production		Reserves[4]
	2011	2012[e]	
United States	W	W	Moderate
Austria (micaceous IOP)	4,000	4,100	NA
Cyprus (umber)	4,000	4,100	Moderate
France	3,000	3,000	NA
Germany[5]	204,000	210,000	Moderate
India (ochre)	1,200,000	1,200,000	50,000,000
Pakistan	40,000	40,000	Moderate
Spain	16,500	17,000	Large
Other countries	20,000	21,000	Moderate
World total	[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 commonly used of the natural minerals suitable for use as pigments after milling. Because IOPs are color stable, low cost, and nontoxic, they can be economically used for imparting black, brown, red, and yellow 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 are thought to produce IOPs, but output is not reported and no basis is available to formulate estimates of output levels, which likely is substantial. Such countries include Azerbaijan, China, Honduras, Kazakhstan, Russia, Turkey, and Ukraine.

KYANITE AND RELATED MINERALS

(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 and the other in Georgia. Commercially produced mullite is synthetic, made by 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. An estimated 60% to 65% of the refractory usage, was used by the iron and steel industries and the remainder was used by industries that manufacture chemicals, glass, nonferrous metals, and other materials. Andalusite was commercially mined 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:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Production:					
Mine[1]	71	93	98	99	95
Synthetic mullite[e]	40	40	40	40	40
Imports for consumption (andalusite)	5	2	5	3	6
Exports	26	38	38	36	37
Consumption, apparent[e]	90	97	105	105	104
Price, average, dollars per metric ton:[2]					
U.S. kyanite, raw concentrate	283	283	300	300	310
U.S. kyanite, calcined	422	422	448	448	450
Andalusite, Transvaal, South Africa	352	336	335	340	350
Employment, kyanite mine, office, and plant, number[e]	110	115	120	115	120
Employment, mullite plant, office, and plant, number[e]	170	180	190	180	180
Net import reliance[3] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (2009–12): South Africa, 81%; France, 8%; Peru, 7%; and other, 4%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–13**
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 MINERALS

Events, Trends, and Issues: Crude steel production in the United States, which ranked third in the world in steel production, decreased by 4% in the first 9 months of 2013 compared with that of the same period in 2012, potentially indicating a future decrease in consumption for kyanite-mullite refractories if the trend continues. Mostly the result of increases in steel production in Asia, total world steel production rose 2.9% during the first 9 months of 2013 compared with the same period in 2012. Of the total world refractories market, estimated to be approximately 40 million tons, crude steel manufacturing consumed up to 70% of refractories production.

Less-than-expected increases in world steel production during 2013 was, in part, the result of a sluggish economy in Western Europe and slower-than-expected economic growth in Eastern Europe and the United States. With steel production expanding in Asia, andalusite and mullite could receive increasing consideration as alternative aluminosilicate refractory minerals to refractory bauxite owing to a continuing lack of readily available, inexpensive refractory-grade bauxite from China, which accounted for about three-quarters of market share worldwide.

China is expected to continue to be the largest market for refractories, comprising the majority of global demand. Above-average growth is expected in India. Eastern Europe, North America, and Western Europe are expected to continue to have significant refractory demand because of their large industrial bases, with Eastern Europe having the highest growth of these regions, reflecting the area's expanding industrialization. North America and Western Europe are expected to have slower growth 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 greatest increases in countries with higher rates of increase in steel production. Increased demand also is anticipated for refractories used to produce other metals and in the industrial mineral market because of increasing production of cement, ceramics, glass, and other mineral products.

A research group found that using mullite as a catalyst in place of platinum in diesel engines could reduce nitric oxide and nitrogen-dioxide pollutants by up to 45% more than using a platinum catalyst. A mullite alternative product was undergoing commercialization; the group explored other applications for mullite, such as in fuel cells.

World Mine Production and Reserves:

	Mine production		Reserves[4]
	2012	2013[e]	
United States[e]	99	95	Large
France	65	65	NA
India	44	50	1,600
South Africa	200	220	NA
Other countries	1	5	NA
World total (rounded)	408	440	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 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: Virginia Department of Mines, Minerals and Energy.
[2]Source: Average of prices reported in 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 2013, based on the average North American producer price, was about $829 million. Six lead mines in Missouri, plus lead-producing mines in Alaska and Idaho, accounted for all domestic mine production. Primary refined lead was produced at one smelter-refinery in Missouri. Of the plants that produced secondary lead at yearend 2013, 12 had capacities of 30,000 tons per year of refined lead or greater and accounted for more than 95% of secondary production. Lead was consumed at more than 70 manufacturing plants. The lead-acid battery industry accounted for about 90% of the reported U.S. lead consumption during 2013. Lead-acid batteries were primarily used as starting-lighting-ignition (SLI) batteries for automobiles and trucks and as industrial-type batteries for standby power for computer and telecommunications networks and for motive power. During the first 9 months of 2013, 93.2 million lead-acid automotive batteries were shipped by North American producers, a slight increase from those shipped in the same period of 2012.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production:					
Mine, lead in concentrates	406	369	342	345	340
Primary refinery	103	115	118	111	118
Secondary refinery, old scrap	1,110	1,140	1,130	1,110	1,100
Imports for consumption:					
Lead in concentrates	([1])	([1])	([1])	([1])	([1])
Refined metal, wrought and unwrought	252	273	316	351	470
Exports:					
Lead in concentrates	287	299	223	214	250
Refined metal, wrought and unwrought	82	83	47	53	50
Consumption:					
Reported	1,290	1,430	1,410	1,360	1,400
Apparent[2]	1,400	1,450	1,540	1,500	1,620
Price, average, cents per pound:					
North American Producer	86.9	109	122	114	114
London Metal Exchange	78.0	97.4	109	93.5	94
Stocks, metal, producers, consumers, yearend	63	65	48	72	90
Employment:					
Mine and mill (average), number[3]	1,560	1,590	1,700	1,660	1,850
Primary smelter, refineries	310	290	290	290	290
Secondary smelters, refineries	1,600	1,600	1,600	1,700	1,700
Net import reliance[4] as a percentage of apparent consumption	13%	13%	19%	18%	25%

Recycling: In 2013, about 1.10 million tons of secondary lead was produced, an amount equivalent to 68% of apparent domestic lead consumption. Nearly all secondary lead was recovered from old (post-consumer) scrap at secondary smelters.

Import Sources (2009–12): Metal, wrought and unwrought: Canada, 78%; Mexico, 15%; and other, 7%.

Tariff: Item	Number	Normal Trade Relations[5] 12–31–13
Unwrought (refined)	7801.10.0000	2.5% ad val.
Antimonial lead	7801.91.0000	2.5% ad val.
Alloys of lead	7801.99.9030	2.5% ad val.

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

Government Stockpile: None.

Events, Trends, and Issues: Lead stocks held in global London Metal Exchange (LME) warehouses declined to 240,600 tons by the end of September from 317,700 tons at yearend 2012. LME stocks held in domestic warehouses declined to 11,000 tons from 53,225 tons during that time period. North American producer prices were relatively stable throughout the first 9 months of the year. LME lead cash prices averaged $2,340 per metric ton in January and declined to $2,088 per metric ton in September. Domestic mine production in 2013 was expected to be relatively unchanged from that in the previous year. In February, a silver-lead mine in Idaho, which had shut down for maintenance work in early 2012, restarted mining and reached full production capacity by late September.

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LEAD

The operator of the only domestic primary lead smelter, in Herculaneum, Missouri, planned to close the smelter by yearend, per an agreement with the U.S. Environmental Protection Agency. After the smelter closes the company expected to export all of the concentrates produced at its six mines in Missouri.

In 2013, total secondary lead production in the United States was expected to be slightly less than that in 2012. Some producers expanded capacity and others closed plants, but total production capacity remained essentially unchanged. Producers, facing increased operating costs owing to regulatory changes that take effect in 2017, would need to substantially reduce allowable lead emissions. In some cases, producers closed plants instead of attempting to bring them into compliance. In April 2013, a leading producer that had closed one of its five smelters in November 2012, closed its 70,000-ton-per-year smelter in Reading, PA, and in September reduced production at its 90,000-ton-per-year plant in Vernon, CA, by 15%. Another producer, however, continued to ramp up production at its 132,000-ton-per-year secondary lead smelter in Florence, SC, which opened in 2012. Increases in exports of spent lead-acid batteries during the past few years (the majority of which went to Mexico) have decreased the amount of scrap available to secondary smelters. During the first 9 months of the year, 19.3 million spent SLI lead-acid batteries, containing an estimated 190,000 tons of lead, were exported.

Global mine production of lead was expected to increase to about 5.40 million tons in 2013, mainly owing to production increases in Australia (primarily from the restart of an 85,000-ton-per-year lead mine), and China. The International Lead and Zinc Study Group (ILZSG) forecast global refined lead production to increase by about 5% from that in 2012, to 11.0 million tons, primarily driven by new production capacity in China (despite shutdowns of many smaller smelters) and increases in Australia, Belgium, India, Italy, Kazakhstan, and Peru. ILZSG projected global lead consumption to increase by about 5% in 2013 from that in 2012, to 11.0 million tons, partially owing to an increase in China, and that global refined lead production would exceed consumption by 22,000 tons.

World Mine Production and Reserves: Reserve estimates for Peru were revised based on information from Government and industry sources.

	Mine production		Reserves[6]
	2012	2013[e]	
United States	345	340	5,000
Australia	648	690	36,000
Bolivia	88	90	1,600
Canada	59	35	450
China	2,800	3,000	14,000
India	118	120	2,600
Ireland	51	43	600
Mexico	210	220	5,600
Peru	249	250	7,500
Poland	58	60	1,700
Russia	95	90	9,200
South Africa	55	52	300
Sweden	62	62	1,100
Other countries	330	350	3,000
World total (rounded)	5,170	5,400	89,000

World Resources: Identified lead resources of the world total more than 2 billion tons. 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).

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 toward lead-free solders with compositions of bismuth, copper, silver, and tin. Steel and zinc are common substitutes for lead in wheel weights.

[e]Estimated.
[1]Less than ½ unit.
[2]Apparent consumption series revised to reflect metal consumption. Defined as primary refined production + secondary refined production + refined imports – refined exports + 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 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 2013, an estimated 19.0 million tons (20.9 million short tons) of quicklime and hydrate was produced (excluding commercial hydrators), valued at about $2.3 billion. At yearend, 30 companies were producing lime, which included 20 companies with commercial sales and 11 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, Alabama, Ohio, and Texas. 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:	2009	2010	2011	2012	2013[e]
Production[2]	15,800	18,300	19,100	18,800	19,000
Imports for consumption	422	445	512	468	400
Exports	108	215	231	212	260
Consumption, apparent	16,100	18,500	19,400	19,100	19,100
Quicklime average value, dollars per ton at plant	102.00	103.70	107.90	115.40	116.00
Hydrate average value, dollars per ton at plant	126.40	124.70	130.90	136.90	138.00
Employment, mine and plant, number	4,800	5,000	5,100	5,100	5,100
Net import reliance[3] as a percentage of apparent consumption	2	1	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 (2009–12): Canada, 91%; Mexico, 8%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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:
Nationally, lime prices appear to have stabilized in 2013, with only small increases expected compared with those in 2012. This breaks the 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).

Companies continued with construction projects in Pennsylvania and Virginia, which involved installation of new natural gas-fired vertical shaft kilns. Low interest rates and low energy prices have provided opportunities for lime companies to add new capacity or replace existing old capacity with natural gas-fired kilns.

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LIME

World Lime Production and Limestone Reserves:

	Production		Reserves[4]
	2012	2013[e]	
United States	18,800	19,000	Adequate for all countries listed.
Australia	2,200	2,200	
Belgium	2,400	2,400	
Brazil	8,300	8,500	
Bulgaria	1,500	1,500	
Canada	1,960	1,800	
China	220,000	220,000	
France	3,900	3,900	
Germany	6,670	6,500	
India	15,000	16,000	
Iran	2,800	2,800	
Italy[5]	6,200	6,000	
Japan (quicklime only)	8,200	8,200	
Korea, Republic of	5,200	5,100	
Poland	2,000	1,900	
Romania	2,000	2,000	
Russia	10,500	10,400	
South Africa (sales)	1,500	1,500	
Spain	1,800	1,800	
Turkey (sales)	4,500	4,400	
Ukraine	4,200	4,200	
United Kingdom	1,500	1,600	
Vietnam	1,500	1,600	
Other countries	15,400	17,000	
World total (rounded)	348,000	350,000	

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

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 operating in the United States was a brine operation in Nevada. 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, 35%; batteries, 29%; lubricating greases, 9%; continuous casting mold flux powders, 6%; air treatment, 5%; polymer production, 5%; primary aluminum production, 1%; and other uses, 10%. Lithium use in batteries has increased significantly in recent years because rechargeable lithium batteries are used extensively in portable electronic devices, and have been used increasingly in electric tools, electric vehicles, and grid storage applications.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production	W	W	W	W	W
Imports for consumption	1,890	1,960	2,850	2,760	2,000
Exports	919	1,410	1,310	1,300	1,100
Consumption:					
Apparent	W	W	W	W	W
Estimated	1,300	1,100	[1]2,000	[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%	>80%	>60%	>50%

Recycling: Lithium recycling has been insignificant historically, 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 facility in British Columbia, Canada. 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, which was expected to be operational by yearend 2013.

Import Sources (2009–12): Argentina, 51%; Chile, 45%; China, 3%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 slightly in 2013. Production of one major lithium producer in Chile increased through the first half of 2013, while the other major Chilean producer reduced output owing to increased lithium production from other countries. Argentina's major lithium producer increased production capacity during the year. Industry analysts and the major lithium producers expected worldwide consumption of lithium in 2013 to be approximately 30,000 tons, an increase of 6% from that of 2012. Lithium prices, on average, remained flat owing to the balanced increase in worldwide lithium consumption and supply. Many companies continued exploring for lithium, with numerous claims in Nevada, as well as in Argentina, Australia, Bolivia, and Canada, having been leased or staked.

In the late 1990s, subsurface brines became the dominant raw material for lithium carbonate production worldwide because of lower production costs compared with the mining and processing of hard-rock ores. Owing to growing lithium demand from China in the past several years, however, mineral-sourced lithium regained market share and was estimated to account for one-half of the world's lithium supply in 2013. Two brine operations in Chile and a spodumene operation in Australia dominated world production. Argentina produced lithium carbonate and lithium chloride from brines. China produced lithium carbonate, lithium chloride, and lithium hydroxide from domestic brines

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LITHIUM

and domestic and imported spodumene. In the United States, the brine operation in Nevada doubled production capacity in 2013. New brine and spodumene operations in Argentina and Canada, respectively, were expected to be commissioned in 2014. Lithium minerals were used directly as ore concentrates in ceramics and glass applications worldwide and, increasingly, as feedstock for lithium carbonate, lithium hydroxide, and other lithium compounds in China.

Owing to China's growing demand for lithium compounds, its chemical producers were importing high-quality spodumene to use at its lithium chemical facilities. Australia's leading lithium ore miner doubled its production capacity in 2012 to 110,000 tons per year of lithium carbonate equivalent, and in 2013, a Chinese lithium chemical producer acquired the mine. A new Australian lithium chemical producer opened a plant in China to convert Australian lithium concentrate to battery-grade lithium carbonate.

Rechargeable batteries were the largest potential growth area for lithium compounds. Demand for rechargeable lithium batteries exceeds that of other rechargeable batteries for use in cellular telephones, cordless tools, MP3 players, and portable computers and tablets. Major automobile companies were developing lithium batteries for electric and hybrid electric vehicles. 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 to ensure a reliable, diversified supply of lithium for Asia's battery suppliers and vehicle manufacturers.

World Mine Production and Reserves: The reserve estimate for Portugal has been revised based on new information from Government sources.

	Mine production		Reserves[3]
	2012	2013[e]	
United States	W	W	38,000
Argentina	2,700	3,000	850,000
Australia	12,800	13,000	1,000,000
Brazil	150	150	46,000
Chile	13,200	13,500	7,500,000
China	4,500	4,000	3,500,000
Portugal	560	570	60,000
Zimbabwe	1,060	1,100	23,000
World total (rounded)	[4]35,000	[4]35,000	13,000,000

World Resources: Identified lithium resources total 5.5 million tons in the United States and approximately 34 million tons in other countries. Identified lithium resources for Bolivia and Chile are 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. Canada, Congo (Kinshasa), Russia, and Serbia have resources of 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]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 69% of U.S. magnesium compounds production in 2013. Magnesium oxide and other compounds were recovered from seawater by one company in California and another company in 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 53% of the magnesium compounds consumed in the United States was used for refractories. The remaining 47% was used in agricultural, chemical, construction, environmental, and industrial applications.

Salient Statistics—United States:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Production	239	261	306	244	250
Imports for consumption	173	279	316	264	240
Exports	16	19	26	20	18
Consumption, apparent	396	521	596	488	472
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant, number[e]	300	300	300	275	250
Net import reliance[2] as a percentage of apparent consumption	40	50	49	50	47

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

Import Sources (2009–12): China, 56%; Brazil, 9%; Canada, 8%; Australia, 7%; and other, 20%.

Tariff:[3] Item	**Number**	**Normal Trade Relations 12–31–13**
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: A magnesium chloride producer in Utah revised plans to expand production citing environmental and wildlife concerns. New solar evaporation ponds would be constructed on the north and west sides of the Great Salt Lake instead of on the east side of the lake, pending regulatory review. In 2012, the company increased its capacity to 750,000 tons per year of magnesium chloride brine from 550,000 tons per year.

In recent years, several companies throughout the world have made acquisitions to secure supplies of magnesium compounds, as well as expanding existing operations, trends which were expected to continue because demand was projected to increase in many end uses. A French-based company purchased one-half of a magnesia producer in Brazil to secure raw materials for its refractory and agricultural supply businesses. A Russian-based company started a project to double its magnesium chloride capacity from bischofite deposits near Volgograd to 60,000 tons per year for use in producing magnesium hydroxide and magnesia. Russia's leading magnesite producer continued construction of a 100,000-ton-per-year furnace at its magnesia plant in Siberia that would double the plant's calcined magnesia capacity. The Government of China ordered some magnesite mines in Liaoning Province to shut down, resulting in production decreasing in 2013 compared with that in 2012.

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MAGNESIUM COMPOUNDS

An Austrian-based magnesia and refractories producer purchased an idled 60,000-ton-per-year magnesite operation in Turkey and planned to reopen the facility and expand its capacity to 100,000 tons per year during the next few years. The company also installed a 76,000-ton-per-year rotary kiln at another Turkish operation, increasing the dead-burned magnesia production capacity to 216,000 tons per year in 2011.

The expansion of fused-magnesia production capacity in recent years continued. In Russia, the leading magnesia producer was increasing its fused magnesia capacity by 50,000 tons per year. The leading magnesia producer in Iran completed a 5,000-ton-per-year fused-magnesia plant in the first half of 2013. 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, owing to 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.

World Magnesite Mine Production and Reserves:

	Mine production		Reserves[4]
	2012	**2013[e]**	
United States	W	W	10,000
Australia	86	90	95,000
Austria	250	250	15,000
Brazil	140	140	86,000
China	4,600	4,000	500,000
Greece	86	100	80,000
India	100	100	20,000
Korea, North	45	150	450,000
Russia	350	400	650,000
Slovakia	170	200	35,000
Spain	120	120	10,000
Turkey	300	300	49,000
Other countries	100	110	390,000
World total (rounded)	[5]6,350	[5]5,960	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 2013, 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. The leading domestic use for primary magnesium was as a reducing agent for the production of titanium and other metals, accounting for 34% of primary metal use. Use as a constituent of aluminum-base alloys that were used for packaging, transportation, and other applications accounted for 33% of primary magnesium consumption. Structural uses of magnesium (castings and wrought products) accounted for 18% of primary metal consumption, desulfurization of iron and steel, 11%, and other uses, 4%.

Salient Statistics—United States:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Production:					
Primary	W	W	W	W	W
Secondary (new and old scrap)	69	72	67	77	80
Imports for consumption	47	53	48	47	45
Exports	20	15	12	17	18
Consumption:					
Reported, primary	53	57	81	72	75
Apparent	[2]80	[2]100	[3]110	[3]110	[3]110
Price, yearend:					
U.S. spot Western, dollars per pound, average	2.30	2.43	2.13	2.20	2.13
China free market, dollars per metric ton, average	2,950	2,925	3,025	3,170	2,590
Stocks, producer and consumer, yearend	W	W	W	W	W
Employment, number[e]	400	400	400	420	420
Net import reliance[4] as a percentage of apparent consumption	33	38	33	27	25

Recycling: In 2013, about 25,000 tons of secondary magnesium was recovered from old scrap and 55,000 tons were recovered from new scrap.

Import Sources (2009–12): Israel, 33%; Canada, 25%; China, 8%; and other, 34%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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: At the end of 2012, the U.S. Court of International Trade (CIT) reinstated an antidumping duty of 15.77% ad valorem assessed on magnesium metal imported into the United States from Russia by a specific company during the period of April 1, 2006, through March 31, 2007. In the original ruling, the 15.77% rate had been imposed, but following a company appeal, the CIT lowered the rate to 8.51% ad valorem. That ruling, however, was appealed to the U.S. Court of Appeals for the Federal Circuit, which ordered the CIT to reinstate the 15.77% rate. On January 1, 2013, the Government of China removed a 10% export tax on magnesium ingot and alloys. Following a complaint filed in 2011 by the European Union, Mexico, and the United States with the Word Trade Organization (WTO), the WTO ruled that the export taxes on magnesium and other mineral products from China violated international trade agreements. In June, the U.S. Department of Commerce, International Trade Administration, imposed an antidumping duty of 339.60% ad valorem on imports of pure magnesium between May 1, 2011, and April 30, 2012, from China by a specific company and its affiliate.

According to the China Non-Ferrous Metals Industry Association, China's reported magnesium production was 478,000 tons in the first half of 2013, 26% higher than that in the first half of 2012. Capacity expansion continued in areas adjacent to sources of dolomite or lake brines and coking operations. Although much of the newer capacity is in locations with lower costs, such as Shaanxi Province, older capacity was still producing at reduced rates and could increase output if prices supported it.

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MAGNESIUM METAL

The use of magnesium in automobile parts was expected to continue to increase as automobile manufactures seek to decrease vehicle weight to comply with fuel efficiency standards. A South Korean producer of primary magnesium was developing magnesium automobile seat frames and was constructing a rolling mill to produce magnesium plate for use in the automobile industry. Consumption of magnesium in the production of titanium metal by the Kroll process was expected to increase as the use of titanium increases in aerospace applications.

In September 2013, the U.S. Department of Energy's (DOE) Advanced Research Projects Agency-Energy announced funding for a project to develop a method of recovering magnesium from seawater using less energy than current production methods. The 3-year project would be conducted at DOE's Pacific Northwest National Laboratory in Richland, WA, and cost $2.7 million. Two corporate partners were also participating in the research project.

World Primary Production and Reserves:

	Primary production	
	2012	2013[e]
United States	W	W
Brazil	16	16
China	698	800
Israel	27	28
Kazakhstan	21	21
Korea, Republic of	3	9
Malaysia	5	5
Russia	29	30
Serbia	2	2
Ukraine	2	2
World total[6] (rounded)	802	910

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, 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 could be recovered from seawater 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 one significant digit to protect proprietary data.
[3]Rounded to two significant digits 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 $950 million.

Salient Statistics—United States:[1]	**2009**	**2010**	**2011**	**2012**	**2013**[e]
Production, mine[2]	—	—	—	—	—
Imports for consumption:					
Manganese ore	269	489	552	506	500
Ferromanganese	153	326	348	401	320
Silicomanganese[3]	130	297	348	348	340
Exports:					
Manganese ore	15	14	1	2	1
Ferromanganese	24	19	5	5	2
Silicomanganese	19	9	8	6	7
Shipments from Government stockpile excesses:[4]					
Manganese ore	3	—	-75	—	—
Ferromanganese	25	26	10	6	1
Consumption, reported:[5]					
Manganese ore[6]	422	450	532	538	500
Ferromanganese	242	292	303	382	370
Silicomanganese	94	97	106	150	145
Consumption, apparent, manganese[7]	451	721	699	843	770
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]	7.95	9.64	7.88	6.04	6.00
CNF[8] China, Ryan's Notes	5.61	7.23	5.72	4.84	[9]5.51
Stocks, producer and consumer, yearend:					
Manganese ore[6]	115	168	250	203	200
Ferromanganese	31	32	25	31	30
Silicomanganese	26	26	22	19	10
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 (2009–12): Manganese ore: Gabon, 60%; Australia, 17%; South Africa, 14%; Ghana, 4%; and other, 5%. Ferromanganese: South Africa, 55%; Ukraine, 10%; Norway, 9%; Republic of Korea, 7%; and other, 19%. Manganese contained in principal manganese imports:[11] South Africa, 34%; Gabon, 20%; Australia, 10%; Georgia, 8%; and other, 28%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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—9–30–13[12]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2013	Disposals FY 2013
Manganese ore[13]	292	292	201	—
Ferromanganese, high-carbon	347	347	91	2

Events, Trends, and Issues: U.S. steel production in 2013 was projected to decrease slightly from that in 2012. Imports of ferromanganese were expected to be 20% less in 2013 than in 2012. As a result, U.S. manganese apparent consumption decreased by an estimated 8% to 770,000 tons in 2013. The annual average domestic manganese ore contract price followed the nominal decrease in the average international price for metallurgical-grade ore set between Japanese consumers and major suppliers in 2013. More than 5 million tons per year of additional manganese ore production capacity was under development worldwide in 2013 through mine expansions and startups, the bulk (57%) of which was in South Africa.

World Mine Production and Reserves (metal content): Reserves for Brazil have been revised based on reports by the Government of Brazil. Reserves for Gabon were revised based on new information from major manganese producers in Gabon.

	Mine production		Reserves[14]
	2012	2013[e]	
United States	—	—	—
Australia	3,080	3,100	97,000
Brazil	1,330	1,400	54,000
Burma	115	120	NA
China	2,900	3,100	44,000
Gabon	1,650	2,000	24,000
India	800	850	49,000
Kazakhstan	380	390	5,000
Malaysia	429	250	NA
Mexico	188	200	5,000
South Africa	3,600	3,800	150,000
Ukraine	416	350	140,000
Other countries	920	950	Small
World total (rounded)	15,800	17,000	570,000

World Resources: Land-based manganese resources are large but irregularly distributed; those in 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 2013.
[10]Defined as imports – exports + adjustments for Government and industry stock changes.
[11]Includes imports of ferromanganese, manganese metal, manganese ore, silicomanganese, and synthetic manganese dioxide.
[12]See Appendix B for definitions.
[13]Metallurgical grade.
[14]See Appendix C for resource/reserve definitions and information concerning data sources.

MERCURY

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

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 2013, mercury was recovered as a byproduct from processing gold-silver ore at several mines in Nevada; however, 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 either packaged for permanent storage or processed and refined for domestic resale. Secondary mercury production data were not reported. It was estimated that less than 50 metric tons per year of mercury was consumed domestically. The leading domestic end users of mercury were the chlorine-caustic soda, electronics, and fluorescent-lighting industries. 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 numerous sources, including mercury-containing car switches when automobiles are scrapped for recycling, coal-fired powerplant emissions, and incinerated mercury-containing medical devices. Mercury is no longer used in batteries and paints manufactured in the United States. Some button-type batteries, cleansers, fireworks, folk medicines, grandfather clocks, pesticides, and some skin-lightening creams and soaps may contain mercury. Until December 31, 2012, domestic- and foreign-sourced mercury was refined and then exported for global use, primarily for small-scale gold mining in many parts of the world. Beginning January 1, 2013, export of elemental mercury from the United States was banned, with some exceptions, under the Mercury Export Ban Act of 2008.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production:					
Mine (byproduct)	NA	NA	NA	NA	NA
Secondary	NA	NA	NA	NA	NA
Imports for consumption (gross weight), metal	206	294	110	249	60
Exports (gross weight), metal	753	459	133	103	([1])
Price, average value, dollars per flask, free market[2, 3]	610	1,076	1,850	1,850	1,850
Net import reliance[4] as a percentage of apparent consumption	E	E	E	E	NA

Recycling: In 2013, six companies in the United States accounted for the majority of secondary mercury 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 shipped to the refining companies for retorting to reclaim the mercury. In addition, many collection companies recovered mercury 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 (2009–12): Chile, 47%; Peru, 23%; Argentina, 15%; Canada, 7%; and other, 8%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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—9–30–13[5]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2013	Disposals FY 2013
Mercury	4,436	—	—	—

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MERCURY

Events, Trends, and Issues: The average monthly price of one flask of domestic mercury and free market mercury was unchanged at $1,850 throughout the year. Imports decreased significantly in 2013 because imports were not reported from countries, such as Argentina, Canada, Chile, and Peru, where foreign companies have stored 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.

Global consumption of mercury was estimated to be less than 2,000 tons per year, and approximately 50% of this consumption was as mercury compounds used as catalysts in the coal-based manufacture of vinyl chloride monomer in China. Conversion to nonmercury technology for chloralkali production and the ultimate closure of the world's mercury-cell chloralkali plants may release a large quantity of mercury to the global market for recycling, sale, or, owing to export bans in Europe and the United States, storage. With the conversion of one mercury cell plant in Tennessee to membrane technology and the closure of a mercury cell chorine-caustic soda unit in Georgia in 2012, only 2 mercury cell chlorine-caustic soda plants operated in the United States in 2013.

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. The volume of byproduct mercury entering the global supply from foreign gold-silver processing may fluctuate dramatically from year to year because mercury is frequently stockpiled in exporting countries until sufficient material is available for export. Domestic mercury consumption will continue to decline as nonmercury-containing products, such as digital thermometers, are substituted for them.

World Mine Production and Reserves:

	Mine production		Reserves[6]
	2012	2013[e]	
United States	NA	NA	—
Chile (byproduct)	52	50	NA
China	1,350	1,350	21,000
Kyrgyzstan	250	250	7,500
Mexico (reclaimed)	21	20	27,000
Peru (exports)	40	40	NA
Russia	50	50	NA
Tajikistan	30	30	NA
Other countries	20	20	38,000
World total (rounded)	1,810	1,810	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]Less than ½ unit.
[2]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.
[3]Platts Metals Week average mercury price quotation for the year. Actual prices may vary significantly from quoted prices.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]See Appendix B for definitions.
[6]See Appendix C for resource/reserve definitions and information concerning data sources.

MICA (NATURAL)

(Data in metric tons unless otherwise noted)

Domestic Production and Use: Scrap and flake mica production, excluding low-quality sericite, was estimated to be 50,000 tons in 2013. Mica was mined in 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 2013 scrap mica production was estimated to be $6.4 million.

A minor amount of sheet mica was produced in 2013 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:	2009	2010	2011	2012	2013[e]
Scrap and flake:					
Production:[1, 2]					
Mine	51,100	56,100	52,000	47,500	50,000
Ground	77,000	75,600	80,400	78,500	80,000
Imports, mica powder and mica waste	19,900	26,400	27,500	27,200	33,200
Exports, mica powder and mica waste	8,030	6,480	5,870	5,900	5,190
Consumption, apparent[3]	63,000	76,000	73,600	68,700	78,000
Price, average, dollars per metric ton, reported:					
Scrap and flake	128	147	133	128	128
Ground:					
Dry	284	350	332	332	350
Wet	651	651	651	651	700
Employment, mine, number	NA	NA	NA	NA	NA
Net import reliance[4] as a percentage of apparent consumption	19	26	29	31	36
Sheet:					
Production, mine[e]	([5])	([5])	([5])	([5])	([5])
Imports, plates, sheets, strips; worked mica; split block; splittings; other >$1.00/kg	1,500	1,980	2,190	2,380	2,140
Exports, plates, sheets, strips; worked mica; crude and rifted into sheet or splittings >$1.00/kg	1,110	932	1,040	1,660	1,310
Shipments from Government stockpile excesses	—	—	—	—	—
Consumption, apparent	[6]390	1,050	1,160	716	827
Price, average value, dollars per kilogram, muscovite and phlogopite mica, reported:					
Block	121	130	152	160	160
Splittings	1.66	1.53	1.63	1.72	1.72
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 (2009–12): Scrap and flake: Canada, 34%; China, 29%; India, 22%; Finland, 7%; and other, 8%. Sheet: China, 25%; Brazil, 21%; Belgium, 18%; India, 17%; and other, 19%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 have increased in 2013. The increase primarily resulted from increased production of minerals from which mica is a byproduct, and it seemed that the slight recovery in construction materials markets had finally resulted in increased mica consumption. Apparent consumption of sheet mica increased in 2013. 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[7]	Mine production[e]		Reserves[7]
	2012	2013		2012	2013	
All types:						
United States[1]	47,500	50,000	Large	([5])	([5])	Very small
Argentina	10,000	9,000	Large	—	—	NA
Brazil	6,200	6,200	Large	—	—	NA
Canada	16,000	16,000	Large	—	—	NA
China	770,000	770,000	Large	—	—	NA
Finland:	39,600	40,000	Large			NA
France	20,000	20,000	Large	—	—	NA
India	13,700	14,000	Large	4,000	2,000	Very large
Korea, Republic of	32,000	26,000	Large	—	—	NA
Russia	100,000	100,000	Large	1,500	1,500	Moderate
Turkey	30,300	30,300	Large	—	—	NA
Other countries	15,000	19,000	Large	200	200	Moderate
World total (rounded)	1,100,000	1,100,000	Large	5,700	3,700	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]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 2013, molybdenum, valued at about $1.4 billion (based on an average oxide price), was produced at 11 mines. Molybdenum ore was produced as a primary product at three mines—two in Colorado, and one in Idaho—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 72% of the molybdenum consumed.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production, mine	47,800	59,400	63,700	60,400	61,000
Imports for consumption	11,400	19,700	21,100	19,800	18,500
Exports	27,900	31,600	35,400	29,300	39,400
Consumption:					
Reported[1]	17,700	19,200	19,100	19,700	20,100
Apparent[2]	30,600	46,400	47,400	51,500	40,000
Price, average value, dollars per kilogram[3]	25.84	34.83	34.34	28.09	22.74
Stocks, consumer materials	1,540	1,630	1,810	1,780	1,800
Employment, mine and plant, number	920	940	940	940	960
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 (2009–12): Ferromolybdenum: Chile, 78%; Canada, 8%; United Kingdom, 6%; and other, 8%. Molybdenum ores and concentrates: Mexico, 33%; Chile, 24%; Peru, 23%; Canada, 16%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 2013 increased slightly from that of 2012. U.S. imports for consumption increased by 7% from those of 2012, and U.S. exports increased by 34% from those of 2012. Domestic roasters operated close to full production levels in 2012 and 2013. Reported U.S. consumption of primary molybdenum products slightly decreased from that of 2012. Apparent consumption of roasted molybdenum concentrates decreased by 22% from that of 2012. This decrease in apparent consumption is partially attributed to a 41% increase in exports of roasted molybdenum concentrates in 2013 compared with 2012.

Molybdenum prices continued to decrease throughout the year; the average price for 2013 was lower than that of 2012 as well as that of 2009. However, molybdenum demand remained strong. Byproduct and primary molybdenum production levels in the United States remained stable in 2013 compared with their relatively low levels in 2009. Primary molybdenum production continued at the Climax Mine in Lake County and Summit County, CO, but ceased at the Ashdown Mine in Humboldt County, NV, and at the Questa Mine in Taos County, NM. Byproduct molybdenum production at the Mission Mine in Pima County, AZ, continued to be suspended.

World Mine Production and Reserves: Reserve data from Turkey were revised based on new information from company reports.

	Mine production		Reserves[5]
	2012	2013[e]	(thousand metric tons)
United States	60,400	61,000	2,700
Armenia	4,900	6,500	150
Canada	9,010	9,000	220
Chile	35,100	36,500	2,300
China	104,000	110,000	4,300
Iran	6,300	6,300	50
Kazakhstan	—	—	130
Kyrgyzstan	NA	NA	100
Mexico	11,000	11,000	130
Mongolia	1,900	2,000	160
Peru	16,800	16,900	450
Russia[e]	3,900	4,800	250
Turkey	5,000	5,000	100
Uzbekistan[e]	550	550	60
World total (rounded)	259,000	270,000	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 boron, chromium, niobium (columbium),and vanadium in alloy steels; tungsten in tool steels; graphite, tantalum, and tungsten for refractory materials in high-temperature electric furnaces; and cadmium-red, chrome-orange, and organic-orange pigments for molybdenum orange.

[e]Estimated. E Net exporter. NA Not available.
[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 had only one active nickel mine in 2013—a greenfield, underground operation in Michigan. Contractors completed the main decline tunnel of the new chalcopyrite-pentlandite mine in May 2013. The mine was scheduled to be in full production by late 2014. Two mining projects were also in varying stages of development in northeastern Minnesota. On an annual basis, 121 facilities reported nickel consumption. The principal consuming State was Pennsylvania, followed by Kentucky, North Carolina, New York, and Illinois. Approximately 48% of the primary nickel consumed went into stainless and alloy steel production, 41% into nonferrous alloys and superalloys, 7% into electroplating, and 4% into other uses. End uses were as follows: transportation, 31%; fabricated metal products, 13%; 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 $1.79 billion.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production, refinery byproduct	W	W	W	W	W
Shipments of purchased scrap[1]	152,000	139,000	130,000	127,000	130,000
Imports:					
Primary	99,900	129,000	138,000	133,000	130,000
Secondary	17,700	23,800	21,300	22,300	21,800
Exports:					
Primary	7,030	12,600	12,400	9,100	9,900
Secondary	90,000	80,300	64,800	59,800	65,000
Consumption:					
Reported, primary	83,100	98,700	107,000	110,000	97,600
Reported, secondary	79,800	81,900	86,600	89,900	82,200
Apparent, primary	93,500	114,000	124,000	126,000	119,000
Total[2]	173,000	196,000	211,000	216,000	202,000
Price, average annual, London Metal Exchange:					
Cash, dollars per metric ton	14,649	21,804	22,890	17,533	15,018
Cash, dollars per pound	6.645	9.890	10.383	7.953	6.812
Stocks:					
Consumer, yearend	14,700	17,100	18,300	16,700	17,000
Producer, yearend[3]	5,490	6,240	6,650	5,980	6,080
Net import reliance[4] as a percentage of apparent consumption	22	41	48	50	48

Recycling: About 82,200 tons of nickel was recovered from purchased scrap in 2013. This represented about 41% of reported secondary plus apparent primary consumption for the year.

Import Sources (2009–12): Canada, 34%; Russia, 16%; Australia, 11%; Norway, 10%; and other, 29%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 at Paducah, KY, plus 5,080 tons of contaminated shredded nickel scrap at Oak Ridge, TN. Ongoing decommissioning activities at former nuclear defense sites are expected to generate an additional 20,000 tons of nickel in scrap.

Events, Trends, and Issues: The U.S. economy continued to recover from the global recession of 2008–09, but the recovery was slow. The U.S. steel industry produced 1.54 million tons of austenitic (nickel-bearing) stainless steel in 2013—up by 8% from 2012 and 31% 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 14.3 million tons of austenitic stainless steel in 2013.

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NICKEL

Nickel prices deteriorated further in 2013 even though the global economy was slowly recovering. In February 2013, the London Metal Exchange (LME) cash mean for 99.8%-pure nickel peaked briefly at $17,729 per metric ton after partially recovering from an 11-month decline. However, the cash price started contracting again as increased production of nickel pig iron in China weakened demand for imported ferronickel. Manufacturing cutbacks in Europe and related economic problems also helped to depress prices. By November, the cash price had fallen to $13,725 per ton; the price drop was accompanied by the gradual buildup of stocks in LME warehouses to record-high levels.

Mining companies continue to bring on new nickel projects in anticipation of a turnaround in the global economy, despite current weak prices and an oversupply of the metal. For at least 20 years, the nickel price cycle has been shorter than the time period required to develop and commission many greenfield mining projects. Global long-term demand for austenitic stainless steel has been projected to grow despite the current depressed economic climate. Demand for superalloys is expected to be especially strong in the aerospace and power-generation sectors. The Koniambo mining and smelting complex in New Caledonia began producing ferronickel in April 2013. The Government of Indonesia took steps to limit the export of direct shipping ores in an effort to encourage the construction of additional ferronickel and nickel pig iron production facilities in the archipelago. In 2009, Danish geologists identified a 3-billion-year-old meteorite impact site near Maniitsoq, Greenland. Subsequent exploration drilling revealed significant nickel-copper sulfide mineralization. The Greenland discovery, coupled with new projects in Canada and Russia, could help offset the depletion of nickel sulfide reserves elsewhere in the world.

World Mine Production and Reserves: Reserves for Australia, Brazil, and the United States were revised based on new information from company or Government reports.

	Mine production		Reserves[5]
	2012	2013[e]	
United States	—	—	160,000
Australia	246,000	240,000	[6]18,000,000
Brazil	139,000	149,000	8,400,000
Canada	205,000	225,000	3,300,000
China	93,300	95,000	3,000,000
Colombia	84,000	75,000	1,100,000
Cuba	68,200	66,000	5,500,000
Dominican Republic	15,200	12,500	970,000
Indonesia	228,000	440,000	3,900,000
Madagascar	8,250	26,000	1,600,000
New Caledonia[7]	132,000	145,000	12,000,000
Philippines	424,000	440,000	1,100,000
Russia	255,000	250,000	6,100,000
South Africa	45,900	48,000	3,700,000
Other countries	273,000	274,000	5,100,000
World total (rounded)	2,220,000	2,490,000	74,000,000

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 7.5 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 niobium-containing materials 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, 79%; and superalloys, 21%. In 2012, the estimated value of niobium consumption was $487 million and was expected to be about $500 million in 2013, as measured by the value of imports.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production:					
Mine	—	—	—	—	—
Secondary	NA	NA	NA	NA	NA
Imports for consumption[e, 1]	4,400	8,490	9,510	10,100	10,000
Exports[e, 1]	195	281	363	385	300
Government stockpile releases[e, 2]	—	—	—	—	—
Consumption:[e]					
Apparent	4,210	8,210	9,160	9,730	10,000
Reported[3]	4,350	5,590	9,060	7,670	7,000
Unit value, ferroniobium, dollars per metric ton[4]	37,298	37,781	41,825	43,658	44,000
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 (2009–12): Niobium contained in niobium and tantalum ore and concentrate: Mozambique, 23%; Australia, 20%; Canada, 19%; and other, 38%; niobium metal and oxide: Brazil, 84%; Canada, 12%; and other, 4%. Total imports: Brazil, 84%; Canada, 12%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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) 2013, which ended on September 30, 2013, the Defense Logistics Agency, DLA Strategic Materials disposed of no niobium materials. The DLA Strategic Materials had not announced maximum disposal limits for niobium metal in FY 2014. 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—9–30–13[7]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2013	Disposals FY 2013
Niobium metal	10.0	—	—	—

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 2013 as in 2012, when Brazil was the leading niobium supplier. U.S. niobium apparent consumption (measured in contained niobium) in 2012 was 9,160 metric tons (t), 12% more than that of 2011.

In descending order of production, Brazil and Canada were the world's leading niobium producers.

World Mine Production and Reserves:

	Mine production		Reserves[8]
	2012	2013[e]	
United States	—	—	—
Brazil	45,000	45,000	4,100,000
Canada	4,710	5,000	200,000
Other countries	375	700	NA
World total (rounded)	50,100	51,000	>4,300,000

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 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 2013 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 28 plants in 15 States in the United States during 2013; 2 additional plants were idle for the entire year. About 60% 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 2013, U.S. producers operated at about 80% 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 84% 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]	2009	2010	2011	2012	2013[e]
Production	[2]7,700	[2]8,290	[3]9,350	[4]8,730	8,700
Imports for consumption	4,530	5,540	5,600	5,170	5,000
Exports	16	36	26	31	150
Consumption, apparent	12,300	13,800	14,900	13,900	13,500
Stocks, producer, yearend	167	165	178	180	220
Price, dollars per ton, average, f.o.b. Gulf Coast[5]	251	396	531	579	540
Employment, plant, number[e]	1,050	1,050	1,050	1,100	1,200
Net import reliance[6] as a percentage of apparent consumption	38	40	37	37	36

Recycling: None.

Import Sources (2009–12): Trinidad and Tobago, 62%; Canada, 16%; Russia, 7%; Ukraine, 6%; and other, 9%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 $3.10 and $4.30 per million British thermal units for most of the year, with an average of about $3.70 per million British thermal units. Natural gas prices in 2013 were relatively stable; slightly higher prices were a result of increased demand for natural gas owing to high temperatures and associated increased demand for power generation. The average Gulf Coast ammonia price gradually decreased from $685 per short ton at the beginning of 2013 to a low of around $440 per short ton in July. The average ammonia price for the year was estimated to be about $540 per short ton. The U.S. Department of Energy, Energy Information Administration, projected that Henry Hub natural gas spot prices would average $3.84 per million British thermal units in 2014.

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. During the next 4 years, it is expected that about 3.1 million tons of annual production capacity will be added in the United States.

Several companies announced plans to build new ammonia plants in Azerbaijan, Bolivia, Indonesia, Nigeria, Russia, and Saudi Arabia, which would add about 4.7 million tons of annual global production capacity within the next 2 to 4 years. The largest increase in ammonia production is likely to be in North America because of low natural gas prices.

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NITROGEN (FIXED)—AMMONIA

According to the U.S. Department of Agriculture, U.S. corn growers planted 38 million hectares of corn in the 2013 crop year (July 1, 2012, through June 30, 2013), which was slightly lower than the area planted in 2012. Corn acreage utilization was expected to increase in many States in the 2014 crop year because of anticipated higher selling prices and expectations of better net returns from corn compared to other commodities. Overall corn acreage in the United States 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 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. A hypoxic zone happens where water near the bottom of an affected area in a large body of water, such as the Gulf of Mexico, contains less than 2 parts per million of dissolved oxygen. This may cause stress or death in bottom-dwelling organisms that cannot move out of the hypoxic zone. Scientists continued to study the effects of fertilization on the Nation’s environmental health.

World Ammonia Production and Reserves:

	Plant production		Reserves[7]
	2012	2013[e]	
United States	8,730	8,700	Available atmospheric nitrogen and sources of natural gas for production of ammonia are considered adequate for all listed countries.
Australia	1,250	1,300	
Bangladesh	1,300	1,300	
Canada	3,940	3,900	
China	45,200	46,000	
Egypt	3,000	3,000	
France	3,500	3,500	
Germany	2,820	2,800	
India	12,000	12,000	
Indonesia	5,100	5,100	
Iran	2,500	2,500	
Japan	1,200	1,200	
Netherlands	1,800	1,800	
Oman	1,700	1,700	
Pakistan	2,500	2,500	
Poland	1,900	1,900	
Qatar	2,100	2,100	
Russia	10,400	10,000	
Saudi Arabia	2,600	2,600	
Trinidad and Tobago	5,250	5,300	
Ukraine	4,200	4,200	
United Kingdom	1,100	1,100	
Uzbekistan	1,300	1,300	
Venezuela	1,200	1,200	
Other countries	13,000	13,000	
World total (rounded)	140,000	140,000	

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. No practical substitutes for nitrogen explosives and blasting agents are known.

[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 $11.0 million in 2013. Peat was harvested and processed by about 34 companies in 12 of the conterminous States. The Alaska Department of Natural Resources, which conducted its own canvass of producers, reported 93,100 cubic meters of peat was produced in 2012; output was reported only by volume.[2] A production estimate was unavailable for Alaska for 2013. Florida and Minnesota were the leading producing States, in order of quantity harvested. Reed-sedge peat accounted for approximately 78% of the total volume produced followed by sphagnum moss, 16%. About 90% 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:	2009	2010	2011	2012	2013[e]
Production	609	628	568	488	480
Commercial sales	644	605	595	484	460
Imports for consumption	906	947	982	911	950
Exports	77	69	49	76	53
Consumption, apparent[3]	1,440	1,560	1,500	1,240	1,400
Price, average value, f.o.b. mine, dollars per ton	23.24	24.39	22.73	24.44	24.00
Stocks, producer, yearend	149	100	133	218	200
Employment, mine and plant, number[e]	610	610	600	580	560
Net import reliance[4] as a percentage of apparent consumption	58	60	61	61	66

Recycling: None.

Import Sources (2009–12): Canada, 97%; and other, 3%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 480,000 tons per year and imported peat from Canada to account for more than 69% of domestic consumption.

In Canada's eastern and central regions, peat harvest was below average for the 2013 season. A late and interrupted start to the harvest season and wet weather in late summer decreased the peat production. For Manitoba and Saskatchewan, the peat harvest was about average, while Alberta's peat harvest was below average.

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." Reserve data for Belarus was revised based on information reported by The National Academy of Sciences of Belarus.

	Mine production		Reserves[5]
	2012	2013[e]	
United States	488	480	150,000
Belarus	3,250	3,300	2,600,000
Canada	973	1,200	720,000
Estonia	927	930	60,000
Finland	4,760	4,760	6,000,000
Germany	3,050	3,000	([6])
Ireland	1,950	1,950	([6])
Latvia	1,380	1,380	76,000
Lithuania	386	380	190,000
Moldova	475	480	([6])
Norway	440	440	([6])
Poland	736	760	([6])
Russia	1,300	1,300	1,000,000
Sweden	3,300	3,300	([6])
Ukraine	735	740	([6])
Other countries	600	600	1,400,000
World total (rounded)	24,700	25,000	12,000,000

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.[7]

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., July 19, 2013.
[3]Defined as production + imports – exports + adjustments for industry stock changes.
[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]Included with "Other countries."
[7]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 2013 was $21.1 million. Crude ore production came from eight mines operated by six companies in five Western States. New Mexico continued to be the leading producing State. Processed crude perlite was expanded at 48 plants in 27 States. The principal end uses were building construction products, 53%; fillers, 15%; horticultural aggregate, 14%; and filter aid, 10%. The remaining 8% includes miscellaneous uses and estimated expanded perlite consumption, for which end use data is unavailable.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production[1]	348	414	420	396	376
Imports for consumption[e]	153	174	193	150	134
Exports[e]	33	42	36	38	38
Consumption, apparent	468	546	577	508	472
Price, average value, dollars per ton, f.o.b. mine	49	52	56	52	56
Employment, mine and mill	97	102	95	95	92
Net import reliance[2] as a percentage of apparent consumption	26	24	27	22	20

Recycling: Not available.

Import Sources (2009–12): Greece, 100%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 decreased by 5% in 2013 compared with that reported for 2012. Imports decreased by about 11% as demand for perlite-based construction products, fillers, and filter aid failed to sustain a modest recovery that took place in 2010 and 2011.

The quantities of processed crude perlite sold or used each year from 2009 through 2013 had not recovered to levels seen prior to 2006 and in 2013 were about equal to the quantity sold or used in the late 1960s. Imports declined for the second consecutive year, falling to the lowest levels since 1997. The average unit value for crude processed perlite in 2012 fell to the lowest value since 2006, but was thought to have rebounded in 2013. The steep price decline in 2012 was mainly the result of one producer reporting a substantial drop in selling prices. Most producers did not report a substantial decrease in pricing.

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 to contribute to water pollution.

World Processed Perlite Production and Reserves: Newly available data indicate that Greece, Iran, and Turkey have been producing substantially more perlite than the United States since at least 2008. Although production data for China and several other countries are unavailable, the world's leading producers are believed to be Greece and Turkey. 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]
	2012	2013[e]	
United States	396	376	50,000
Greece	800	800	50,000
Hungary	70	70	NA
Iran	500	500	NA
Italy	60	60	NA
Japan	200	200	NA
Turkey	800	800	NA
Other countries	150	150	NA
World total (rounded)	2,980	3,000	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.
[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 32.3 million tons of marketable product valued at $3.0 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:	2009	2010	2011	2012	2013[e]
Production, marketable	26,400	25,800	28,100	30,100	32,300
Sold or used by producers	25,500	28,100	28,600	27,300	29,000
Imports for consumption	2,000	2,400	3,350	3,080	2,600
Consumption[1]	27,500	30,500	32,000	30,400	31,600
Price, average value, dollars per ton, f.o.b. mine[2]	127.19	76.69	96.64	102.54	91.40
Stocks, producer, yearend	8,120	5,620	4,580	6,700	8,200
Employment, mine and beneficiation plant, number[e]	2,500	2,300	2,260	2,240	2,150
Net import reliance[3] as a percentage of apparent consumption	1	16	13	3	3

Recycling: None.

Import Sources (2009–12): Morocco, 70%; and Peru, 30%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–13**
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 of phosphate rock in 2013 was estimated to have increased by less than 4% over that of 2012, owing to increased production of phosphoric acid. World production was estimated to be slightly higher in 2013 compared with that of 2012.

The leading U.S. phosphate rock producer purchased the phosphate assets of the only other phosphate rock producer in central Florida. The transaction included a phosphate rock mine, processing facility, and fertilizer plant. The acquisition was subject to Federal Antitrust review, which was expected to be completed in early 2014.

The development of a new underground phosphate rock mine continued in southeastern Idaho in 2013. The results of a feasibility study reported that the mine has 16.7 million tons of reserves, with an average grade of 29.5% P_2O_5. The Canadian owner of the mine planned to have an average production rate of 904,000 tons per year over the expected 19-year lifespan of the mine. The company expected to begin production in early 2015.

World phosphate rock annual production capacity was projected to increase from 228 million tons in 2013 to about 260 million tons in 2017. The largest of increases in capacity were expected from projects in Brazil, China, Morocco, Peru, and Saudi Arabia. Other significant development projects were planned or in progress in Algeria, Australia, Canada, Kazakhstan, Namibia, Russia, Togo, and Tunisia.

World consumption of P_2O_5 in fertilizers was projected to increase from 40.7 million tons in 2013 to 45 million tons in 2017, with the largest growth in Asia and South America.

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PHOSPHATE ROCK

World Mine Production and Reserves: Reserves for Jordan, Saudi Arabia, and the United States were updated with information in company reports. Reserves for India were updated with data from the Indian Minerals Yearbook. Reserves for Australia were updated with data from Geoscience Australia. Reserves for Israel, Senegal, and Togo were updated with data from the International Fertilizer Development Center. Reserves for Kazakhstan were from individual company reports.

	Mine production		Reserves[4]
	2012	2013[e]	
United States	30,100	32,300	1,100,000
Algeria	1,250	1,500	2,200,000
Australia	2,600	2,600	870,000
Brazil	6,750	6,740	270,000
Canada	900	300	2,000
China[5]	95,300	97,000	3,700,000
Egypt	6,240	6,000	100,000
India	1,260	1,270	35,000
Iraq	200	350	430,000
Israel	3,510	3,600	130,000
Jordan	6,380	7,000	1,300,000
Kazakhstan	1,600	1,600	260,000
Mexico	1,700	1,700	30,000
Morocco and Western Sahara	28,000	28,000	50,000,000
Peru	3,210	3,900	820,000
Russia	11,200	12,500	1,300,000
Saudi Arabia	3,000	3,000	211,000
Senegal	1,380	920	50,000
South Africa	2,240	2,300	1,500,000
Syria	1,000	500	1,800,000
Togo	870	900	30,000
Tunisia	2,600	4,000	100,000
Other countries	5,500	5,630	520,000
World total (rounded)	217,000	224,000	67,000,000

World Resources: Some world reserves were reported only in terms of ore and grade, not as marketable phosphate rock. 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 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; 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 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:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Mine production:[1]					
Platinum	3,830	3,450	3,700	3,670	3,700
Palladium	12,700	11,600	12,400	12,300	12,500
Imports for consumption:					
Platinum	183,000	152,000	129,000	172,000	83,000
Palladium	69,700	70,700	98,900	80,100	87,000
Rhodium	11,200	12,800	13,100	12,800	11,000
Ruthenium	21,200	14,100	13,300	10,200	13,000
Iridium	1,520	3,530	2,790	1,230	1,500
Osmium	68	76	48	130	130
Exports:					
Platinum	15,600	16,900	11,300	8,630	11,000
Palladium	30,300	38,100	32,000	32,200	29,000
Rhodium	1,220	2,320	1,370	1,040	1,500
Other PGMs	4,020	3,720	1,150	1,640	1,100
Price,[2] dollars per troy ounce:					
Platinum	1,207.55	1,615.56	1,724.51	1,555.39	1,511.00
Palladium	265.65	530.61	738.51	649.27	736.00
Rhodium	1,591.32	2,459.07	2,204.35	1,274.98	1,095.00
Ruthenium	97.28	198.45	165.85	112.26	81.00
Iridium	420.40	642.15	1,035.87	1,066.23	921.00
Employment, mine, number[1]	1,270	1,350	1,570	1,660	1,700
Net import reliance[3] as a percentage of apparent consumption[e]					
Platinum	95	91	89	90	79
Palladium	62	49	64	57	60

Recycling: An estimated 155,000 kilograms of PGMs was recovered globally from new and old scrap in 2013, including about 56,000 kilograms of PGMs in North America.

Import Sources (2009–12): Platinum: Germany, 18%; South Africa, 18%; United Kingdom, 9%; Canada, 8%; and other, 47%. Palladium: Russia, 33%; South Africa, 28%; United Kingdom, 25%; Norway, 6%; and other, 8%.

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 2013.

Stockpile Status—9–30–13[4]

Material	**Uncommitted inventory**	**Authorized for disposal**	**Disposal plan FY 2013**	**Disposals FY 2013**
Platinum	261	261	[5]778	—
Iridium	18	18	[5]186	—

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PLATINUM-GROUP METALS

Events, Trends, and Issues: Owing to continued global economic concerns, the average annual prices for iridium, platinum, rhodium, and ruthenium decreased for the second consecutive year. The palladium average yearly price was higher in 2013 than that in 2012, likely owing to increased consumption in the automobile sector. Prices for platinum and rhodium increased early in the year but then generally decreased; iridium prices were stable until midyear and then decreased markedly toward yearend, reportedly owing to lack of buying interest. Platinum prices remained higher than those for rhodium for the second consecutive year, and remained below those for gold during the first quarter of 2013 before increasing above gold prices.

Three expansion projects continued on schedule, adjacent to the only U.S. PGM mining company's existing mines. The projects were expected to begin producing in 2014 and 2016. A detailed engineering and feasibility study on the company's Canadian PGM project was expected to be completed by the end of 2013.

Unrest continued in the platinum mining sector in South Africa, the world's leading supplier of PGMs. Although workers' strikes at several mining companies resulted in production losses, production at other mines more than made up for the losses. Disputes at various mining companies were fueled by rivalry between two workers' unions. Owing to increased costs and lower metal prices, several mines were placed on care-and-maintenance status. In an effort to return to profitability, a leading PGM producer planned to restructure its operations by consolidating mines, closing an unprofitable mine, and abolishing thousands of workers' positions.

The Government of Zimbabwe announced plans to seize nearly 28,000 hectares of land from a South African mining company, Zimbabwe's leading PGMs miner, and sell the land to new investors. The Government also planned to require that a PGM refinery be built in Zimbabwe within the next 2 years so that PGMs mined in Zimbabwe would be refined locally to derive greater value.

A new platinum exchange-traded fund (ETF) was launched in Johannesburg, South Africa, at the end of April. By late August, the fund contained 18,000 kilograms of platinum, making it the leading global platinum ETF. Investment interest in platinum was supported by supply concerns caused by the unrest in the South African PGM mining sector.

World Mine Production and Reserves:

	Mine production				PGMs
	Platinum		Palladium		Reserves[6]
	2012	2013[e]	2012	2013[e]	
United States	3,670	3,700	12,300	12,500	900,000
Canada	7,000	7,000	12,200	13,000	310,000
Russia	24,600	25,000	82,000	82,000	1,100,000
South Africa	133,000	140,000	74,000	82,000	63,000,000
Zimbabwe	11,000	12,000	9,000	9,000	([7])
Other countries	3,480	4,000	11,500	12,000	800,000
World total (rounded)	183,000	192,000	201,000	211,000	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 as much as 50% in some applications. For other end uses, some PGMs can be substituted for other PGMs, with some losses in efficiency.

[e]Estimated. — Zero.
[1]Estimates from published sources.
[2]Engelhard Corporation unfabricated metal.
[3] Defined as imports – exports + adjustments for Government and industry stock changes.
[4] See Appendix B for definitions.
[5] Actual quantity limited to remaining inventory.
[6] See Appendix C for resource/reserve definitions and information concerning data sources.
[7]Included with "Other countries."

POTASH

(Data in thousand metric tons of K_2O equivalent unless otherwise noted)

Domestic Production and Use: In 2013, the production value of marketable potash, f.o.b. mine, was about $649 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 facility was closed in November, as the operating company focused on its larger potash mines in New Mexico and Saskatchewan, Canada.

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:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Production, marketable[1]	720	930	1,000	900	970
Sales by producers, marketable[1]	630	1,000	990	980	880
Imports for consumption	2,220	4,760	4,980	4,240	4,750
Exports	303	297	202	234	180
Consumption:[1, 2]	2,500	5,500	5,800	5,000	5,500
Price, dollars per metric ton of K_2O, average, muriate, f.o.b. mine[3]	800	630	745	765	740
Employment, number:					
Mine	610	650	660	750	770
Mill	700	700	620	740	770
Net import reliance[4] as a percentage of apparent consumption	73	83	83	82	82

Recycling: None.

Import Sources (2009–12): Canada, 85%; Russia, 10%; Israel, 2%, Chile 2%, and other, 1%.

Tariff:

Item	Number	Normal Trade Relations 12–31–13
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: Domestic sales of potash decreased from those of 2012 because of delayed fall fertilizer applications and the uncertainty of prices in the second half of the year.

In July 2013, the leading Russian potash producer dissolved its marketing affiliation with the only Belarus potash producer. Following the breakup, potash prices dropped by nearly 30% worldwide, as lower selling prices by the Russian producer forced other companies to lower prices to remain competitive. Potash sales decreased worldwide in last half of 2013, as many buyers waited for a significant drop in prices.

In New Mexico, a new solar solution mine began pumping enriched brine into evaporation ponds and initial potash production was expected by early 2014. The company expected to complete construction of the processing facility at the mine in 2014 and to start full production of 150,000 to 200,000 per year in the second half of 2015.

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POTASH

A Canadian company continued development of a new underground potash mine in southeastern New Mexico. The company plans to produce only SOP and SOPM. Initial production was expected to begin in 2016, with annual production of 568,000 tons of SOP and 275,000 tons of SOPM.

In 2013, progress continued in the development of new mines and expansion of existing facilities in more than 15 countries worldwide. Projects in Canada, Laos, and Russia were expected to be completed by 2017. Other important projects in Belarus, Brazil, Congo (Brazzaville), Eritrea, Ethiopia, Russia, Turkmenistan, United Kingdom, and Uzbekistan were not expected to be operational until after 2018.

World consumption of potash, for all applications, was expected to increase by about 3% per year over the next several years.

World Mine Production and Reserves:. Reserves for Belarus were revised using official Government sources and may not be comparable to the reserves definition in Appendix C. Belarus reserves are in terms of gross tonnage only. Previously, Russian reserves were reported using only Russian reserve system criteria. Recently, Russian producers began reporting reserves that have been revised to the K_2O content of JORC potash reserves as reported by producers. Additionally, the leading Russian producer changed its reserves to reflect only properties that were planned to be mined in the next 20 years. Previously, the potash reserve estimate for Canada contained data in terms of K_2O content and gross tonnage. Canadian reserve estimates were revised to reflect the K_2O content for proven and probable reserves. U.S. reserves were revised to account for reported data from projects under development.

	Mine production		Reserves[5]
	2012	2013[e]	
United States[1]	900	970	200,000
Belarus	4,760	4,900	3,300,000
Brazil	425	425	300,000
Canada (K_2O content)*	8,980	10,500	1,000,000
Chile	1,050	1,100	150,000
China	4,100	4,300	210,000
Germany	3,120	3,000	140,000
Israel	1,900	2,000	[6]40,000
Jordan	1,090	1,200	[6]40,000
Russia (K_2O content)*	5,470	5,300	600,000
Spain	420	436	20,000
United Kingdom	470	470	22,000
Other countries	—	—	50,000
World total (rounded)	32,700	34,600	*6,000,000

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 more than 75 million tons. Estimated world resources total about 250 billion tons.

Substitutes: No substitutes exist 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 sales + imports – exports.
[3]Average prices based on actual sales; excludes soluble and chemical muriates.
[4]Defined as imports – exports.
[5]See Appendix C for resource/reserve definitions and information concerning data sources.
[6]Total reserves in the Dead Sea are arbitrarily divided equally between Israel and Jordan for inclusion in this tabulation.
*Corrections posted on

PUMICE AND PUMICITE

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2013, domestic production of pumice and pumicite was estimated to be 400,000 tons with an estimated processed value of about $11.4 million, f.o.b. plant. Production took place at 10 operations in 6 States. Pumice and pumicite were mined in Oregon, Idaho, Arizona, California, New Mexico, and Kansas, in descending order of production. About 38% of mined pumice was used in the production of construction building block; horticulture consumed 37%; concrete admixture and aggregate, 15%; abrasives, 7%; and the remaining 3% was used for absorbent, filtration, laundry stone washing, and other applications.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production, mine[1]	384	296	398	397	400
Imports for consumption	26	34	23	67	34
Exports[e]	11	13	14	12	13
Consumption, apparent	399	317	406	451	421
Price, average value, dollars per ton, f.o.b. mine or mill	31.10	23.90	27.20	28.00	28.50
Employment, mine and mill, number	150	145	140	140	140
Net import reliance[2] as a percentage of apparent consumption	4	7	2	14	5

Recycling: Not available.

Import Sources (2009–12): Greece, 89%; Iceland, 5%; Mexico, 3%; Montserrat, 2%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 2013 increased to 400,000 tons, compared with 397,000 tons in 2012. Exports increased and imports decreased compared with those of 2012. Approximately 98% of pumice imports originated from Greece and Mexico in 2013, 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 2013 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]
	2012	2013[e]	
United States[1]	397	400	Large in the United States. Quantitative estimates of reserves for most countries are not available.
Algeria	300	300	
Cameroon	500	500	
Chile	820	830	
Ecuador	650	675	
Ethiopia	350	350	
Greece	1,180	1,200	
Italy	3,020	3,000	
Saudi Arabia	1,000	1,000	
Spain	600	600	
Syria	300	500	
Turkey	5,500	5,500	
Other countries	1,900	1,800	
World total (rounded)	16,500	16,700	

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 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 2013, 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 $200 per kilogram in 2013. 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 2013; 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 (2009–12): 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 12–31–13
Sands:		
95% or greater silica	2505.10.1000	Free.
Less than 95% silica	2505.10.5000	Free.
Quartz (including lascas)	2506.10.0050	Free.
Piezoelectric quartz	7104.10.0000	3% ad val.

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

Government Stockpile: As of September 30, 2013, 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 2013. 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—9–30–13[2]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2013	Disposals FY 2013
Quartz crystal	7	([3])	—	—

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QUARTZ CRYSTAL (INDUSTRIAL)

Events, Trends, and Issues: Demand for electronics such as cellular telephones, computers, and including end uses as diverse as entertainment and military applications, indicates that the manufacture of 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 cellular telephones, computers, electronic games, and tablet computers) 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 2013. Bastnäsite, a rare-earth fluocarbonate mineral, was mined as a primary product at Mountain Pass, CA. Rare-earth concentrates produced at Mountain Pass 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 2013. The estimated value of refined rare earths imported by the United States in 2013 was $260 million, a significant decrease from $519 million imported in 2012. Based on reported data through September 2013, the estimated 2013 distribution of rare earths by end use was as follows, in decreasing order: catalysts, 65%; metallurgical applications and alloys, 19%; permanent magnets, 9%; glass polishing, 6%; and other, 1%.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production, bastnäsite concentrates	—	—	—	[e]800	4,000
Imports:[2]					
Cerium compounds	1,500	1,770	1,120	1,390	1,100
Ferrocerium, alloys	102	131	186	267	320
Mixed rare-earth chlorides	411	956	382	495	360
Mixed REOs	4,750	5,480	1,830	537	2,500
Rare-earth oxides, compounds	5,080	3,980	3,770	2,840	5,800
Rare-earth metals, alloy	226	525	468	240	390
Exports:[2]					
Cerium compounds	840	1,350	1,640	992	730
Rare-earth metals, alloys	4,930	1,380	3,030	2,080	1,000
Other rare-earth compounds	455	1,690	3,620	1,830	5,400
Ferrocerium, alloys	2,970	3,460	2,010	951	1,400
Consumption, apparent[3]	W	W	W	NA	NA
Price, dollars per kilogram, yearend:					
Bastnäsite concentrate, REO basis	5.73	6.87	NA	NA	NA
Mischmetal, metal basis, metric ton quantity[4]	8–9	45–55	47–50	28–30	12–13
Stocks, producer and processor, yearend	W	W	W	NA	NA
Employment, mine and mill, number at yearend	110	220	230	283	380
Net import reliance[5] as a percentage of apparent consumption	100	100	100	NA	NA

Recycling: Small quantities, mostly permanent magnet scrap.

Import Sources (2009–12): Rare-earth metals, compounds, etc.: China, 79%; France, 6%; Japan, 5%; Austria, 3%; and other, 7%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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		
Oxides	2846.10.0010	5.5% ad val.
Other	2846.10.0050	5.5% ad val.
Other rare-earth compounds		
Lanthanum oxides	2846.90.2005	Free.
Other oxides	2846.90.2045	Free.
Chlorides	2846.90.2080	Free.
Mixtures of other chlorides	2846.90.2090	Free.
Lanthanum carbonates	2846.90.8070	3.7% ad val.
Mixtures of other carbonates	2846.90.8075	3.7% ad val.
Other rare-earth compounds	2846.90.8090	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 mine and separation plant at Mountain Pass continued to produce bastnäsite concentrates and other rare-earth intermediates and refined products throughout 2013. The company neared completion of new processing facilities at Mountain Pass and demonstrated a capacity rate of 15,000 tons per year of REO. The operation was expected to continue to increase its production rate in 2014.

Domestic consumption of rare-earth imports in 2013 increased to 10,500 tons compared with 5,770 tons in 2012. Improved economic conditions and lower prices of rare-earth materials resulted in increased consumption of REOs. Prices for most rare-earth compounds declined in 2013. Prices for neodymium oxide used to produce magnets began the year at $78 per kilogram, but fell to $73 per kilogram by yearend.

China continued efforts to restrict the supply of REOs and consolidate its rare-earth industry. China's rare-earth production and export quotas for 2013 were 93,800 tons and 31,000 tons, respectively. In Malaysia, the commissioning and debottlenecking of a REO processing plant was underway. As of September, the Malaysian operation had produced 397 tons of REO-equivalent products. In Australia, a second concentration plant was being commissioned at the Mount Weld, Western Australia, operation, although production was limited by demand from the Malaysian processing operation.

Exploration efforts to develop rare-earth projects continued in 2013. Exploration and development assessments in the United States included Bear Lodge, WY, Bokan Mountain, 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: Reserves for Australia and Brazil were revised based on information from Government reports.

	Mine production[e]		Reserves[6]
	2012	2013	
United States	800	4,000	13,000,000
Australia	3,200	2,000	2,100,000
Brazil	140	140	22,000,000
China	100,000	100,000	55,000,000
India	2,900	2,900	3,100,000
Malaysia	100	100	30,000
Russia	2,400	2,400	([7])
Vietnam	220	220	([7])
Other countries	NA	NA	41,000,000
World total (rounded)	110,000	110,000	140,000,000

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, and 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 and 2013, insufficient data were available to determine stock 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, Metal-Pages Ltd., and Hefa Rare Earth Canada Co. Ltd., Richmond, British Columbia, Canada.
[5]Defined as imports – exports + adjustments for industry stock changes. In 2012 and 2013, insufficient data were available to determine stock changes used to calculate net import reliance.
[6]See Appendix C for resource/reserve definitions and information concerning data sources.
[7]Included with "Other countries."

RHENIUM

(Data in kilograms of rhenium content unless otherwise noted)

Domestic Production and Use: During 2013, 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 uses. 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 2013 was about $69 million.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production[1]	5,580	6,100	8,610	7,910	8,100
Imports for consumption	31,500	33,600	33,500	40,200	32,000
Exports	NA	NA	NA	NA	NA
Consumption, apparent	37,100	39,700	42,100	48,100	40,000
Price,[2] average value, dollars per kilogram, gross weight:					
Metal pellets, 99.99% pure	7,500	4,720	4,670	4,040	3,200
Ammonium perrhenate	7,580	4,630	4,360	3,990	3,400
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	80	84	80

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 (2009–12): Rhenium metal powder: Chile, 91%; Poland, 4%; Germany, 2%; and other, 3%. Ammonium perrhenate: Kazakhstan, 27%; Republic of Korea, 18%; United Kingdom, 14%; Poland, 10%; and other, 31%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 2013, 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 decreased by 20% from those of 2012. Rhenium production in the United States increased slightly from that of 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 2013, the catalytic-grade APR price remained at $3,800 per kilogram until April, when the price slowly began to decrease to $3,150 per kilogram in July and remained at that level until yearend. Rhenium metal pellet price started out the year at $3,420 per kilogram until the beginning of May, when it began to slowly decrease until July where it remained at $2,980 per kilogram until yearend.

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 one-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:

	Mine production[4]		Reserves[5]
	2012	2013[e]	
United States	7,910	8,100	390,000
Armenia	600	350	95,000
Canada	—	—	32,000
Chile[6]	27,000	27,000	1,300,000
Kazakhstan	3,000	3,000	190,000
Peru	—	—	45,000
Poland	6,000	6,000	NA
Russia	1,500	1,500	310,000
Uzbekistan	5,400	5,400	NA
Other countries	1,200	1,500	91,000
World total (rounded)	52,600	53,000	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. 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 2013, one company offered 1-gram ampoules of 99.75%-grade rubidium (metal basis) for $77.20 and 100 grams ampoules of the same material for $1,415.00, a 3.5% increase from that of 2012. The price for 10 grams of 99.8% rubidium formate hydrate (metal basis) was $54.00.

Recycling: None.

Import Sources (2009–12): The United States is 100% import reliant on byproduct rubidium concentrate imports, most of which is thought to be imported from Canada.

Tariff:

Item	Number	Normal Trade Relations 12–31–13
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-accurate atomic clocks. Research into the use of rubidium in superconductors was increasing. A process for routinely producing Bose-Einstein Condensates (BEC) using rubidium was developed for the first time outside of government and university laboratories, making BEC available for research and uses in commercial applications. Rubidium was used in systems designed as quantum computing devices, which improved calculations and response times in comparison to less-advanced systems. Quantum computers have the potential to be useful in creating and testing radar, space, and aircraft systems.

In medical applications, 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 continued to increase. Improvements in PET/CT scanning machines could lead to the replacement of technetium-99 with rubidium-82 as a safer, efficient, and stable component.

World Mine Production and Reserves: 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.

	Reserves[1]
Canada	110,000,000
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, the United States, 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 increased by 8% in 2013. The total value was estimated to be about $1.6 billion. Twenty-eight companies operated 61 plants in 16 States. The estimated percentage of salt sold or used, by type, was salt in brine, 46%; rock salt, 36%; vacuum pan, 11%; and solar salt, 7%.

The chemical industry accounted for about 45% of total salt sales with salt in brine accounting for 91% of the salt used for chemical feedstock. The chlorine and caustic soda manufacturing sector was the main consumer within the chemical industry. Highway deicing consumed about 30% of total salt. The remaining markets for salt were, in declining order, distributors, 10%; food processing, 5%, agricultural, 4%; general industrial, 3%; other uses and exports, 2%; and primary water treatment, 1%.

Salient Statistics—United States:[1]	2009	2010	2011	2012	2013[e]
Production	46,000	43,300	45,000	37,200	40,100
Sold or used by producers[2]	43,100	43,500	45,500	34,900	39,200
Imports for consumption	14,700	12,900	13,800	9,880	11,300
Exports	1,450	595	846	809	546
Consumption:					
Reported	45,000	48,600	48,000	36,900	45,000
Apparent[2]	56,400	55,800	58,500	44,000	50,000
Price, average value of bulk, pellets and packaged salt, dollars per ton, f.o.b. mine and plant:					
Vacuum and open pan salt	178.67	180.08	174.00	170.00	175.00
Solar salt	72.09	57.41	51.19	71.87	70.00
Rock salt	36.08	35.67	38.29	36.89	37.00
Salt in brine	7.85	7.49	8.14	8.44	8.50
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	24	22	22	21	22

Recycling: None.

Import Sources (2009–12): Canada, 38%; Chile, 37%; Mexico, 10%; The Bahamas, 5%; and other, 10%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
Salt (sodium chloride)	2501.00.0000	Free.

Depletion Allowance: 10% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: The 2012–13 winter was colder than the 2011–12 winter, and the amount of frozen precipitation was closer to normal in most of the United States, requiring more salt for highway deicing. Despite some municipalities and local and State transportation departments reporting moderate levels of rock salt inventories at the beginning of winter, rock salt production and imports in 2013 increased from the low levels in 2012. Many contracts between salt suppliers and consumers require that the customer take delivery of at least 80 percent of its order, and after having too much salt in recent years, some customers were hesitant to enter into these contracts, leaving them subject to substantial spikes in pricing if they required emergency salt purchases. Because of the relatively lower demand for deicing salt, a few salt companies were forced to temporarily lay off workers.

The majority of local and State governments reportedly have ample supplies of rock salt for the winter of 2013–14. Many weather forecasters indicated that it may be a slightly warmer than average winter in the southern two thirds of the United States, which could reduce the demand for deicing salts. Parts of the northern one-third of the United States may be wetter and colder than average according to predictions from National Oceanic and Atmospheric Administration. The forecast for the traditional snow belt in the northeastern part of the United States was uncertain, with an above- or below-average winter equally likely. It is anticipated that the domestic salt industry would be able to provide adequate salt supplies from domestic and foreign sources for emergency use in the event of adverse winter weather.

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SALT

World Production and Reserves:

	Production		Reserves[4]
	2012	2013[e]	
United States[1]	37,200	40,100	Large. Economic and subeconomic deposits of salt are substantial in principal salt-producing countries. The oceans contain a virtually inexhaustible supply of salt.
Australia	10,800	11,000	
Brazil	7,020	6,170	
Canada	10,800	11,000	
Chile	8,060	8,000	
China	70,000	71,000	
France	6,100	6,000	
Germany	11,900	12,000	
India	17,000	18,000	
Mexico	10,800	9,500	
Poland	3,810	3,900	
Spain	4,390	4,400	
Turkey	5,000	5,000	
Ukraine	5,900	6,200	
United Kingdom	6,700	6,800	
Other countries	43,500	45,000	
World total (rounded)	259,000	264,000	

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 primarily in the States of Kansas, Louisiana, Michigan, New York, Ohio, and Texas. Saline lakes and solar evaporation salt facilities are in the States of Arizona, California, Nevada, New Mexico, Oklahoma, and Utah. Almost every country in the world has salt deposits or solar evaporation operations of various sizes.

Substitutes: No economic substitutes or alternates for salt in most applications exist. 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 production from Puerto Rico.
[2] Defined as sold or used by producers + imports – exports.
[3]Defined as imports – exports.
[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 $6.7 billion was produced by an estimated 4,100 companies and government agencies from about 6,600 operations in 50 States. Leading producing States were, in order of decreasing tonnage, Texas, California, Minnesota, Michigan, Arizona, Washington, Colorado, North Dakota, Ohio, and New York, which together accounted for about 52% of total output. It is estimated that about 44% of construction sand and gravel was used as concrete aggregates; 25% for road base and coverings and road stabilization; 13% as asphaltic concrete aggregates and other bituminous mixtures; 12% as 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 3% for filtration, golf courses, railroad ballast, roofing granules, and other miscellaneous uses.

The estimated output of construction sand and gravel in the United States, 657 million tons shipped for consumption in the first 9 months of 2013, was 3% higher than the 637 million tons estimated for the same period in 2012. The first two quarters of the year were slightly lower than the same quarters in 2012, but a 9% increase in the third quarter pushed the year-to-date production increase to 3%. A snowier- and colder-than-average fourth quarter may dampen demand and 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:	2009	2010	2011	2012	2013[e]
Production	838	805	810	[e]839	861
Imports for consumption	3	3	3	3	3
Exports	([3])	([3])	([3])	([3])	([3])
Consumption, apparent	841	808	813	[e]842	864
Price, average value, dollars per ton	7.51	7.30	7.43	[e]7.74	7.80
Employment, mines, mills, and shops, number	30,800	29,500	29,800	30,600	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, although it was still a small percentage of aggregates consumption.

Import Sources (2009–12): Canada, 79%; Mexico, 7%; The Bahamas, 5%; and other, 9%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 gradually improving, construction sand and gravel output for 2013 increased about 3% compared with that of 2012. The total number of employees in the U.S. construction sand and gravel industry continued to increase from the low employment figure of 2010. According to the U.S. Census Bureau of the Department of Commerce, construction spending in the United States for the first 10 months of 2013 increased by about 5% compared to the same period in 2012. This growth is an indicator of improving conditions for sand and gravel consumption in the United States.

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 regions was expected to continue where regulations and local sentiment discouraged them. Resultant regional 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[5]
	2012	2013[e]	
United States	[e]839	861	Reserves are controlled largely by land use and/or environmental concerns.
Other countries[6]	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 2013.

[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]See Appendix C for resource/reserve definitions and information concerning data sources.
[6]No reliable production information is available for most countries 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 $2.6 billion was produced by 120 companies from 177 operations in 31 States. Leading States were, in order of tonnage produced, Wisconsin, Illinois, Texas, Minnesota, Oklahoma, Arkansas, Michigan, and Iowa. Combined production from these States accounted for 74% of the domestic total. About 62% of the U.S. tonnage was used as hydraulic fracturing sand and well-packing and cementing sand, 16% as glassmaking sand, 9% as foundry sand, 3% as whole-grain fillers and building products, 2% as other whole-grain silica, 2% as ground and unground sand for chemicals, 1% as recreational sand, and 5% for other uses.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production	27,500	32,300	43,800	50,700	52,500
Imports for consumption	95	132	316	306	144
Exports	2,150	3,950	4,330	4,360	4,400
Consumption, apparent	25,500	28,500	39,800	46,600	48,200
Price, average value, dollars per ton	34.25	35.63	45.74	52.80	49.60
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: Some foundry sand is recycled, and recycled cullet (pieces of glass) represents a significant proportion of reused silica.

Import Sources (2009–12): Canada, 65%; Mexico, 31%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
Sand containing 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 2013 compared with those of 2012. Mine 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 to support production of natural gas and petroleum from shale deposits has led to production capacity upgrades and ongoing permitting and opening of numerous new mines. U.S. apparent consumption was about 48.2 million tons in 2013, a 3% increase from that of the previous year. Imports of industrial sand and gravel in 2013 decreased to about 144,000 tons from 306,000 tons in 2012. 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 2013 were about the same as in 2012.

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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 2013. 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]
	2012	**2013**	
United States	50,700	52,500	
Australia	5,300	5,600	Large. Industrial sand and gravel deposits are widespread.
Canada	1,590	1,600	
Chile	1,270	1,200	
Czech Republic	1,340	1,300	
Finland	2,400	2,400	
France	6,290	6,300	
Gambia	1,200	1,200	
Germany	7,500	7,400	
India	1,900	1,900	
Italy	16,400	16,400	
Japan	3,200	3,200	
Malaysia	1,200	1,000	
Mexico	3,590	3,600	
Moldova	2,970	3,000	
Norway	1,000	1,500	
Poland	2,570	2,600	
South Africa	2,600	2,200	
Spain	5,000	5,000	
Turkey	7,000	7,000	
United Kingdom	3,760	3,800	
Other countries	10,000	10,100	
World total (rounded)	139,000	141,000	

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 been neither 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.

The principal use for scandium in 2013 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, solid oxide fuel cells (SOFCs), and oil-well tracers.

Salient Statistics—United States:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Price, yearend, dollars:					
Per kilogram, oxide, 99.99% purity[2]	1,620	1,620	4,700	4,700	5,000
Per kilogram, oxide, 99.999% purity[2]	2,540	2,540	5,200	5,200	5,000
Per kilogram, oxide, 99.9995% purity[2]	3,260	3,260	5,900	5,900	6,000
Per gram, dendritic, metal[3]	189.00	193.00	199.00	206.00	213.00
Per gram, metal, ingot[4]	155.00	158.00	163.00	169.00	175.00
Per gram, scandium acetate, 99.9% purity[5, 6]	NA	47.00	48.40	50.10	51.90
Per gram, scandium chloride, 99.9% purity[5]	60.40	62.40	138.00	143.00	148.00
Per gram, scandium fluoride, 99.9% purity[5]	224.60	229.00	235.80	244.00	253.00
Per gram, scandium iodide, 99.999% purity[5]	203.00	207.00	213.00	220.00	228.00
Per kilogram, scandium-aluminum alloy[2]	74.00	74.00	220.00	220.00	155.00
Net import reliance[7] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2009–12): Although no definitive data exist listing import sources, imported material is mostly from China.

Tariff: **Item**	**Number**	**Normal Trade Relations 12–31–13**
Rare-earth metals, scandium and yttrium, whether or not intermixed or interalloyed, including scandium	2805.30.0000	5.0% ad val.
Compounds of rare-earth metals:		
Mixtures of rare-earth oxides, other, including scandium	2846.90.2045	Free
Mixtures of oxides of yttrium or scandium	2846.90.8050	3.7% ad val.
Mixtures of chlorides of yttrium or scandium	2846.90.8060	3.7% ad val.
Mixtures of rare-earth carbonates, other, including scandium	2846.90.8075	3.7% ad val.
Other rare-earth compounds, including scandium	2846.90.8090	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: In northern Queensland, Australia, measured and indicated resources of a scandium-cobalt-nickel deposit were estimated to include 3,970 tons of scandium oxide, using a 1% nickel-equivalent cut-off grade. If developed, the deposit could become a leading source of scandium. In New South Wales, ownership of the Nyngan scandium project was consolidated to a single Australian company following the resolution of a legal dispute, allowing the project to proceed. In the Philippines, a 10-kilogram-per-month pilot plant was under construction to recover scandium oxide following the leaching of nickel laterite for nickel-cobalt sulfide. A commercial scale plant was contemplated for 2015.

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SCANDIUM

The supply of domestic and foreign scandium metal remained stable. Global scandium consumption was estimated to be less than 10 tons per year in 2013. Scandium-aluminum alloys for sporting goods and aerospace applications remained the leading use of scandium. Consumption of scandium for SOFCs doped with scandium was reported to be increasing. 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. A radioactive scandium isotope was used as a tracing agent in oil refining.

In 2013, nominal prices for domestically produced scandium oxide changed little, although prices for other scandium compounds increased compared with those of the previous year. Scandium metal prices increased moderately, but the total market remained very small.

World Mine Production and Reserves:[8] No scandium was mined in the United States. 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.

There are identified scandium resources 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 are in apatites and eudialytes in Russia's Kola Peninsula and in uranium-bearing deposits in Kazakhstan. In Madagascar, scandium is contained in pegmatites in the Befanomo area. Resources are dispersed in the thortveitite-rich pegmatites of the Iveland-Evje Region in Norway 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 in 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 and scandium-aluminum master alloy (with a 2% scandium metal content and sold in metric ton quantities) from Stanford Materials Corp.
[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 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. Of the three electrolytic refineries operating in the United States, one in Texas reported production of primary selenium, one exported semirefined selenium for toll refining in Asia, and one generated selenium-containing slimes that 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. It is used as a metallurgical additive to improve machinability of copper, lead, and steel alloys, and in thin-film photovoltaic copper indium gallium diselenide (CIGS) solar cells.

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.

Salient Statistics—United States:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Production, refinery	W	W	W	W	W
Imports for consumption, metal and dioxide	263	480	601	454	475
Exports, metal, waste and scrap	613	857	1,350	952	680
Consumption, apparent	W	W	W	W	W
Price, dealers, average, dollars per pound, 100-pound lots, refined	23.07	37.83	66.35	54.47	35.00
Stocks, producer, refined, yearend	W	W	W	W	W
Net import reliance[1] 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 from older plain paper photocopiers and electronic materials were exported for recovery of the contained selenium.

Import Sources (2009–12): Belgium, 17%; China, 17%; Japan, 16%; Philippines, 12%; and other, 38%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12–31–13**
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. In 2013, estimated domestic selenium recoverable from domestic electrolytic copper refining increased slightly owing to an increase in electrolytic copper production. Domestic production of refined selenium, however, was estimated to have declined owing to lower refined copper production by the only domestic selenium refiner.

In 2013, the price of selenium decreased significantly owing to decreased consumption in China. In China, the world's leading consumer of selenium, selenium dioxide was mainly used in the refining of manganese. In 2013, Chinese manganese producers were operating at about 40% of capacity because of higher energy costs, export tariffs, and declining demand for manganese. Domestic and global use of selenium in glass remained unchanged because of stagnate glass production. The use of selenium in fertilizers and supplements in the plant-animal-human food chain and as human vitamin supplements also was unchanged. Selenium consumption in solar cells decreased because oversupply in the solar cell market in 2012 led solar manufacturers to curtail some of their production in 2013.

World Refinery Production and Reserves: Selenium reserves in China were estimated based on selenium content of Chinese copper reserves, but production estimates for China were not available.

	Refinery production[2]		Reserves[3]
	2012	2013[e]	
United States	W	W	10,000
Belgium	200	200	—
Canada	144	150	6,000
Chile	70	70	25,000
China	NA	NA	26,000
Finland	93	100	—
Germany	650	700	—
Japan	755	780	—
Peru	50	54	13,000
Poland	80	80	3,000
Russia	145	150	20,000
Other countries	[4]50	[4]50	21,000
World total (rounded)	[5]NA	[5]NA	120,000

World Resources: Reserves for selenium are based on only 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 to be economical in the foreseeable future.

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 plain paper 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. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Defined as imports – exports + adjustments for Government and industry stock changes.
[2]Insofar as possible, data relate to refinery output only; thus, countries that produced selenium contained in copper ores, copper concentrates, blister copper, and (or) refinery residues but did not recover refined selenium from these materials indigenously were excluded to avoid double counting.
[3]Appendix C for resource/reserve definitions and information concerning data sources.
[4]Includes India, Serbia, and Sweden.
[5]Australia, China, Iran, Kazakhstan, Mexico, the Philippines, and Uzbekistan are known to produce refined selenium, but output is not reported, and information is inadequate for formulation of reliable production estimates. Total world production is not shown because of the lack of data from China and other major world producers.

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 2013 was $1.19 billion. Three companies produced silicon materials in seven plants, all east of the Mississippi River. Ferrosilicon and metallurgical-grade silicon metal were produced in four and five plants, respectively. 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:	2009	2010	2011	2012	2013[e]
Production:					
Ferrosilicon, all grades[1]	139	176	W	W	W
Silicon metal[2]	W	W	W	W	W
Total	W	W	326	383	360
Imports for consumption:					
Ferrosilicon, all grades[1]	70	157	156	173	160
Silicon metal	113	171	187	136	120
Exports:					
Ferrosilicon, all grades[1]	9	15	20	12	10
Silicon metal	38	65	79	75	33
Consumption, apparent:					
Ferrosilicon, all grades[1]	207	312	W	W	W
Silicon metal[2]	W	W	W	W	W
Total	W	W	564	601	600
Price,[3] average, cents per pound Si:					
Ferrosilicon, 50% Si	76.9	109	111	100	100
Ferrosilicon, 75% Si	68.9	97.2	102	91.7	93
Silicon metal[2]	116	140	158	127	120
Stocks, producer, yearend:					
Ferrosilicon, all grades[1]	14	20	W	W	W
Silicon metal[2]	W	W	W	W	W
Total	W	W	30	34	29
Net import reliance[4] as a percentage of apparent consumption:					
Ferrosilicon, all grades[1]	33	44	<50	<50	<60
Silicon metal[2]	<50	<50	<40	<25	<40
Total	W	W	42	36	40

Recycling: Insignificant.

Import Sources (2009–12): Ferrosilicon: Russia, 47%; China, 22%; Canada, 12%; Venezuela, 11%; and other, 8%. Silicon metal: Brazil, 39%; South Africa, 20%; Canada, 14%; Australia, 9%; and other, 18%. Total: Russia, 21%; Brazil, 18%; Canada, 13%; South Africa, 9%; and other, 39%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 2013, expressed in terms of contained silicon, was expected to decrease by 7% from that of 2012. Annual average U.S. ferrosilicon spot market prices in 2013 were expected to be about the same as those of 2012 because domestic crude steel production in 2013 was essentially the same as that in 2012.

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 6% in 2013 from that in 2012. Domestic chemical production was projected to increase slightly (by about 1%) in 2013.

Significant increases in silicon materials production capacity occurred worldwide in 2013. About 580,000 tons of annual production capacity (gross weight) was added to the global silicon industry in China, Malaysia, Russia, Sweden, and Uzbekistan. However, world production of silicon materials was about the same in 2013 as in 2012, mainly as a result of less raw steel production throughout the Commonwealth of Independent States, Europe, and North America.

World Production and Reserves:

	Production[e, 5]		Reserves[6]
	2012	2013	
United States	383	360	The reserves in most major producing countries are ample in relation to demand. Quantitative estimates are not available.
Bhutan[7]	61	61	
Brazil	225	230	
Canada	55	35	
China	5,050	5,100	
France	174	170	
Iceland	75	80	
India[7]	70	70	
Norway	339	175	
Russia	733	700	
South Africa	132	130	
Ukraine[7]	78	78	
Venezuela[7]	53	60	
Other countries	349	430	
World total (rounded)	7,770	7,700	

Ferrosilicon accounts for about 94% of world silicon production on a gross-weight basis and 75% on a silicon-content basis. The leading countries for ferrosilicon production were, in descending order and on a gross-weight basis, China, Russia, the United States, Brazil, and Ukraine, and for silicon metal production were China, the United States, Brazil, France, and Norway. China was by far the leading producer of ferrosilicon (5,600,000 tons) and silicon metal (1,500,000 tons) in 2013.

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 2013, the United States produced approximately 1,090 tons of silver with an estimated value of $840 million. Silver was produced at 3 silver mines and as a byproduct or coproduct from 39 domestic base- and precious-metal mines. Alaska continued as the country's leading silver-producing State, followed by Nevada. There were 14 U.S. refiners that indicated production of commercial-grade silver, with an estimated total output of 2,500 tons from domestic and foreign ores and concentrates, and from old and new scrap. The physical properties of silver include high ductility, electrical conductivity, malleability, and reflectivity. Silver's principal end use categories include coins and medals, electrical and electronics, jewelry and silverware, and photography. Other applications for silver include use of silver in alloys, bandages for wound care, batteries, bearings, brazing and soldering, catalytic converters in automobiles, cell phone covers to reduce the spread of bacteria, clothing to minimize odor, electroplating, inks, mirrors, solar cells, water purification, and wood treatment. 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 2013, the estimated uses for silver were electrical and electronics, 35%; coins and medals, 25%; photography, 10%; jewelry and silverware, 6%; and other, 24%.

Salient Statistics—United States:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Production:					
Mine	1,250	1,280	1,120	1,060	1,090
Refinery:					
Primary	796	819	790	796	800
Secondary (new and old scrap)	1,340	1,330	1,710	1,660	1,700
Imports for consumption[2]	3,450	5,370	6,410	5,140	5,000
Exports[2]	419	709	904	946	340
Consumption, apparent[3]	6,110	7,530	7,920	5,990	6,710
Price, dollars per troy ounce[4]	14.69	20.20	35.26	31.21	23.80
Stocks, yearend:					
Industry	150	123	150	109	110
Treasury Department[5]	498	498	498	498	498
COMEX	3,500	3,260	3,650	4,610	5,350
Employment, mine and mill,[6] number	764	814	1089	1,249	1,390
Net import reliance[7] as a percentage of apparent consumption	58	65	64	55	58

Recycling: In 2013, approximately 1,700 tons of silver was recovered from new and old scrap.

Import Sources (2009–12):[2] Mexico, 51%; Canada, 25%; Poland, 6%; Peru, 3%; and other, 15%.

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 November 2013, silver prices averaged $24.10 per troy ounce, 23% lower than the average of the first 11 months of 2012. The overall decline in silver prices corresponded to a drop in industrial consumption owing to a depressed global economic environment. Investment demand for silver continued to increase as investors sought safe-haven investments. Holdings in 13 silver exchange traded funds (ETFs), were about 24,000 tons at the end of October, up by 4,800 tons from yearend 2012.

Global demand for silver in photography continued to decline, and in the United States, demand fell to about 520 tons, compared with a high of about 2,000 tons in 2000. Although silver was still used in x-ray films, imaging facilities have been transitioning to digital imaging systems. Demand for silver in jewelry, electronic applications, and other industrial applications declined, while the use of silver in brazing alloys, coins, and solders increased. Silver demand for silverware remained unchanged. 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 high of 26,600 tons, principally as a result of increased production from mines in China, Mexico, and the Russian Federation, including increased recoveries from mines in Russia and Kazakhstan, and Mexico's Peñasquito Mine. Overall, domestic silver production rose slightly, with the reopening in the first quarter of the Lucky Friday Mine (silver-lead zinc) in Idaho's Coeur d'Alene mining district. The Lucky Friday Mine was ordered closed at yearend 2011 by the Mine Safety and Health Administration after an accident and rock burst led to a buildup of material in the Silver Shaft, the primary access to the mine. The Drumlummon Mine (silver-gold) in Montana closed in the second quarter, owing to a drop in precious metal prices and was placed in care-and-maintenance status.

World Mine Production and Reserves: Reserves for Peru were revised based on new information from Government and industry sources.

	Mine production		Reserves[8]
	2012	2013[e]	
United States	1,060	1,090	25,000
Australia	1,730	1,700	88,000
Bolivia	1,210	1,200	22,000
Canada	663	720	7,000
Chile	1,190	1,200	77,000
China	3,900	4,000	43,000
Mexico	5,360	5,400	37,000
Peru	3,480	3,500	87,000
Poland	1,150	1,150	85,000
Russia	1,500	1,700	NA
Other countries	4,230	4,300	50,000
World total (rounded)	25,500	26,000	520,000

World Resources: Although silver was a principal product at several mines, silver was primarily 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. 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]Defined as mine production + secondary production + imports – exports + adjustments for Government and industry stock changes.
[4]Handy & Harman quotations.
[5]Balance in U.S. Mint only, includes deep storage and working stocks.
[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 2013 was estimated to be about $1.8 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 owned 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 2012 reported data, the estimated 2013 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:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Production[2]	9,310	10,600	10,700	11,100	11,400
Imports for consumption	6	20	27	13	9
Exports	4,410	5,390	5,470	6,110	6,410
Consumption:					
Reported	5,020	5,270	5,150	5,060	5,000
Apparent	4,950	5,200	5,220	4,980	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	275.00	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	129.88	116.47	133.57	141.90	145.00
Stocks, producer, yearend	217	220	282	338	350
Employment, mine and plant, number	2,400	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 (2009–12): Canada, 17%; United Kingdom, 17%; China, 12%; Mexico, 10%; and other, 44%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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: A State-owned corporation in Tanzania was seeking a partner to develop a 1,000,000-ton-per-year soda ash facility at Lake Natron, a salt lake in northern Tanzania. The project is controversial because Lake Natron is the breeding ground for approximately one-third of the world's Lesser Flamingos.

In 2013, Kenya upgraded security efforts along the Somali border in an effort to thwart illegal export of soda ash, which was reportedly being used by terrorists to manufacture explosives. The heightened security efforts notwithstanding, soda ash smuggling had been reported in the country. Kenya hosts vast amounts of soda ash, particularly at Lake Magadi.

In June, one of the major Wyoming soda ash producers announced that it would increase its off-list price of soda ash effective July 1, 2013, 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 2014.

World Production and Reserves:

	Production		Reserves[4, 5]
Natural:	2012	2013[e]	
United States	11,100	11,400	[6]23,000,000
Botswana	230	250	400,000
Kenya	500	500	7,000
Mexico	290	290	200,000
Turkey	1,800	1,800	200,000
Uganda	NA	NA	20,000
Other countries	—	—	260,000
World total, natural (rounded)	13,900	14,200	24,000,000
World total, synthetic (rounded)	39,000	39,000	XX
World total (rounded)	52,900	53,200	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.

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, Missouri, Pennsylvania, Florida, Kentucky, Ohio, Illinois, North Carolina, Indiana, and Virginia, which together accounted for more than one-half of the total crushed stone output. Of the total crushed stone produced in 2013, 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 1.25 billion tons of crushed stone consumed in the United States in 2013, 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 575 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 9 months of 2013 was 904 million tons, a slight increase compared with that of the same period of 2012. Third quarter shipments for consumption increased by 8% compared with those of the same period of 2012. 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:	2009	2010	2011	2012	2013[e]
Production	1,160	1,160	1,160	1,170	1,200
Recycled material	29	26	27	30	31
Imports for consumption	12	15	15	15	17
Exports	1	1	1	1	1
Consumption, apparent	1,200	1,200	1,200	1,210	1,250
Price, average value, dollars per metric ton	9.73	9.58	9.65	9.73	9.75
Employment, quarry and mill, number[e, 3]	53,300	52,200	51,900	50,300	50,000
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 all 50 States. The amount of material reported to be recycled increased slightly in 2013 compared with that of the previous year.

Import Sources (2009–2012): Canada, 43%; Mexico, 38%; The Bahamas, 17%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 1.20 billion tons in 2013, an increase of 3% compared with that of 2012. Apparent consumption also increased to about 1.25 billion tons. Demand for crushed stone was slightly higher in 2013 because of record demand in the third quarter of the year which offset the slowdown in activity that some of the principal construction markets had experienced during the previous four quarters. 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 2014, 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 be located away from large population centers.

World Mine Production and Reserves:

	Mine production		Reserves[5]
	2012	2013[e]	
United States	1,170	1,200	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 2.17 million tons of dimension stone, valued at $460 million, was sold or used by U.S. producers in 2013. Dimension stone was produced by 208 companies, operating 276 quarries, in 34 States. Leading producer States, in descending order by tonnage, were Texas, Indiana, Wisconsin, Massachusetts, and Georgia. These five States accounted for about 65% of the production and contributed about 60% of the value of domestic production. Approximately 41%, by tonnage, of dimension stone sold or used was limestone, followed by granite (23%), miscellaneous stone (16%), sandstone (15%), marble (3%), and slate (2%). By value, the leading sales or uses were for limestone (40%), followed by granite (26%), miscellaneous stone (14%), sandstone (11%), marble (5%), and slate (4%). Rough stone represented 59% of the tonnage and 50% 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 (57%), and in irregular-shaped stone (28%). Dressed stone mainly was sold for ashlars and partially squared pieces (46%), curbing (22%), and flagging (9%), by tonnage.

Salient Statistics—United States:[2]	2009	2010	2011	2012	2013[e]
Sold or used by producers:					
Tonnage	1,620	1,670	1,850	2,150	2,170
Value, million dollars	328	323	395	452	460
Imports for consumption, value, million dollars	1,350	1,500	1,590	1,740	1,860
Exports, value, million dollars	48	55	66	65	70
Consumption, apparent, value, million dollars	1,630	1,770	1,910	2,130	2,250
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)	80	82	80	79	80
Granite only:					
Production	469	699	462	500	500
Exports (rough and finished)	75	96	80	77	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 (2009–12 by value): All dimension stone: China, 29%; Brazil, 28%; Italy, 22%; Turkey, 14%; and other, 7%. Granite only: Brazil, 42%; China, 23%; India, 14%; Italy, 13%; and other, 8%.

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 2013. 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 $1.86 billion compared with $1.74 billion in 2012. Slow growth in the U.S. economy coupled with increases in new residential construction starts, particularly in the southern United States, resulted in a slight increase in production and imports of dimension stone. Sales of dimension stone for use in existing homes also increased in 2013. Dimension stone for construction and refurbishment was used in commercial and residential markets; 2013 refurbishment activity was comparable with that of 2012. Dimension stone exports increased to about $70 million. The weakening of the U.S. dollar has aided the U.S. export market for dimension stone. Apparent consumption, by value, was estimated to be $2.25 billion in 2013—a $120 million increase from that of 2012.

World Mine Production and Reserves:

	Mine production		Reserves[5]
	2012	2013[e]	
United States	2,150	2,170	Adequate except for certain
Other countries	NA	NA	special types and local
World total	NA	NA	shortages.

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 from imported strontium carbonate. Estimates for end uses of primary strontium compounds in the United States were pyrotechnics and signals, 30%; ceramic ferrite magnets, 30%; master alloys, 10%; pigments and fillers, 10%; electrolytic production of zinc, 10%; and other applications, including glass, 10%. It is thought that virtually all of the strontium minerals consumed in the United States since 2006 was used in drilling fluids for oil and natural gas wells. Imports of the strontium mineral celestite have increased steadily since 2007, except in 2010. Imports of strontium minerals more than doubled in 2013 compared with those of 2012.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production	—	—	—	—	—
Imports for consumption:					
Strontium minerals	6,420	2,370	7,320	8,660	21,500
Strontium compounds	5,860	8,640	10,000	8,150	7,140
Exports, compounds	94	72	18	71	43
Consumption, apparent, minerals and compounds	12,200	10,900	17,300	16,700	28,600
Price, average value of mineral imports at port of exportation, dollars per ton	47	45	46	67	50
Net import reliance[2] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2009–12): Strontium minerals: Mexico, 100%. Strontium compounds: Mexico, 80%; Germany, 12%; China, 7%; and other, 1%. Total imports: Mexico, 87%; Germany, 8%; China, 4%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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: Imports of celestite, the most commonly used strontium mineral, have increased every year since 2010 and increased dramatically in 2013, with virtually all of the material coming from Mexico. Celestite is typically used as the raw material for the production of strontium compounds; however, these imports are thought to be used in drilling fluids for oil and natural gas exploration and production. As such, celestite is ground, but undergoes no chemical processing.

Consumption of strontium compounds was thought to be approximately equal in the production of ceramic ferrite magnets and pyrotechnics and signals. Strontium carbonate is sintered with iron oxide to produce permanent ceramic ferrite magnets. Strontium nitrate contributes a brilliant red color to fireworks and signal flares. Smaller quantities of strontium compounds were consumed in several other applications, including glass production, electrolytic production of zinc, master alloys, and pigments and fillers.

With expected improvements to global economic conditions, consumption of strontium compounds is expected to increase. Little information is available about the potential for celestite consumption in drilling fluids.

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.

World Mine Production and Reserves:[3]

	Mine production		Reserves[4]
	2012	2013[e]	
United States	—	—	—
Argentina	5,000	5,000	All other:
China	100,000	95,000	6,800,000
Mexico	40,900	45,000	
Morocco	2,500	2,500	
Spain	80,000	97,000	
World total (rounded)	228,000	245,000	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]Gross weight of strontium minerals in metric tons.
[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 2013, elemental sulfur and byproduct sulfuric acid were produced at 110 operations in 27 States. Total shipments were valued at about $1.1 billion. Elemental sulfur production was 8.5 million tons; Louisiana and Texas accounted for about 54% 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 104 plants in 26 States. 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 61% of domestic consumption, and byproduct acid accounted for about 5%. The remaining 34% of sulfur consumed was provided by imported sulfur and sulfuric acid. About 90% of sulfur consumed was in the form of sulfuric acid.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production:					
Recovered elemental	8,190	8,320	8,230	8,410	8,500
Other forms	749	791	720	586	650
Total (rounded)	8,940	9,110	8,950	9,000	9,100
Shipments, all forms	8,860	9,170	8,930	9,030	9,100
Imports for consumption:					
Recovered, elemental[e]	1,700	2,950	3,270	2,930	2,900
Sulfuric acid, sulfur content	413	690	872	933	990
Exports:					
Recovered, elemental	1,430	1,450	1,310	1,850	1,800
Sulfuric acid, sulfur content	83	71	109	53	59
Consumption, apparent, all forms	9,520	11,300	11,700	11,000	11,000
Price, reported average value, dollars per ton of elemental sulfur, f.o.b., mine and (or) plant	1.73	70.16	159.88	123.54	124.00
Stocks, producer, yearend	231	167	176	132	144
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	6	19	23	18	18

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 (2009–12): Elemental: Canada, 82%; Mexico, 11%; Venezuela, 3%; and other, 4%. Sulfuric acid: Canada, 65%; Mexico, 14%; and other, 21%. Total sulfur imports: Canada, 78%; Mexico, 11%; Venezuela, 3%; and other, 8%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 and shipments increased slightly compared with those of 2012. 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 increased slightly and 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 2013 at around $160 per ton. The price decreased to $75 per ton in October and remained at that level through mid-December. Export prices were higher than the domestic prices.

Domestic phosphate rock consumption was about 4% higher in 2013 than in 2012, which resulted in increased demand for sulfur to process the phosphate rock into phosphate fertilizers.

World Production and Reserves:

	Production—All forms		Reserves[2]
	2012	2013[e]	
United States	9,000	9,100	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	860	900	
Brazil	480	500	
Canada	5,910	6,000	
Chile	1,680	1,700	
China	9,900	10,000	
Finland	1,350	1,400	
France	650	650	
Germany	3,820	3,800	
India	1,190	1,200	
Iran	1,880	1,900	
Italy	740	740	
Japan	3,250	3,300	
Kazakhstan	2,700	2,700	
Korea, Republic of	1,200	1,200	
Kuwait	800	800	
Mexico	1,740	1,700	
Netherlands	515	520	
Poland	1,160	1,200	
Qatar	820	820	
Russia	7,270	7,300	
Saudi Arabia	4,090	4,100	
South Africa	310	310	
Spain	680	680	
United Arab Emirates	1,900	2,000	
Uzbekistan	540	540	
Venezuela	800	800	
Other countries	2,900	2,900	
World total (rounded)	68,100	69,000	

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[1]

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Domestic talc production in 2013 was estimated to be 531,000 tons valued at $18 million. Four companies operated six talc-producing mines in four States in 2013. The top three companies accounted for more than 99% of the U.S. talc production. One company in California shipped from stocks. Montana was the leading producer State, followed by Texas, Vermont, and Virginia. Sales of talc were estimated to be 589,000 tons valued at $89 million. Talc produced and sold in the United States was used for ceramics, 25%; paper, 22%; paint, 19%; roofing, 9%; plastics, 8%; cosmetics and rubber, 3% each; and other, 11%. About 240,000 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, including imported talc, was plastics, 27%; ceramics, 18%; paint, 16%; paper, 15%; roofing, 6%; cosmetics, 5%; rubber, 3%; and other, 10%. One company in North Carolina mined pyrophyllite. Production of pyrophyllite remained unchanged from that of 2012 and consumption was, in decreasing order by tonnage, in refractory products, ceramics, and paint.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production, mine	511	604	616	515	531
Sold by producers	512	567	567	575	590
Imports for consumption	134	242	285	325	240
Exports	188	240	223	251	170
Shipments from Government stockpile excesses	—	—	—	—	—
Consumption, apparent	457	606	678	589	600
Price, average, processed, dollars per metric ton	111	150	155	152	160
Employment, mine and mill	285	280	290	310	300
Net import reliance[2] as a percentage of apparent consumption	E	1	6	13	12

Recycling: Insignificant.

Import Sources (2009–12): China, 35%; Canada, 31%; Pakistan, 18%; Japan, 4%; and other, 12%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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:

Stockpile Status—9–30–13[3]
(Metric tons)

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2013	Disposals FY 2013
Talc, block and lump	865	865	[4]580	—
Talc, ground	621	621	—	—

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TALC AND PYROPHYLLITE

Events, Trends, and Issues: Talc production and sales increased slightly in 2013. U.S. exports decreased by 32% from those of 2012. Canada accounted for more than 50% of the decline in exports. Countries that had increased imports of U.S. talc in 2012 generally had lower imports in 2013, based on trade data through July. U.S. imports decreased by 26% from those of 2012. Reduced shipments from Pakistan, which probably included talc from Afghanistan, resulted in most of the decline in U.S. imports. Estimated imports in 2013 were more in balance with demand in the United States than in 2012; it appears that one company imported more talc than required to increase stocks at its mill. Canada and China supplied more than 75% of the talc imported into the United States in 2013.

The Board of Governors of the Federal Reserve System reported a 2.6% increase in general manufacturing, including automobile and truck manufacture. The U.S. Census Bureau reported that housing starts increased by 19% between August 2012 and August 2013. 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). Talc is used to manufacture such construction products as adhesives, caulks, ceramics, joint compounds, paint, and roofing.

Sales of pyrophyllite remained unchanged in 2013. Sales to industries that use pyrophyllite to manufacture ceramics and paints had limited growth in 2013 owing to the slow recovery of that sector of the economy.

World Mine Production and Reserves:

	Mine production		Reserves[5]
	2012	2013[e]	
United States	515	531	140,000
Brazil[6]	550	540	230,000
China	2,200	2,200	Large
Finland	440	440	Large
France	420	420	Large
India[6]	662	650	75,000
Japan[6]	365	370	100,000
Korea, Republic of[6]	515	480	14,000
Other countries[6]	1,760	1,800	Large
World total (rounded)[6]	7,430	7,400	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, unless noted.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix B for definitions.
[4]Included talc, block and lump, and talc, ground.
[5]See Appendix C for resource/reserve definitions and information concerning data sources.
[6]Includes pyrophyllite.

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 2012 was estimated at about $285 million and was expected to exceed $300 million in 2013 as measured by the value of imports.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production:					
Mine	—	—	—	—	—
Secondary	NA	NA	NA	NA	NA
Imports for consumption[e, 1]	798	1,600	1,850	1,010	1,110
Exports[e, 1]	326	438	648	577	833
Government stockpile releases[e, 2]	—	—	—	—	—
Consumption, apparent	473	1,160	1,210	437	278
Price, tantalite, dollars per pound of Ta_2O_5 content[3]	40	54	125	108	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 (2009–12): Tantalum minerals: Mozambique, 24%; Australia, 21%; and Canada, 20%. Tantalum metal: China, 30%; Kazakhstan, 27%; and Germany, 14%. Tantalum waste and scrap: Estonia, 22%; Russia, 14%; and China, 12%. Tantalum contained in niobium (columbium) and tantalum ore and concentrate; tantalum metal; and tantalum waste and scrap: China, 19%; Germany, 13%; Kazakhstan, 11%; Russia, 7%; and other, 50%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 fluortantalate[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) 2013, which ended on September 30, 2013, 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 2014. 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—9–30–13[6]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2012	Disposals FY 2012
Tantalum carbide powder	1.71	[7]—	[7]—	—
Tantalum metal scrap	0.09	[7]—	[7]—	—

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TANTALUM

Events, Trends, and Issues: U.S. tantalum apparent consumption in 2013 was estimated to have been about 60% that of 2012. Tantalum waste and scrap was the leading imported tantalum material, accounting for about 51% of tantalum imports.

World Mine Production and Reserves: Reserves for Brazil were revised based on a Departamento Nacional de Produção Mineral publication. Reserves for Australia were revised based on a Geoscience Australia publication.

	Mine production[8]		Reserves[9]
	2012	2013[e]	
United States	—	—	—
Australia	—	—	[10]62,000
Brazil	140	140	36,000
Burundi	33	30	NA
Canada	50	50	NA
Congo (Kinshasa)	100	110	NA
Ethiopia	95	10	NA
Mozambique	39	40	NA
Nigeria	63	60	NA
Rwanda	150	150	NA
World total (rounded)	670	590	>100,000

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 2013 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 applications; 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 29,000 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, each 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 used in the production of cadmium-tellurium-based solar cells, which was the major end use for tellurium. Although not a major use domestically, in China, tellurium is used with bismuth in thermoelectric devices, such as refrigerators and water dispensers because of increased energy efficiency. Other uses were as an alloying additive in steel to improve machining characteristics, 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 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:	2009	2010	2011	2012	2013[e]
Production, refinery	W	W	W	W	W
Imports for consumption, unwrought, waste and scrap	84	42	71	36	40
Exports	9	59	39	47	8
Consumption, apparent	W	W	W	W	W
Price, dollars per kilogram, 99.95% minimum[1]	158	221	349	150	112
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 metallurgical and chemical uses, there was little or no old scrap from which to extract secondary tellurium because these uses of tellurium were highly dispersive or 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 (2009–12): Canada, 43%, China, 23%; Philippines, 12%; Belgium, 4%; and other, 18%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
Tellurium	2804.50.0020	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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TELLURIUM

Events, Trends, and Issues: In 2013, estimated domestic tellurium production was slightly less than production in 2012. Although detailed information on the world tellurium market was not available, world tellurium consumption was estimated to have decreased in 2013. The price of tellurium continued to decline in 2013 because of the continued decrease in use of tellurium in solar cells owing to the surplus of all types of solar cells. In addition, Chinese consumption was estimated to have decreased because of lower sales of refrigerators and water dispensers, which accounted for about 75% of Chinese consumption of tellurium.

Although Canada remained the leading source of U.S. imports of tellurium, having displaced China in 2010, imports from Belgium rose substantially during the first 8 months of 2013 compared with those in the same period of 2012, and accounted for 37% of imports. Belgium had been the leading source of imported tellurium in 2005 and 2006.

World Refinery Production and Reserves: 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 is recoverable.

	Refinery production		Reserves[3]
	2012	2013[e]	
United States	W	W	3,500
Canada	11	10	800
Japan	45	45	—
Peru	—	—	3,600
Russia	35	40	NA
Other countries[4]	NA	NA	16,000
World total (rounded)	NA	NA	24,000

World Resources: Data on tellurium resources were not available. More than 90% of tellurium has been 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-zinc ores. In copper production, tellurium was recovered only during electrolytic refining of smelted copper. Increased use of leaching solvent extraction-electrowinning processes for copper extraction, which does not capture tellurium, has limited the future supply of tellurium from certain copper deposit types. Other potential sources of tellurium include bismuth telluride, gold telluride, and lead-zinc ores.

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 plain paper photocopiers and laser printers have been replaced by organic photoreceptors in newer devices. Amorphous silicon and copper indium diselenide were the two principal competitors to cadmium telluride in thin-film photovoltaic power cells.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]For 2009, the price listed was the average price published by Mining Journal for United Kingdom lump and powder, 99.95% tellurium. In 2010 through 2013, 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, Poland, and Sweden produce refined tellurium, but output was not reported, and available information was inadequate for formulation of reliable production and detailed reserve 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, lead, and zinc 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:	2009	2010	2011	2012	2013[e]
Production, refinery	—	—	—	—	—
Imports for consumption:[1]					
Unwrought and powders	1,600	2,000	1,300	—	—
Other	160	200	200	685	600
Total	1,760	2,200	1,500	685	600
Exports:[1]					
Unwrought and powders	260	45	34	21	—
Waste and scrap	75	55	42	26	70
Other	595	835	469	31	25
Total	930	935	545	78	95
Consumption[e]	830	1,270	955	607	505
Price, metal, dollars per kilogram[2]	5,700	5,930	6,000	6,800	6,990
Net import reliance[3] as a percentage of estimated consumption	100	100	100	100	100

Recycling: None.

Import Sources (2009–12): Germany, 80%; Russia, 19%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 2013 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 2013, 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 2013, the company continued exploration activities and investigated partnerships with other firms to help finance the project.

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THALLIUM

In 2012, leading producers of thallium isotopes used in medical imaging reported declines in sales compared with those of the same period in 2011. Beginning in 2009, there was a global shortage of the medical isotope technetium-99, which was widely used for medical imaging tests owing to the superior diagnostic quality of images produced. Following the closure of two isotope-producing nuclear reactors in Canada and the Netherlands in 2009, medical care facilities substituted thallium-201 for technetium-99 in cardiac scans and producers increased production of thallium-201 in order to meet anticipated demand. In late 2010, the National Research Universal reactor in eastern Ontario, Canada, restarted production of technetium-99, which was cited for declining consumption of thallium-201 since 2011. Although consumption of thallium-201 was anticipated to return to pre-2009 levels, future disruption to the supply of technetium-99 could potentially increase thallium consumption.

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. The leading sources of thallium released into the environment are coal-burning powerplants and smelters of copper, lead, and zinc ores. The major sources of thallium in drinking water are ore-processing sites and discharges from electronics, drugs, and glass factories. 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 for public water supplies, the EPA has set an enforceable Maximum Contaminant Level for thallium at 2 parts per billion. The EPA continued to conduct studies at its National Risk Management Research Laboratory to develop and promote technologies that protect and improve human health and the environment, including methods to remove thallium from mine wastewaters.

World Refinery Production and Reserves: There are only a few countries where thallium is obtained commercially as a byproduct in the roasting of copper, lead, and zinc ores or is collected from flue dust. Because most producers withhold thallium production data, estimating global production is challenging. In 2013, global production of thallium was estimated to be less than 10,000 kilograms. China, Kazakhstan, and Russia were believed to be leading producers of primary thallium. Since 2005, substantial thallium-rich deposits have been identified in China, Macedonia, and Russia.

World Resources: Although the metal is reasonably abundant in the Earth's crust at a concentration estimated to be about 0.7 part per million, it exists mostly in association with potassium minerals in clays, granites, and soils, and it is not generally considered to be commercially recoverable from those forms. The major source of commercial thallium is the trace amounts found in copper, lead, zinc, and other sulfide ores. Quantitative estimates of reserves are not available owing to the difficulty in identifying deposits where thallium can be extracted economically. Previous estimates of reserves were based on thallium content of zinc ores. World resources of thallium contained in zinc resources could be as much as 17 million kilograms; most are in Canada, Europe, and the United States. An additional 630 million kilograms is in world coal resources.

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 HTS that does not contain thallium. If research on HTS not using thallium is successful, HTS products would not 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]Thallium content was estimated by the U.S. Geological Survey.
[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.

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. Monazite itself may be recovered as a byproduct of processing heavy-mineral sands for titanium and zirconium minerals. In 2013, 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 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 imported for consumption by the domestic industry was $54,000, a significant decrease compared with that of 2012.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production, refinery[1]	—	—	—	—	—
Imports for consumption:					
Thorium ore and concentrates (monazite), gross weight	26	—	30	43	—
Thorium compounds (oxide, nitrate, etc.), gross weight[2]	2.25	3.03	5.71	4.40	0.83
Thorium compounds (oxide, nitrate, etc.), ThO_2 content[2]	1.66	2.24	4.22	3.26	0.61
Exports:					
Thorium ore and concentrates (monazite), gross weight	18	1	—	—	—
Thorium compounds (oxide, nitrate, etc.), gross weight[2]	4.73	1.50	4.28	3.16	2.20
Thorium compounds (oxide, nitrate, etc.), ThO_2 content[2]	3.50	1.11	3.17	2.34	1.60
Consumption, apparent[2]	([3])	1.13	1.05	0.92	([3])
Price, thorium compounds, gross weight, dollars per kilogram:[4]					
France	193	131	158	153	NA
India	51	58	58	60	65
Net import reliance[5] as a percentage of apparent consumption[1]	100	100	100	100	100

Recycling: None.

Import Sources (2009–12): Monazite: United Kingdom, 100%. Thorium compounds: India, 84%; and France, 16%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 2013. Domestic demand for thorium alloys, compounds, metals, and ores has exhibited a long-term declining trend.

On the basis of data through September 2013, the average value of imported thorium compounds decreased to $65 per kilogram from the 2012 average of $68 per kilogram (gross weight). The average value of exported thorium compounds increased to $480 per kilogram based on data through September 2013, compared with $232 per kilogram for 2012. The increase was attributed to variations in the type and purity of compounds exported in each year.

Global production of monazite was primarily for its rare-earth element content, and only a small fraction of the byproduct thorium produced was consumed. Monazite-producing countries were, in decreasing order of production, India, Malaysia, Vietnam, and Brazil. Thorium consumption worldwide is relatively small compared with that of most other mineral commodities. Issues associated with thorium's natural radioactivity represented a significant cost to those companies involved in its mining, processing, manufacture, transport, and use.

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THORIUM

In Australia, mining at the Mount Weld, Western Australia, operation was idled during a portion of the year pending the ramp up of rare-earth separation operations in Malaysia. In April, a second concentration plant circuit was commissioned at the Mount Weld operation. As of June 2013, 15,700 tons of concentrate containing 5,626 tons of rare-earth oxides and trace amounts of thorium were stockpiled in Australia. In South Africa, plans were underway to resume mining and processing monazite at the Steenkampskraal operation for the production of rare earths. The thorium produced at Steenkampskraal during the production of rare earths was expected to be sold or stored onsite in a recoverable form.

Interest in thorium as an energy source increased worldwide, as various countries continued research and development of thorium-fueled nuclear power as an alternative to uranium. The Chinese Academy of Sciences continued a research initiative to develop thorium molten-salt reactor technologies. The Indian Department of Atomic Energy continued development of a 300-MW advanced heavy water reactor fueled by a thorium-mixed oxide fuel (MOX). In Norway, a testing program backed by an international consortium of utilities, industry, and research organizations was hoping to demonstrate that thorium-MOX fuel could operate safely in a commercial reactor.

In 2013, exploration and development of rare-earth projects associated with thorium were underway in Australia, Brazil, Canada, Greenland, India, South Africa, the United States, and Vietnam. Greenland's parliament voted to remove a 25-year-old ban on mining thorium and uranium. The policy change may allow the commercialization of the Kvanefjeld mining project currently in the feasibility stage of development.

World Refinery Production and Reserves:

	Refinery production		Reserves[6]
	2012	2013	
United States	—	—	440,000
Australia	NA	NA	[7]410,000
Brazil	NA	NA	[8]16,000
Canada	NA	NA	100,000
India	NA	NA	290,000
Malaysia	NA	NA	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 occur in certain iron ore deposits and carbonatites. Thorium enrichment is known to occur in iron (Fe)-rare-earth-element-thorium-apatite (FRETA) deposits, such as 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]Apparent consumption calculation excludes ore and concentrates.
[3]Apparent consumption calculations in 2009 and 2013 resulted in a negative number, but all exported materials were produced from imported materials.
[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.
[8]Reserves for Brazil were under review pending new information from the Departamento Nacional de Produção Mineral.

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 accounted for about 90% of the primary tin consumed domestically in 2013. The major uses for tin were cans and containers, 23%; construction, 18%; transportation, 17%; electrical, 12%; and other, 30%. Based on the average Platts Metals Week composite price for tin, the estimated value of primary tin consumed domestically was $783 million, the value of imported refined tin was $1.08 billion, and the value of old scrap recovered domestically was $331 million.

Salient Statistics—United States:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Production, secondary:					
Old scrap[e]	11,100	11,100	11,000	11,200	11,200
New scrap	2,310	2,680	2,530	2,440	2,600
Imports for consumption, refined tin	33,000	35,300	34,200	36,900	36,600
Exports, refined tin and tin alloys	3,170	5,630	5,450	5,560	5,760
Shipments from Government stockpile	—	—	—	—	—
Consumption, reported:					
Primary	24,800	25,300	25,200	24,500	26,500
Secondary	7,750	4,820	3,280	3,240	3,260
Consumption, apparent[1]	42,400	41,400	40,300	42,300	41,600
Price, average, cents per pound:					
New York dealer	642	954	1,216	990	1,040
Platts Metals Week composite	837	1,240	1,575	1,283	1,340
London Metal Exchange, cash	615	925	1,184	957	1,010
Kuala Lumpur	609	922	1,188	958	1,010
Stocks, consumer and dealer, yearend	7,070	6,410	5,880	6,140	6,600
Net import reliance[2] as a percentage of apparent consumption	74	73	73	74	73

Recycling: About 13,800 tons of tin from old and new scrap was recycled in 2013. Of this, about 11,200 tons was recovered from old scrap at 2 detinning plants and about 75 secondary nonferrous metal-processing plants.

Import Sources (2009–12): Peru, 47%; Bolivia, 17%; Indonesia, 13%; Malaysia, 9%; and other, 14%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–13**
Unwrought tin:		
Tin, not alloyed	8001.10.0000	Free.
Tin alloys, containing, by weight:		
5% or less of lead	8001.20.0010	Free.
More than 5% but not more than 25% of lead	8001.20.0050	Free.
More than 25% of lead	8001.20.0090	Free.
Tin waste and scrap	8002.00.0000	Free.

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

Government Stockpile: The Defense Logistics Agency, DLA Strategic Materials made no tin sales in fiscal year 2013.

Stockpile Status—9–30–13[3]

Material	**Uncommitted inventory**	**Authorized for disposal**	**Disposal plan FY 2013**	**Disposals FY 2013**
Tin	4,020	—	804	—

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TIN

Events, Trends, and Issues: Apparent consumption of tin in the United States decreased slightly in 2013 compared with that of 2012, and the annual average composite price of tin increased by 4%.

Indonesia, the world's leading exporter of tin, enacted new regulations in August that raised the minimum purity level of exported tin to 99.9% and required all tin ingot exports to be traded through the Indonesia Commodities and Derivatives Exchange.

World Mine Production and Reserves: Reserves figures were revised for Brazil based on new data from the Instituto Brasileiro de Mineracao, and reserves figures for Peru were revised based on data from the Ministerio de Energia y Minas del Peru.

	Mine production		Reserves[4]
	2012	2013[e]	
United States	—	—	—
Australia	5,000	5,900	240,000
Bolivia	19,700	18,000	400,000
Brazil	10,800	11,900	700,000
Burma	11,000	11,000	NA
China	110,000	100,000	1,500,000
Congo (Kinshasa)	4,000	4,000	NA
Indonesia	41,000	40,000	800,000
Laos	800	800	NA
Malaysia	3,000	3,700	250,000
Nigeria	570	570	NA
Peru	26,100	26,100	91,000
Russia	280	300	350,000
Rwanda	2,300	1,600	NA
Thailand	300	300	170,000
Vietnam	5,400	5,400	NA
Other countries	73	70	180,000
World total (rounded)	240,000	230,000	4,700,000

World Resources: U.S. identified 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 extensive and, if developed, could 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 old scrap + imports – exports + adjustments for Government and industry stock changes.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix B for definitions.
[4]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. Titanium ingot was produced by 10 operations in 8 States and consumed by numerous firms to produce wrought products and castings. In 2013, an estimated 73% of the titanium metal was used in aerospace applications. The remaining 27% was used in armor, chemical processing, marine, medical, power generation, sporting goods, and other nonaerospace applications. The value of sponge metal consumed was about $335 million, assuming an average selling price of $13.60 per kilogram.

In 2013, titanium dioxide (TiO_2) pigment, which was valued at about $4.0 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), 60%; plastic, 25%; paper, 10%; and other, 5%. Other uses of TiO_2 included catalysts, ceramics, coated fabrics and textiles, floor coverings, printing ink, and roofing granules.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Titanium sponge metal:					
Production	W	W	W	W	W
Imports for consumption	16,600	20,500	33,800	33,600	18,600
Exports	820	293	256	1,420	1,130
Consumption, reported	W	34,900	48,400	35,100	24,600
Price, dollars per kilogram, yearend	15.58	10.74	9.93	11.31	13.60
Stocks, industry yearend[e]	15,300	10,500	10,800	18,100	24,400
Employment, number[e]	300	300	300	300	300
Net import reliance[2] as a percentage of reported consumption	W	72	69	71	45
Titanium dioxide:					
Production	1,230,000	1,320,000	1,290,000	1,140,000	1,200,000
Imports for consumption	175,000	204,000	200,000	203,000	210,000
Exports	649,000	758,000	789,000	624,000	650,000
Consumption, apparent	757,000	767,000	706,000	719,000	760,000
Producer price index, yearend	164	194	268	268	248
Employment, number[e]	3,800	3,400	3,400	3,400	3,400
Net import reliance[2] as a percentage of apparent consumption	E	E	E	E	E

Recycling: About 45,000 tons of scrap metal was recycled by the titanium industry in 2013. Estimated use of titanium scrap by the steel industry was about 11,000 tons; by the superalloy industry, 1,100 tons; and in other industries, 1,000 tons.

Import Sources (2009–12): Sponge metal: Japan, 48%; Kazakhstan, 34%; China; 10%; and other, 8%. Titanium dioxide pigment: Canada, 41%; China, 17%; Germany, 6%; and other, 36%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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: Domestic production of TiO_2 pigment was 1.20 million tons, a 5% increase compared with that in 2012. Imports in 2013 were expected to increase slightly over those of 2012. Exports in 2013 were also expected to increase over those of 2012 but remain considerably lower than the record-high export level of 2011.

In October, one of the leading global producers of TiO_2 pigment announced that it expected to complete the spinoff of its performance chemical division into a separate company within 18 months. In Ukraine, a new 120,000-ton-per-year pigment plant was expected to be constructed in the Crimea by 2015, and capacity at an existing plant in the same region was to increase to 120,000 tons per year from 40,000 tons per year. In Canada, a new 50,000-ton-per-year pigment plant in Quebec was expected to be constructed by 2015. In Singapore, a 54,000-ton-per-year pigment plant was closed owing to reduced demand and an increase in feedstock prices.

Although domestic consumption of titanium sponge in 2013 decreased by 30% from that of the previous year, shipments of titanium mill products in 2013 increased by 44% from those of 2012 owing to increased demand from the commercial aerospace industry. Several agreements were signed between aircraft and aircraft engine manufacturers with titanium metal and parts producers to ensure titanium supply. In Helena, MT, a major aerospace manufacturer announced plans to increase its titanium machining capacity for the manufacture of titanium airframe components. In South Africa, a pilot program was begun to develop the technology to refine titanium powder from titanium tetrachloride and was expected to produce 500 tons per year by 2017.

World Sponge Metal Production and Sponge and Pigment Capacity:

	Sponge production		Capacity 2013[3]	
	2012	2013[e]	Sponge	Pigment
United States	W	W	24,000	1,470,000
Australia	—	—	—	281,000
Belgium	—	—	—	74,000
Canada	—	—	—	104,000
China[e]	80,000	100,000	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]	25,000	27,000	27,000	1,000
Mexico	—	—	—	130,000
Russia[e]	44,000	45,000	46,500	20,000
Spain	—	—	—	80,000
Ukraine[e]	10,000	10,000	10,000	120,000
United Kingdom	—	—	—	300,000
Other countries	—	—	—	900,000
World total (rounded)	[4]200,000	[4]222,000	284,000	6,560,000

World Resources:[5] Resources and reserves of titanium minerals are discussed under Titanium Mineral Concentrates. The commercial feedstock sources for titanium are ilmenite, leucoxene, rutile, slag, and synthetic rutile.

Substitutes: Few materials 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. 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 2013 was about $1,140 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:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Production[2] (rounded)	200	200	300	300	300
Imports for consumption	927	958	1,030	1,120	1,170
Exports,[e] all forms	9	12	16	26	13
Consumption, estimated	1,360	1,460	1,310	1,390	1,460
Price, dollars per metric ton, yearend:					
Ilmenite, bulk, minimum 54% TiO_2, f.o.b. Australia	73	75	195	300	300
Rutile, bulk, minimum 95% TiO_2, f.o.b. Australia	533	540	1,400	2,400	1,700
Slag, 80%–95% TiO_2[3]	401–439	367–433	468–494	512–763	537–765
Employment, mine and mill, number[e]	194	178	195	195	195
Net import reliance[4] as a percentage of apparent consumption	68	65	77	78	79

Recycling: None.

Import Sources (2009–12): South Africa, 35%; Australia, 34%; Canada, 23%; Mozambique, 5%; and other, 3%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 5% in 2013 compared with that in 2012.

World mine production in 2013 increased by about 4% in response to a similar increase in global TiO_2 pigment production. The price of ilmenite remained constant throughout 2013, but the price of rutile decreased in 2013 after reaching record-high levels in 2012. The high price of titanium minerals has encouraged vertical integration between the mineral production and pigment industries.

Global production of titanium mineral concentrates was expected to increase during the next several years. Mining at the Kwale project in Kenya was expected to begin in late 2013, and production was anticipated to be 330,000 and 79,000 tons per year of ilmenite and rutile, respectively. In South Africa, production at the Tormin project was planned to begin in late 2013, with an anticipated output of 48,000 tons per year of nonmagnetic concentrate grading 81% zircon and 11.6% rutile over a 4-year mine life. The Fairbreeze Mine in the KwaZulu-Natal Sands region, which was being developed to serve as a replacement to the Hillendale Mine in the same region, was expected to start up in the first half of 2015. In Western Australia, the heavy-mineral resource, data for at the Keysbrook project were revised to include 78.8 million tons grading 2.4% heavy-mineral concentrates, and the expected mine life increased to more than 15 years. Production was expected to begin in the first half of 2014.

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TITANIUM MINERAL CONCENTRATES

World Mine Production and Reserves: Reserves for Australia were revised based on a Geoscience Australia publication. Revisions to reserves in Mozambique were based on company reports.

	Mine production		Reserves[5]
	2012	2013[e]	
Ilmenite:			
United States[2]	[6]300	[6]300	2,000
Australia	940	940	160,000
Brazil	45	45	43,000
Canada[7]	750	770	31,000
China	960	950	200,000
India	340	340	85,000
Madagascar	380	430	40,000
Mozambique	350	480	14,000
Norway	360	400	37,000
South Africa[7]	1,100	1,100	63,000
Sri Lanka	32	32	NA
Ukraine	360	410	5,900
Vietnam	510	500	1,600
Other countries	74	90	26,000
World total (ilmenite, rounded)	6,500	6,790	700,000
Rutile:			
United States	([8])	([8])	([8])
Australia	410	450	24,000
Brazil	2	2	1,200
India	24	26	7,400
Mozambique	7	9	510
Sierra Leone	89	90	3,800
South Africa	120	120	8,300
Ukraine	56	60	2,500
Other countries	24	17	400
World total (rutile, rounded)	[8]730	[8]770	48,000
World total (ilmenite and rutile, rounded)	7,230	7,550	750,000

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.
[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 2013. 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. Sixty percent 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 2013 was approximately $800 million.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production:					
Mine	NA	NA	NA	NA	NA
Secondary	3,690	5,680	11,000	9,190	8,300
Imports for consumption:					
Concentrate	3,590	2,740	3,640	3,650	4,000
Other forms	6,410	9,690	9,600	8,060	8,100
Exports:					
Concentrate	38	276	169	203	840
Other forms	2,730	4,350	6,960	6,530	7,200
Government stockpile shipments:					
Concentrate	688	2,060	1,180	1,780	2,100
Other forms	12	([1])	46	([1])	—
Consumption:					
Reported, concentrate	W	4,820	W	W	W
Apparent,[2, 3] all forms	11,600	15,500	18,100	15,000	13,900
Price, concentrate, dollars per mtu WO_3,[4] average:					
U.S. spot market, Platts Metals Week	151	183	248	358	360
European market, Metal Bulletin	150	150	150	NA	NA
Stocks, industry, yearend:					
Concentrate	W	W	W	W	W
Other forms	2,210	2,530	W	W	W
Net import reliance[5] as a percentage of apparent consumption	68	63	40	39	41

Recycling: In 2013, the tungsten contained in scrap consumed by processors and end users represented approximately 50% of apparent consumption of tungsten in all forms.

Import Sources (2009–12): Tungsten contained in ores and concentrates, intermediate and primary products, wrought and unwrought tungsten, and waste and scrap: China, 45%; Bolivia, 8%; Germany, 5%; Portugal, 5%; and other, 37%.

Tariff: Item	Number	Normal Trade Relations[6] 12–31–13
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—9–30–13[7]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2013	Disposals FY 2013
Metal powder	125	125	35	—
Ores and concentrates	12,100	12,100	2,300	2,240

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 stop illegal mining and close small inefficient mines, to continue to use quotas to control tungsten mine production, to improve its tungsten-processing technology and increase tungsten recovery from ores and tailings, 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 to develop tungsten deposits or restart tungsten production from inactive mines in Asia, Australia, Europe, and North America. The amount, location, and timing of future production will depend on the companies' abilities to acquire funding. Increased production capacity for ammonium paratungstate and ferrotungsten outside China is also planned. Scrap will continue to be an increasingly important source of raw material for the tungsten industry, worldwide.

World Mine Production and Reserves: Reserves for Canada were revised upward based on company data; reserves for "Other countries" were revised upward based on company and Government data.

	Mine production		Reserves[8]
	2012	2013[e]	
United States	NA	NA	140,000
Austria	800	800	10,000
Bolivia	1,270	1,200	53,000
Canada	2,190	2,200	290,000
China	64,000	60,000	1,900,000
Portugal	763	800	4,200
Russia	3,000	2,500	250,000
World total (rounded)	[3]75,700	[3]71,000	3,500,000

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 compose 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. In 2009–12, small amounts of vanadium were produced as a coproduct from the mining of uraniferous sandstones on the Colorado Plateau. In the second quarter of 2012, the only coproduct producer of vanadium was acquired by a new company and all coproduct vanadium production for 2013 was suspended. Metallurgical use, primarily as an alloying agent for iron and steel, accounted for about 93% of the domestic vanadium consumption in 2013. 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:	2009	2010	2011	2012	2013[e]
Production, mine, mill	230	1,060	590	272	—
Imports for consumption:					
Ferrovanadium	353	1,340	2,220	4,190	4,080
Vanadium pentoxide, anhydride	1,120	4,000	2,810	1,640	1,590
Oxides and hydroxides, other	25	167	886	905	350
Aluminum-vanadium master alloys[1] (gross weight)	25	63	86	115	40
Ash and residues	791	521	1,420	2,040	3,040
Sulfates	16	48	42	29	50
Vanadates	214	158	303	280	390
Vanadium metal, including waste & scrap (gross weight)	22	10	44	154	140
Exports:					
Ferrovanadium	672	611	314	337	500
Vanadium pentoxide, anhydride	401	140	98	62	100
Oxides and hydroxides, other	506	1,100	254	287	540
Aluminum-vanadium master alloys[1] (gross weight)	67	133	318	432	10
Vanadium metal, including waste & scrap	23	21	102	26	60
Consumption:					
Apparent	1,190	5,450	7,490	8,530	8,350
Reported	4,690	5,030	4,140	3,980	3,700
Price, average, dollars per pound V_2O_5	5.43	6.46	6.76	6.49	6.25
Stocks, consumer, yearend	295	248	[2]193	[2]223	[2]298
Net import reliance[3] as a percentage of apparent consumption	81	81	92	97	100

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. The quantity of vanadium recycled from spent chemical process catalysts was significant and may comprise as much as 40% of total supply.

Import Sources (2009–12): Ferrovanadium: Canada, 28%; Czech Republic, 28%; Republic of Korea, 23%; Austria, 19%; and other, 2%. Vanadium pentoxide: Russia, 43%; South Africa, 37%; China, 15%; and other, 5%.

Tariff: Ash, residues, slag, and waste and scrap enter duty-free.

Item	Number	Normal Trade Relations 12–31–13
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	8112.99.2000	2.0% ad val.

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 2013 decreased slightly from its 2012 level. Among the major uses for vanadium, production of carbon, full-alloy, and high-strength low-alloy steels accounted for 17%, 44%, and 33%, respectively, of domestic consumption. U.S. imports for consumption of vanadium in 2013 increased slightly from those of the previous year. U.S. exports increased by 6% from those of the previous year.

In January 2012, vanadium pentoxide (V_2O_5) prices were at their year-to-date low of $5.83 per pound of V_2O_5, but gradually increased to a year-to-date high of $6.75 per pound of V_2O_5 in October. Starting in November 2012, prices slowly decreased until March 2013. In June 2013, prices averaged $6.10 per pound of V_2O_5. U.S. ferrovanadium (FeV) prices trended upward from January 2012 and reached a year-to-date high of $17.00 per pound FeV (contained vanadium) in June 2012. In July 2012, prices decreased until February 2013 when prices began to increase. In May 2013, prices began to decrease again. In June 2013, prices averaged $13.25 per pound of FeV.

World Mine Production and Reserves:

	Mine production		Reserves[4]
	2012	2013[e]	(thousand metric tons)
United States	272	—	45
China	39,000	40,000	5,100
Russia	15,000	15,000	5,000
South Africa	19,500	20,000	3,500
Other countries	600	600	NA
World total (rounded)	74,000	76,000	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 typically 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. Currently, no acceptable substitute for vanadium is available in aerospace titanium alloys.

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

[1]In previous years, imports and exports of aluminum-vanadium master alloys (HTS 7601.20.9030) were reported. Starting with MCS 2014, imports and exports of aluminum-vanadium master alloys (HTS 8112.99.2000) consisting of 35% aluminum and 64.5% vanadium were reported, resulting in changes to apparent consumption calculations.

[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, 50%; lightweight concrete aggregates (including cement premixes, concrete, and plaster), 20%; insulation, 5%; and other, 25%.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production[e, 1]	100	100	100	100	100
Imports for consumption[e, 2]	39	29	53	57	42
Exports[e]	3	2	2	2	2
Consumption, apparent, concentrate[3]	140	130	150	160	140
Consumption, exfoliated[e]	64	66	64	60	70
Price, range of value, concentrate, dollars per ton, ex-plant[4]	95–400	100–400	115–460	145–525	150–550
Employment, number[e]	75	80	80	75	85
Net import reliance[5] as a percentage of apparent consumption[6]	30	20	30	35	30

Recycling: Insignificant.

Import Sources (2009–12): South Africa, 54%; China, 26%; Brazil, 17%; and other, 3%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 an independent industry trade information source, U.S. imports, excluding any material from Canada and Mexico, were about 35,000 tons for the first 10 months of 2013, about 13% less than during the first 10 months of 2012. Brazil provided 51%; South Africa, 35%; China, 13%; and other countries, 1% of vermiculite imports. Supplies of coarse grades were tight, and prices rose slightly in 2013.

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VERMICULITE

An Australian company kept its vermiculite mine at the East African Namekara vermiculite deposit in Uganda on care-and-maintenance status, owing to an oversupply of the medium-to-finer grades in the world market and transportation-and-related infrastructure-improvement issues. The company was negotiating a mining agreement with the Ugandan Government and working to ease local tensions that followed the mine shutdown. Although no vermiculite was produced, removal of overburden continued. The Namekara deposit has sufficient resources for more than 50 years of production and is a portion of the larger East African vermiculite project, which has about 55 million tons of inferred resources and is considered to be one of the world's largest deposits. The Ugandan government invited Russian mineral companies to explore for vermiculite, based on data from a recent geophysical survey indicating the potential for large occurrences of vermiculite and other industrial minerals in the country.

The leading vermiculite producer in South Africa was sold to a consortium of South African and Chinese private and parastatal companies in December 2012. Reserves identified on properties adjacent to and near ongoing vermiculite mining operations could enable increased vermiculite production and extend the mine's current expected 24-year mine life.

A Brazilian company was expanding production capacity at its vermiculite mine in central Brazil in 2013 and was expected to begin production at another deposit under development near Brasilia, bringing the company's total production capacity to 200,000 tons per year in 2016.

World Mine Production and Reserves: The estimates of reserves were revised for Brazil and India based on new information from official Government sources in those countries.

	Mine production		Reserves[7]
	2012	2013[e]	
United States[e, 1]	100	100	25,000
Brazil	50	55	15,800
Bulgaria	19	20	NA
China	15	50	NA
India	13	20	1,700
Russia	25	25	NA
South Africa	140	130	14,000
Uganda	8	12	NA
Other countries	10	10	15,000
World total	380	420	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 bark and other plant materials, peat, perlite, sawdust, and synthetic soil conditioners.

[e]Estimated. NA Not available.
[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]Price ranges, depending on grade and size, as reported in annual Mining Engineering "Vermiculite" reports (June 2009–12 and July 2013).
[5]Defined as imports – exports.
[6]Rounded to one significant digit to protect proprietary data.
[7]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. 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%; and paint, friction products, and miscellaneous, 10% to 15%, each. In ceramics, wollastonite decreases shrinkage and gas evolution during firing; increases green and fired strength; maintains brightness during firing; permits fast firing; and reduces crazing, cracking, and glaze defects. In metallurgical applications, wollastonite serves as a flux for welding, a source for calcium oxide, a slag conditioner, and to protect the surface of molten metal during the continuous casting of steel. As an additive in paint, it improves the durability of the paint film, acts as a pH buffer, improves its resistance to weathering, reduces gloss, reduces pigment consumption, and acts as a flatting and suspending agent. In plastics, wollastonite improves tensile and flexural strength, reduces resin consumption, and improves thermal and dimensional stability at elevated temperatures. Surface treatments are used to improve the adhesion between the wollastonite and the polymers to which it is added. As a substitute for asbestos in floor tiles, friction products, insulating board and panels, paint, plastics, and roofing products, wollastonite is resistant to chemical attack, inert, stable at high temperatures, and improves flexural and tensile strength.

Salient Statistics—United States: U.S. production was withheld to protect company proprietary data. In 2013, U.S. production and apparent consumption were estimated to have increased slightly compared with those in 2012. Comprehensive trade data are not available (the United States was a net exporter of wollastonite). Exports were estimated to be less than 10,000 tons and imports probably remained less than 4,500 tons in 2013. Prices for wollastonite were reported in trade literature to range from $80 to $400 per metric ton. Products with finer grain sizes and acicular (highly elongated) particles sold for higher prices. Surface treatment, when necessary, also increased the selling price.

Recycling: None.

Import Sources (2009–12): Comprehensive trade data are not available, but wollastonite was imported from China, Finland, India, and Mexico.

Tariff:

Item	Number	Normal Trade Relations 12–31–13
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 consumption of wollastonite increased slightly in 2013. Exports probably increased slightly and imports were likely to have remained unchanged in 2013.

In September 2012, one of the domestic wollastonite producers was acquired by a Greek mining company. During 2013, the company was engaged in arranging a land swap with the State of New York to acquire additional wollastonite reserves located on State land.

In December 2012, a Canadian mining company received approval for a proposed wollastonite mine in Ontario, Canada. The approval covered only part of the company's land holdings; however, the company planned to seek a zoning amendment in 2013 to allow it to mine the remaining portions of the wollastonite deposit on land owned by a nearby city.

The wollastonite industry is strongly dependent on sales to the ceramics, metallurgical, paint, and plastic industries, all of which declined during the global recession. U.S. sales of products in industries on which wollastonite sales are dependent increased slightly in 2013 compared with sales in 2012. Sales to construction-related markets, such as adhesives, caulks, ceramic tile, and paints, increased slightly in 2013 because of growth in residential and commercial construction. In Western Europe, demand for wollastonite continued to stagnate because of economic uncertainties. Consumption in China continued to increase, although at a slower pace than prior to 2011.

World Mine Production and Reserves: World production data for wollastonite are not available for many countries.

	Mine production		Reserves[1]
	2012	2013[e]	
United States	W	W	
Finland	11,500	12,000	World reserves of wollastonite were estimated to exceed 90 million tons. Many deposits, however, have not been surveyed, making accurate reserve estimates unavailable.
India	[e]150,000	160,000	
Mexico	55,200	55,000	
Other countries	[e]8,000	5,000	
World total (rounded)[2]	225,000	230,000	

World Resources: World resources have not been estimated for wollastonite. Large deposits of wollastonite were in China, Finland, India, Mexico, and the United States. Smaller, but significant, deposits were 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; China produced wollastonite, but information was inadequate to estimate output.

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 2013. Bastnasite, a rare-earth fluorocarbonate mineral, was mined as a primary product at Mountain Pass, CA. Domestic production of rare-earth oxide mineral concentrate in 2013 was estimated to be 4,000 tons in 2013. Yttrium was estimated to represent 0.12 percent of the rare-earth elements in the Mountain Pass bastnasite ore.

The leading end uses of yttrium, in decreasing order, were in phosphors, ceramics, and metallurgy. Yttrium was used in phosphor compounds for flat panel televisions and displays, and in fluorescent lights. In ceramic applications, yttrium compounds were used in abrasives, bearings and seals, high-temperature refractories for continuous-casting nozzles, jet-engine coatings, oxygen sensors in automobile engines, and wear-resistant and corrosion-resistant cutting tools. In metallurgical applications, yttrium was used as a grain refining additive and as a deoxidizer. Yttrium was used in heating-element alloys, high-temperature superconductors, and superalloys. 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.

Salient Statistics—United States:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Production, mine[2]	—	—	—	NA	NA
Imports for consumption:					
Yttrium, alloys, compounds, and metal[e, 3]	450	670	550	160	200
Exports, in ore and concentrate	NA	NA	NA	NA	NA
Consumption, estimated[4]	450	670	550	160	200
Price,[e] dollars:					
Monazite concentrate, per metric ton[5]	480	1,700	1,600	660	660
Yttrium oxide, per kilogram, minimum 99.999 purity[6]	13–14	25–27	136–141	86-91	24-28
Yttrium metal, per kilogram, minimum 99.9% purity[6]	35–45	50-60	162-172	141-15	61-71
Net import reliance[e, 7] as a percentage of apparent consumption	100	100	100	100	100

Recycling: Small quantities, primarily from phosphors.

Import Sources (2009–12): Yttrium compounds, greater than 19% to less than 85% weight percent yttrium oxide equivalent: China, 67%; Japan, 15%; Austria, 5%; France, 5%; and other, 8%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12–31–13**
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 ≥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.

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YTTRIUM

Events, Trends, and Issues: China produced 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, and from a lesser number of deposits in Guangxi and Hunan. Processing was primarily at facilities in Guangdong, Jiangsu, and Jiangxi Provinces.

Globally, yttrium was mainly consumed in the form of high-purity oxide compounds for phosphors. Lesser amounts were consumed in ceramics, electronic devices, lasers, and metallurgical applications. Global consumption of yttrium oxide was estimated to be about 7,000 tons. Owing to weak global demand in the phosphor market, prices for yttrium metal and oxide decreased significantly in 2013.

No imports of yttrium-bearing thorium ores and concentrates were reported through July 2013. In 2012, 45 tons of thorium ores and concentrates were imported through Dallas-Fort Worth, TX (17 tons), and Miami, FL (26 tons). The yttrium content of the thorium ores and concentrates was not available.

World Mine Production and Reserves: Mine production of rare-earth oxides in Australia, including yttrium oxide, was estimated to be 3,000 tons in 2012 and 2,000 tons in 2013. The yttrium oxide content of the rare-earth oxides in the Australia's Central Lanthanide deposit was estimated to be 0.76%.

	Mine production[e, 8]		Reserves[9]
	2012	2013	
United States	NA	NA	120,000
Australia	NA	NA	100,000
Brazil	15	15	2,200
China	7,000	7,000	220,000
India	55	56	72,000
Malaysia	2	2	13,000
Sri Lanka	—	—	240
Other countries	—	—	17,000
World total (rounded)	7,100	7,100	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). 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.

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 the substitutes generally impart lower toughness.

[e]Estimated. NA Not available. — Zero.
[1]See also Rare Earths; trade data for yttrium are included in the data shown for rare earths.
[2]Includes yttrium contained in rare-earth ores and mineral concentrates.
[3]Imports based on data from the Port Import/Export Reporting Service, Journal of Commerce.
[4]Essentially, all yttrium consumed domestically was imported or refined from imported ores and concentrates.
[5]Monazite price estimated based on imports to China.
[6]Free on board China from Metal-Pages Ltd., Teddington, United Kingdom.
[7]Defined as imports – exports + adjustments for Government and industry stock changes. Insufficient data were available to determine exports and stocks changes and were excluded from the calculation.
[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 eight companies in the United States. Chabazite was mined in Arizona; clinoptilolite was mined in California, Idaho, New Mexico, Oregon, and Texas. New Mexico was the leading zeolite-producing State in 2013, followed by Texas, Idaho, California, Arizona, and Oregon.

Natural zeolites mined in the United States are associated with the alteration of volcanic tuffs found in alkaline lake deposits and open hydrologic systems. Smaller, noncommercial deposits are found in several other Midwestern and Western States. Numerous zeolite minerals, including chabazite, clinoptilolite, erionite, mordenite, and phillipsite, occur in these deposits, but the most commonly mined zeolites were chabazite, clinoptilolite, and mordenite.

Domestic uses for natural zeolites were, in decreasing order by tonnage, animal feed, pet litter, cement (primarily down-hole cement applications by the drilling industry), water purification, odor control, wastewater cleanup, fungicide or pesticide carrier, gas absorbent, fertilizer carrier, oil absorbent, desiccant, catalyst, and aquaculture. The six leading uses accounted for more than 70% of the domestic natural zeolite sales tonnage.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production	59,500	61,300	65,400	74,000	75,000
Sales, mill	59,400	60,000	65,200	70,500	72,000
Imports for consumption[e]	200	150	100	5	5
Exports[e]	500	400	1,100	750	700
Consumption, apparent[e, 1]	59,100	59,800	64,200	69,800	71,300
Price, range of value, dollars per metric ton[2]	30–900	30–900	40–800	50–800	50–800
Net import reliance[3] 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 (2009–12): Comprehensive trade data are not available for natural zeolites. Nearly all exports and imports were synthetic zeolites.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 slightly in 2013. Increases were mainly in markets such as animal feed, down-hole cement 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. Although specific data are not available on U.S. trade of natural zeolites, the United States was believed to have been a net exporter of natural zeolites in 2013.

In the United States, natural zeolite markets were smaller and less associated with construction and manufacturing than many 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 sluggish economic growth and the associated 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 encouraging 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. 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[e, 4]		Reserves[5]
	2012	2013[e]	
United States	74,000	75,000	
China[6]	2,000,000	2,000,000	World reserves are
Jordan	15,000	13,000	not determined but are
Korea, Republic of	230,000	230,000	estimated to be large.
Turkey	150,000	50,000	
Other countries[6]	350,000	350,000	
World total (rounded)	2,800,000	2,700,000	

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]Defined as sales, mill + imports – exports.
[2]Estimate based on values reported by U.S. producers and prices published in the trade literature. Bulk shipments typically range from $100 to $240 per ton.
[3]Defined as imports – exports.
[4]Estimates for countries that do not report production represent a range with possibly 15% to 20% variability, rather than an absolute value.
[5]See Appendix C for resource/reserve definitions and information concerning data sources.
[6]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 2013, based on zinc contained in concentrate, was about $1.60 billion. Zinc was mined in 4 States at 14 mines operated by 4 companies. Two facilities—one primary and the other secondary—produced the bulk of commercial-grade refined zinc metal. Of the total reported zinc consumed, about 80% was used in galvanizing, 6% in brass and bronze, 5% in zinc-base alloys, and 9% in other uses.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production:					
Mine, zinc in concentrate	736	748	769	738	760
Metal production					
At primary smelters	94	120	110	114	120
At secondary smelters	109	129	138	147	130
Imports for consumption:					
Zinc in ore and concentrate	74	32	27	6	3
Refined zinc	686	671	716	655	700
Exports:					
Zinc in ore and concentrate	785	752	660	592	650
Refined zinc	3	4	19	14	15
Shipments from Government stockpile	([1])	—	—	—	—
Consumption, apparent, refined zinc[2]	893	907	939	892	950
Price, average, cents per pound:					
North American[3]	77.9	102.0	106.2	95.8	96.0
London Metal Exchange (LME), cash	75.1	98.0	99.5	88.3	87.0
Reported producer and consumer stocks, refined zinc, yearend	85	108	145	155	140
Employment:					
Mine and mill, number[4]	1,580	1,790	2,240	2,310	2,540
Smelter primary, number	248	255	244	252	252
Net import reliance[5] as a percentage of apparent consumption (refined zinc)	77	73	74	71	74

Recycling: In 2013, about 60% (150,000 tons) of the refined zinc produced in the United States was recovered from secondary materials at both primary and secondary smelters. Secondary materials included galvanizing residues and crude zinc oxide processed from electric arc furnace dust.

Import Sources (2009–12): Ore and concentrate: Peru, 76%; Ireland, 8%; Mexico, 8%; Canada, 7%; and other, 1%. Metal: Canada, 72%; Mexico, 13%; Peru, 7%; Spain, 2%; and other, 6%. Waste and scrap: Canada, 65%; Mexico, 31%; Dominican Republic, 2%; and other, 2%. Combined total: Canada, 69%; Mexico, 13%; Peru, 10%; and other, 8%.

Tariff: Item	Number	Normal Trade Relations[6] 12–31–13
Zinc ores and concentrates, Zn content	2608.00.0030	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.

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

Government Stockpile:

Stockpile Status—9–30–13[7]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2013	Disposals FY 2013
Zinc	7	7	—	—

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ZINC

Events, Trends, and Issues: Global zinc mine production in 2013 was essentially unchanged at 13.5 million tons. According to the International Lead and Zinc Study Group, refined zinc production in 2013 increased by 3% to 13.0 million tons, and metal consumption rose by 5% to 12.9 million tons, resulting in a production-to-consumption surplus of 120,000 tons of refined zinc. A smaller surplus of 115,000 tons was expected in 2014.

Domestic zinc mine production increased slightly in 2013 from that of 2012 owing to increases in zinc production at a zinc-lead mine in Alaska and two zinc-mining complexes in Tennessee. Zinc metal production decreased by 4% owing to a decline in secondary production; a zinc-recycling company closed its smelter in Pennsylvania in the latter half of the year as it began production at its new recycling facility in North Carolina. Apparent zinc consumption increased by 7% in 2013 from that of 2012 owing to a similar rise in net imports of unwrought zinc.

The monthly average North American Special High Grade (SHG) zinc price began the year at $1.00 per pound in January, peaked at $1.05 per pound in February, and then declined through May when it reached a low of $0.92 per pound. By mid-October, prices averaged about $0.95 per pound. North American SHG zinc premiums began the year at 8 cents per pound and rose to around 9 to 9.5 cents per pound by October.

Concern over increasing premiums and long load-out queues at LME warehouses prompted action by the LME and regulatory agencies. The LME approved new delivery rate policies effective April 2014 requiring warehouses to deliver out more metal than they load in until their metals queues fall to fewer than 50 days. The U.S. Commodity Futures Trading Commission began a preliminary investigation into the metal warehousing businesses of certain banks and trading companies.

World Mine Production and Reserves: Reserves estimates for Bolivia, Canada, India, Ireland, Mexico, and the United States were revised based on company data. The reserves estimate for Australia was revised based on data provided by Geoscience Australia, and the reserves estimate for Peru was revised based on data from the Ministerio de Energia y Minas del Peru.

	Mine production[8]		Reserves[9]
	2012	2013[e]	
United States	738	760	10,000
Australia	1,510	1,400	64,000
Bolivia	405	400	5,200
Canada	641	550	7,000
China	4,900	5,000	43,000
India	758	800	11,000
Ireland	338	330	1,300
Kazakhstan	371	370	10,000
Mexico	660	600	18,000
Peru	1,280	1,290	24,000
Other countries	1,930	1,950	57,000
World total (rounded)	13,500	13,500	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]Apparent consumption from 2009 through 2011 does not necessarily reflect reported industry stock changes. Stocks increased during these years owing to an increased response rate from industry.
[3]Platts Metals Week price for North American SHG zinc; based on the LME cash price plus premiums or discounts, depending on market conditions.
[4]Includes mine and mill employment at all zinc-producing mines. Source: Mine Safety and Health Administration.
[5]Defined as imports – exports + adjustments for Government and industry stock changes. The net import reliance from 2009 to 2011 does not necessarily reflect reported industry stock changes. Stocks increased during these years owing to an increased response rate from industry.
[6]No tariff for Canada, Mexico, and Peru for items shown.
[7]See Appendix B for definitions.
[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:	**2009**	**2010**	**2011**	**2012**	**2013[e]**
Production, zircon	W	W	W	W	W
Imports:					
Zirconium, ores and concentrates (ZrO_2 content)	9,370	14,900	17,200	16,700	6,500
Zirconium, unwrought, powder, and waste and scrap	451	727	485	279	484
Zirconium, wrought	526	435	392	289	314
Hafnium, unwrought, powder, and waste and scrap	5	8	10	23	10
Exports:					
Zirconium ores and concentrates (ZrO_2 content)	25,700	30,800	15,800	13,000	14,200
Zirconium, unwrought, powder, and waste and scrap	223	519	675	555	720
Zirconium, wrought	2,080	1,540	1,330	1,250	1,240
Consumption, zirconium ores and concentrates, apparent (ZrO_2 content)	W	W	W	W	W
Prices:					
Zircon, dollars per metric ton (gross weight):					
Domestic[1]	830	860	2,650	2,650	2,650
Imported, f.o.b.[2]	850	870	2,500	2,075	1,400
Zirconium, unwrought, import, France, dollars per kilogram[3]	51	74	64	91	95
Hafnium, unwrought, import, France, dollars per kilogram[3]	472	453	544	503	594
Net import reliance[4] as a percentage of apparent consumption:					
Zirconium	E	E	<10%	<10%	E
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 (2009–12): Zirconium mineral concentrates: South Africa, 52%; Australia, 43%; and other, 5%. Zirconium, unwrought, including powder: Japan, 43%; Germany, 40%; Kazakhstan, 7%; France, 4%; Canada, 4%; and other, 2%. Hafnium, unwrought: France, 58%; Australia, 24%; Germany, 11%; other, 7%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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.

Prepared by **George M. Bedinger [(703) 648–6183, gbedinger@usgs.gov]**

ZIRCONIUM AND HAFNIUM

Events, Trends, and Issues: Domestic production of zirconium mineral concentrates remained unchanged from that in 2012, although consumption decreased from that in 2012 as reflected by decreased imports. Domestic mining of heavy minerals continued near Stony Creek, VA, and Starke, FL. Construction began at a new zircon mine in Charlton County, GA, and was expected to be completed in the second quarter 2014. A second mine in Brantley County, GA, was expected to come on stream in the first quarter 2015. Construction of a mineral sands plant in Pierce County, GA, to process the heavy minerals from the two new mines, was expected to begin in late 2014.

Global production of zirconium concentrates in 2013 remained at about the same level as that in 2012, despite a weakening demand, particularly in China, resulting from a sharp price increase beginning in late 2011. Globally, several projects were under development that could significantly contribute to global zircon supply. In Kenya, mining at the Kwale project was expected to begin in late 2013. Production of zircon was expected to be 30,000 tons per year during a mine life of 13 years. In South Africa, production at the Tormin project was expected to begin in late 2013 at a rate of 48,000 tons per year of nonmagnetic concentrate grading 81% zircon and 11.6% rutile, with a 4-year mine life. In Senegal, the Grande Cote project was expected to produce about 80,000 tons per year of zircon by the end of 2013, with a mine life of more than 20 years. In New South Wales, Australia, zircon production from the Dubbo Zirconia project was expected to begin in 2016 at a rate of 16,000 tons per year of zircon.

World Mine Production and Reserves: Zirconium reserves for Australia were revised based on a Geoscience Australia publication. Revisions to reserves in Mozambique were based on company reports. 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[5] (thousand metric tons, ZrO_2)
	2012	2013[e]	
United States	W	W	500
Australia	605	600	40,000
China	140	140	500
India	40	40	3,400
Indonesia	120	120	NA
Mozambique	47	65	1,100
South Africa	380	360	14,000
Other countries	130	110	7,200
World total (rounded)	[6]1,460	[6]1,440	67,000

World Resources: Resources of zircon in the United States included about 14 million tons associated with titanium resources in heavy-mineral sand deposits. Phosphate rock and sand and gravel deposits could potentially yield substantial amounts of zircon as a byproduct. 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] Yearend average of high-low price range.
[2] Unit value based on U.S. imports for consumption.
[3] Unit value based on U.S. imports for consumption from France.
[4] Defined as imports – exports.
[5] See Appendix C for resource/reserve definitions and information concerning data sources.
[6] 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 2013 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 2013 (fiscal year 2013 is the period October 1, 2012, through September 30, 2013). 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 2013 refers to material sold or traded from the stockpile in FY 2013.

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, almost 460 million metric tons of copper have been produced worldwide, but world copper reserves in 2013 were estimated to be 690 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 minerals 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.[1]

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 subeconomic 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*

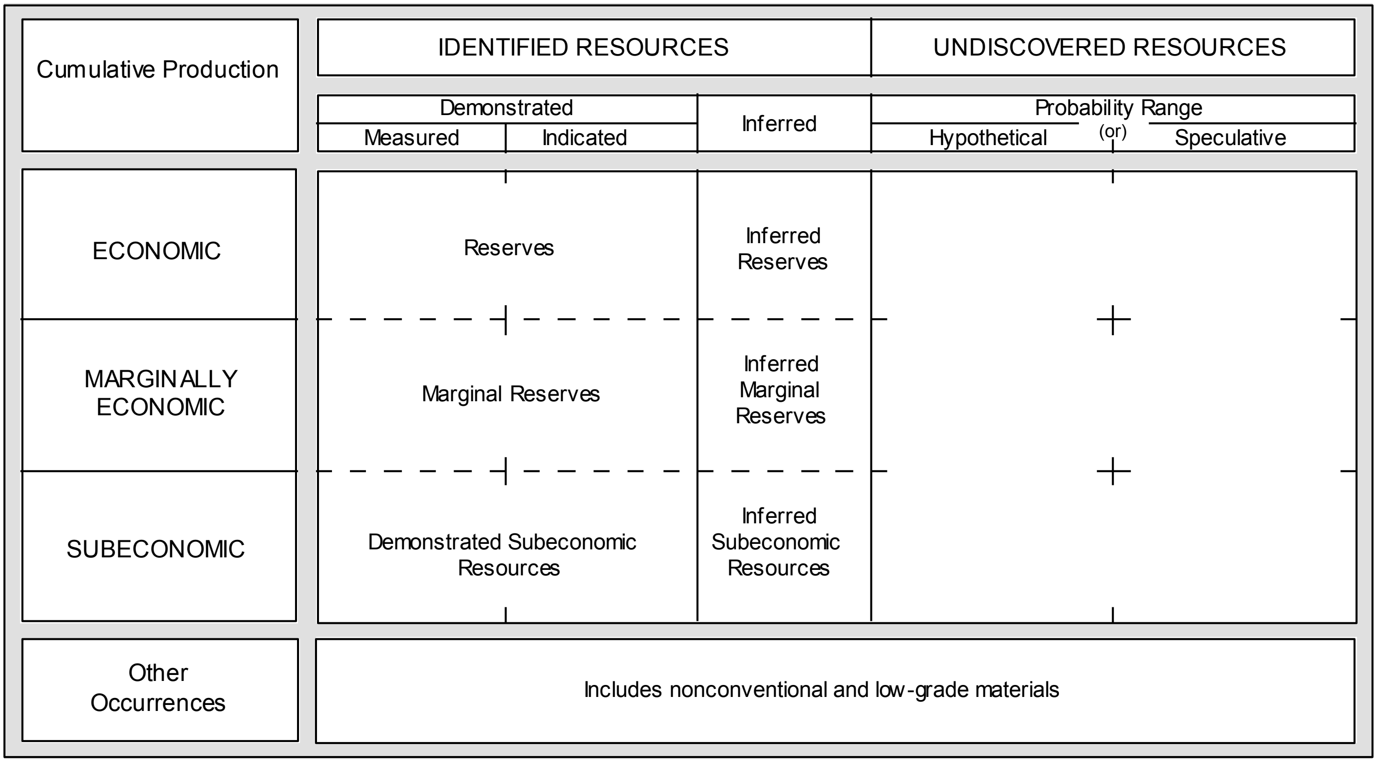
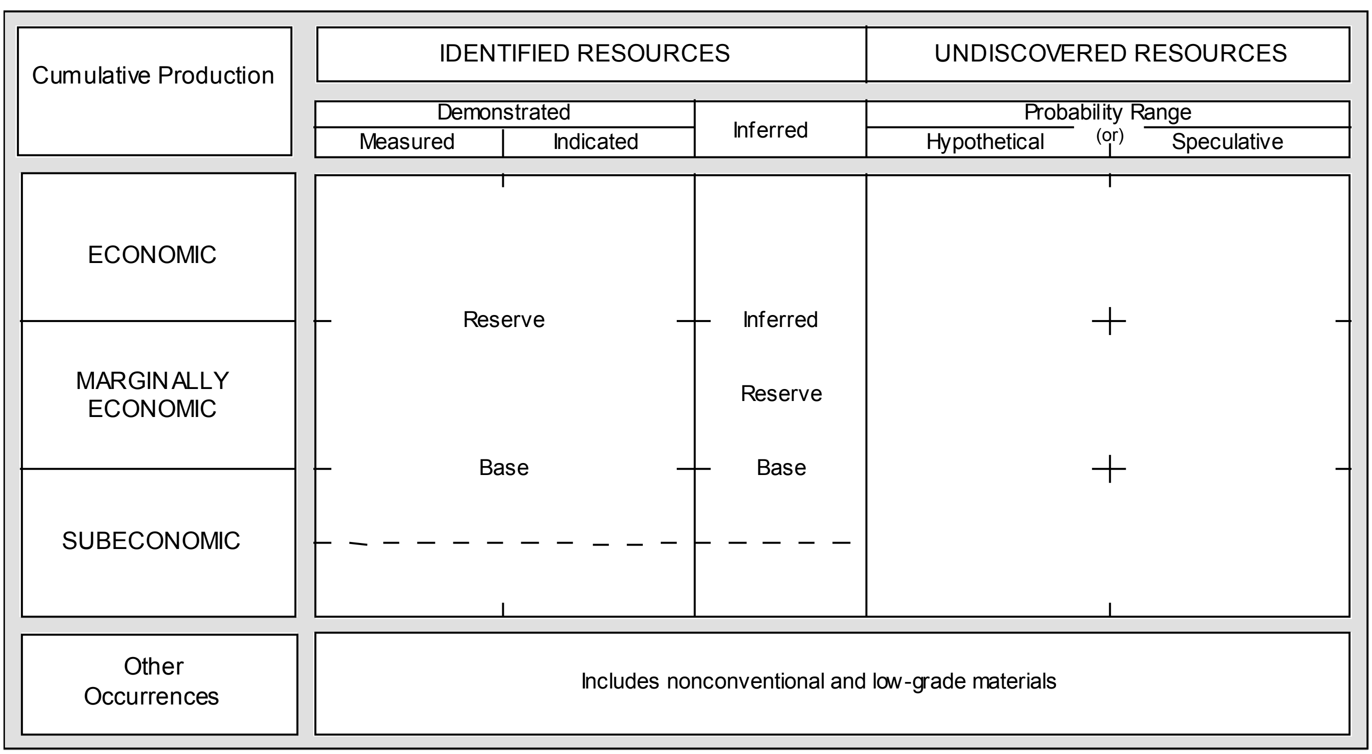


FIGURE 2.—*Reserve Base* and *Inferred Reserve Base* Classification Categories



Part B—Sources of Reserve 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 2014 are Accessible EDR. For more information, see Australia's Identified Mineral Resources 2012 (http://www.ga.gov.au/minerals/mineral-resources/aimr/table-1.html).

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	Yadira Soto-Viruet
Armenia[1]	Elena Safirova
Austria[2]	Steven D. Textoris
Azerbaijan[1]	Elena Safirova

Europe and Central Eurasia—continued

Belarus[1]	Elena Safirova
Belgium[2]	Alberto A. Perez
Bosnia and Herzegovina	Yadira Soto-Viruet
Bulgaria[2]	Yadira Soto-Viruet
Croatia[2]	Harold R. Newman
Cyprus[2]	Harold R. Newman
Czech Republic[2]	Steven D. Textoris
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 D. Textoris
Greece[2]	Harold R. Newman
Hungary[2]	Steven D. Textoris
Iceland	Harold R. Newman
Ireland[2]	Alberto A. Perez
Italy[2]	Alberto A. Perez
Kazakhstan[1]	Elena Safirova
Kosovo	Yadira Soto-Viruet
Kyrgyzstan[1]	Elena Safirova
Latvia[2]	Alberto A. Perez
Lithuania[2]	Alberto A. Perez
Luxembourg[2]	Alberto A. Perez
Macedonia	Yadira Soto-Viruet
Malta[2]	Harold R. Newman
Moldova[1]	Elena Safirova
Montenegro	Harold R. Newman
Netherlands[2]	Alberto A. Perez
Norway	Harold R. Newman
Poland[2]	Yadira Soto-Viruet
Portugal[2]	Alfredo C. Gurmendi
Romania[2]	Alberto A. Perez
Russia[1]	Elena Safirova
Serbia	Yadira Soto-Viruet
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]	Elena Safirova
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
Bolivia	Steven D. Textoris
Brazil	Alfredo C. Gurmendi
Chile	Steven D. Textoris
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.
[2]Member of European Union.

Country specialist	Telephone	E-mail
Omayra Bermúdez-Lugo	(703) 648–4946	obermude@usgs.gov
Yolanda Fong-Sam	(703) 648–7756	yfong-sam@usgs.gov
Alfredo C. Gurmendi	(703) 648–7745	agurmend@usgs.gov
Chin S. Kuo	(703) 648–7748	ckuo@usgs.gov
Philip M. Mobbs	(703) 648–7740	pmobbs@usgs.gov
Harold R. Newman	(703) 648–7742	hnewman@usgs.gov
Alberto A. Perez	(703) 648–7749	aperez@usgs.gov
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